Higher Secondary Course

HOME SCIENCE

Class XII

Government of Kerala
Department of Education

State Council of Educational Research and Training (SCERT),

KERALA
2015

THE NATIONAL ANTHEM

Jana-gana-mana adhinayaka, jaya he
Bharatha-bhagya-vidhata.
Punjab-Sindh-Gujarat-Maratha
Dravida-Utkala-Banga
Vindhya-Himachala-Yamuna-Ganga
Uchchala-Jaladhi-taranga
Tava subha name jage,
Tava subha asisa mage,
Gahe tava jaya gatha.
Jana-gana-mangala-dayaka jaya he
Bharatha-bhagya-vidhata.
Jaya he, jaya he, jaya he,
Jaya jaya jaya, jaya he!

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

Prepared by :
State Council of Educational Research and Training (SCERT)
Poojappura, Thiruvananthapuram - 695012, Kerala.
Website : www.scertkerala.gov.in *e-mail* : scertkerala@gmail.com
Phone : 0471 - 2341883, Fax : 0471 - 2341869
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Dear Students,

It gives immense pleasure to introduce the Textbook of Home Science for Class XII. The new textbook pertains to three areas of Home science namely Food and Nutrition, Fibre Science and Extension Education, which are presented in twelve chapters.

Food and Nutrition is perhaps one of the most relevant areas of study in Home Science. Learning about healthy nutritional practices has several positive implications for a student's physical well being. Studies have shown that food habits learned at an early age are hard to influence and change. Possessing knowledge about food and its nutritional content is valuable at any age, as people continue to make eating choices throughout the course of their lifetime. The first five chapters of this book are devoted to the basic concepts of nutrition.

Perhaps, one of the most enjoyable parts in Home Science Education is the ability of the students to understand the basics of Fibre Science. The remaining five chapters are dedicated for Fibre Science, which gives an overview of the properties of various fibres, yarns, different aspects of fabric construction and dyeing and printing.

Extension Education, which is one of the core arenas of Home Science teaching, is introduced this year, in order to develop valuable intra personal communication skill as well as to imbibe in students a flair for community development and social work. This is the only branch of Home Science, which interacts with all the other areas of the discipline. It extends and translates the knowledge gained from other areas into action for the well being of the community and society at large. The last two chapters are resolute for upbringing the scope and importance of extension work and for the importance of communication skill in carrying out community development activities.

I look forward that, this text book may enhance the status of Home Science to a 'responsible science' that is put into practice to ensure the future of a civilized society. State Council of Educational Research and Training appreciates the sheer dedication and enthusiasm of the Textbook Development Committee in upbringing this book.

As an organization committed to systematic reform and continuous improvement in the quality of its products, SCERT welcomes comments and suggestions for further revision and refinement.

Dr. S. Raveendran Nair

Director,

SCERT, Kerala.

Textbook Development Team

Dr. Elizabeth Varghese

Asst. Professor, Department of Home Science, Govt. College for Women, Thiruvananthapuram.

Dr. Mini Joseph

Asst. Professor, Department of Home Science, Govt. College for Women, Thiruvananthapuram.

Dr. Nisha Sheen

Asst. Professor, Department of Home Science, Govt. College for Women, Thiruvananthapuram.

Pratheetha Pradyoth.R.S
HSST, BNVV & HSS
Thiruvallam, Thiruvananthapuram

Preethi George
HSST, GGHS, Piravam, Ernakulam

Dr. Sajan. K.S.
Asst.Professor, NSS Training College, Ottapalam, Palakkad

Dr. Sithara Balan. V

Asst. Professor, Department of Home Science,
Govt. College for Women,
Thiruvananthapuram.

Thanuja.N
HSST, Govt.Tamil HSS, Chalai, Thiruvananthapuaram

Experts

Dr. Raheena Beegum
Professor and Head (Rtd.),
Govt. College for Women,
Thiruvananthapauram

Dr. Sheeja. P.R
Asst. Professor, Department of Home Science, HHMSPB NSS College for women, Neeramankara, Thiruvananthapuram

Dr. Sushil Kumar.R
Associate Professor in English,
D. B. College, Sasthamkotta,
Kollam

Smt. Moncey Abraham
Reader (Rtd.) in English,
University College,
Thiruvananthapuram

Artist

Bimal kumar.S, Art Teacher, Govt. Model HSS for Boys, Kollam

Academic Co-ordinator

Dr. Sobha Jacob
Lecturer, SCERT

Contents

Certain icons are used in this textbook for convenience

Activities

Do you know! (Additional information)

1 Basic Nutrition

Key Concepts

1.1 Nutrition - terms and definitions

1.2 Nutrients - functions, effect of deficiency and sources

1.3 Importance of dietary fibre

Significant Learning Outcomes

After the completion of this chapter, the learner:

- defines health, nutrition, nutrients, malnutrition, optimum nutrition, under nutrition, over nutrition
- classifies nutrients and differentiates their functions and sources.
- describes the effects of deficiency of various nutrients.
- explains the importance of dietary fibre and water.
- develops a positive attitude towards good food and for good health.

Food plays a vital role in maintaining proper health enabling man to live long. It also helps in the prevention and cure of diseases. Good nutritive food gives health while bad or unhealthy food gives rise to several diseases. Our cells, tissues and organs function effectively when we eat nutritious food. Body functions such as metabolic, hormonal, mental, physical or chemical actions cannot be performed by the body without nutritive food. Food provides us good nutrition, which is important for the cure of diseases and in building up the immunity of our body. Let us understand the components of food and its significance in the maintenance of health.

1.1 Nutrition-terms and definitions

Now, try to understand the meaning of certain terms related to food and nutrition.

What do you mean by health?

- .....

The word 'health' means different ideas to different people, depending on the situation. World Health Organisation (WHO) defines health as 'a state of complete physical, mental and social well being and not merely the absence of disease or infirmity'.

A. Dimensions of health

Health is multi dimensional. Although these dimensions are interrelated, each has its own nature. The following are the dimensions of health (Fig 1.1) :

a. **Physical dimension**: Physical dimension implies the concept of 'perfect functioning of the body'. It conceptualizes health biologically as a state in which every cell and every organ is functioning at optimum capacity and in perfect harmony with the rest of the body.

b. **Mental dimension**: Mental health is the ability to respond to the varied experiences of life with flexibility and a sense of purpose. Mental health has been defined as 'a state of balance between the individual and the surrounding world, a state of harmony between oneself and others, co-existence between the realities of the self and the rest of the people and that of the environment'.

c. **Social dimension**: Social well being implies harmony and integration with the individual, between each individual and other member of the society and between the individual and the world in which he/she lives. It has been defined as 'the quantity and quality of an individual's interpersonalties and the extent of involvement with the community.'

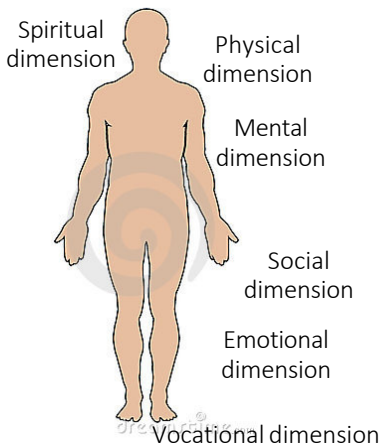


Fig. 1.1 Dimensions of health

d. **Spiritual dimension:** Spiritual health refers to that aspect of the individual which reaches out and strives for meaning and purpose in life. It is the intangible 'something' that transcends physiology and psychology.

Do you know!

The English word **"health"** comes from the Old English word hale, meaning "wholeness, being whole, sound or well".

e. **Emotional dimension:** Emotional health refers to feelings. This dimension reflects emotional aspects of humanness.

f. **Vocational dimension:** Work often plays a role in promoting both physical and mental health. Physical work is usually associated with an improvement in physical capacity, while goal achievement and self realization in work are sources of contentment and enhancement of self esteem. To maintain health in good condition we need good food.

B. Food

Food is that which nourishes the body. Food may also be defined as 'anything eaten or drunk, which meets the need for energy, body building, regulation, and protection of the body.' In short, food is the raw material by which our bodies are made. Food provides nutrition for our body.

C. Nutrition

Can you define nutrition?

- .....

Nutrition is defined as food at work in the body. Nutrition includes everything that happens to food from the time it is taken in until it is used for various functions in the body. In simple terms nutrition is defined as the fate of food in our body. In a broader sense nutrition is defined as the combination of processes by which the living organism receives food, digests, absorbs and utilizes its contents for growth, maintenance and repair of the body. So this includes a balanced amount of all the varieties of nutrients.

D. Optimum nutrition

When all essential substances (nutrients) are present in the correct proportion, as required by our body, the person is said to be at optimum nutrition. Optimum nutrition provides health, happiness, efficiency and longevity. The signs of optimum nutrition are:

- Height for age
- Weight for height and age
- Clear complexion
- Fresh and lively skin
- Healthy hair
- Healthy pink nails
- Correct posture
- Correct gait
- Inquisitive and alert eyes
- Good appetite
- Proper bowel evacuation
- Emotional maturity
- Self confidence
- Pleasing personality
- Optimism in life and overall health

If this optimal nutrition is not achieved it will lead to ill health.

E. Malnutrition

Malnutrition means an undesirable kind of nutrition leading to ill-health. Malnutrition results from a lack, excess or imbalance of nutrients in the diet. It includes under-nutrition and over-nutrition. Under-nutrition is the state of an insufficient supply of essential nutrients. Over-nutrition refers to an excessive intake of one or more nutrients which creates a stress in the bodily function.

Try to find out some diseases caused by malnutrition.

Know your progress

Define the following.

a. Health
b. Nutrition
c. Optimum nutrition
d. Under nutrition
e. Over nutrition

1.2 Nutrients - Importance, Sources and Deficiency States

Nutrients are components of food that are needed by the body in adequate amounts in order to grow, reproduce and lead a normal healthy life.

Nutrients are defined as the constituents of food which help us to perform the functions of the body.

There are two basic groups of nutrients that the body needs to function. They are macronutrients and micronutrients. Some nutrients are required in relatively large amounts; hence they are called macronutrients, and some nutrients are required in small amounts; hence they are called micronutrients. Each of these types has very important and specific functions. Carbohydrates, proteins and fats are macronutrients and vitamins and minerals are micro nutrients. Nutrient composition in human body is tabulated in Table 1.1.

Nutrients	Man (%)	Women (%)
Water	60-62%	54
Proteins	17	15
Fats	14	25
Minerals	6	5
Carbohydrates	1	1
Vitamins	Negligible amounts	Negligible amounts

Table 1.1 *Nutrient composition of human body*

Analyse Table 1.1 and try to answer why carbohydrates (a macronutrient) not much found in human body.

For this, let us examine the significance of these nutrients namely carbohydrates, proteins, lipids, minerals, vitamins and water.

A. Carbohydrates

Carbohydrates are the main component of our food! Can you say why?

- .....

Carbohydrates occur abundantly in nature. Plants manufacture carbohydrates through a process called photosynthesis. Carbohydrates form the principal constituent of most of the normal diets. It is the most important energy source. Carbohydrates are mainly present in plant food with few exceptions like glycogen in muscles, lactose in milk and ribose in animal cells.

Carbohydrates are simple sugars or a compound formed by the combination of two or more simple sugars. There are many carbohydrates all of which are compounds of hydrogen, oxygen and carbon but only a few of these are important.

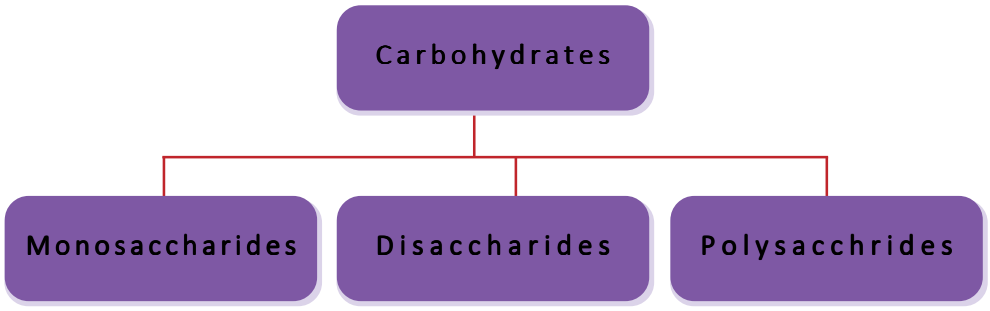
a. Classification of carbohydrates

Carbohydrates are chemically known as saccharides. Carbon, hydrogen and oxygen form a saccharide group. The ratio of carbon, hydrogen and oxygen is 1:2:1.

Do you know!

The Greek word 'Saccharon' means 'sugar'. Hence they are called saccharides.

Carbohydrates are classified based on the number of saccharide groups in them. They are monosaccharides, disaccharides and polysaccharides.



i. Monosaccharides

If a person suddenly faints and is hospitalised, glucose solution is injected into his blood. Why?

- .....

Monosaccharides are the simplest forms of carbohydrates which cannot be hydrolysed to simpler compounds. All carbohydrates should be reduced to this form for absorption and utilization. The monosaccharides of nutritional importance are glucose, fructose and galactose.

Glucose is also called dextrose or grape sugar. It is the carbohydrate currency of the body. Glucose can easily be digested and absorbed. Sweet fruits contain glucose. Vegetables like sweet corn, carrots, onion etc. and honey also contain glucose.

A normal healthy person has 80-100 mg of glucose in 100 ml of blood.

What will happen, if the glucose level increases in our body? Note down your inference.

- .....

Fructose is also called levulose or fruit sugar. It is sweeter than glucose. Fructose is readily absorbed by the body. It is found in honey and ripe fruits.

Galactose, another monosaccharide is not present freely in nature but is widely distributed in the combined state. Lactose, the sugar present in milk, is a compound of glucose and galactose.

ii. Disaccharides

Disaccahrides are formed by combination of two monosaccharides with the elimination of one molecule of water. They split into simple sugars by acid hydrolysis or digestive enzymes to be absorbed in the body.

The disaccharides of nutritional importance are sucrose, maltose and lactose.

Sucrose is also known as invert sugar. This is manufactured in large scale from sugar cane or beetroot. Many fruits and vegetables contain small amounts of sucrose. This is the common form of sugar in our diet.

Sucrose = glucose + fructose with the elimination of one molecule of water

Maltose is a sugar formed in cereal grains during germination. It is also known as malt sugar.

Maltose= 2 molecules of glucose with the elimination of one molecule of water.

Lactose is also known as milk sugar as it is found in the milk of mammals. Lactose can be added to the diet to increase the calorie content.

Lactose= glucose + galactose with the elimination of one molecule of water

iii. Polysaccharides

Polysaccharides are made up of many units of monosaccharides. The majority are insoluble or only slightly soluble in water. Some of the nutritionally important polysaccharides are starch, dextrines, glycogen and dietary fibres.

Starch is found in the plant kingdom. Starch is composed of several hundreds of glucose units linked together into a complex structure. The important sources of starch are cereals, millets and roots and tubers.

Dextrines are a group of substances formed during the breakdown of starch to maltose during the process of digestion in human body or in the germination of seeds or during some of the processes in cooking.

Glycogen is a reserve carbohydrate found in liver (3-7%) and muscles (0.3-1%) of animals and man. It is sometimes called animal starch. It must be converted back into glucose to be used by the body. Glycogen is formed by the condensation of large number of glucose molecules.

Dietary fibres are polysaccharides like cellulose, hemicelluloses, pectin, gums, mucilages and algal substances and lignins.

Cellulose is a polysaccharide made up of glucose which is an insoluble indigestible form of carbohydrate. But it provides bulk to the diet and helps in bowel movements.

Hemicellulose is found in bran, cereals, whole grain cereals and vegetables.

Pectin is a polysaccharide with no nutritional significance. But it is useful in the preparation of jam and jellies. Apples and citrus fruits are the important sources of pectin.

Gums are found in oatmeal, dried beans, and legumes.

Muscilages and algal substances are also found in food product thickeners and stabilizers.

Lignins are found in whole wheat, peach, pear, plum and mature vegetables. Fibre in food serves as a laxative by holding water and increasing the bulk of faeces, binds bile acids and cholesterol.

Prepare an organisation chart based on the details of polysaccharides given above.

b. Functions of carbohydrates

1. The most important function of carbohydrate is to supply energy for the body. 1 gm of carbohydrate provides 4.3 K Cals of energy.
2. Carbohydrates have a protective and detoxifying action on the liver. Toxic substances produced by bacterial action are removed from the liver by glycogen.
3. Carbohydrate is used by the heart for muscular activities. Glycogen stored in the heart muscle is used for this purpose especially in an emergency.
4. A continuous supply of glucose is essential for nervous tissues to function normally.
5. Protein is another important nutrient in our body with special functions. If enough carbohydrate is not present in the diet, then protein is used for energy purposes. This function of carbohydrate to spare protein for energy purposes, is known as protein sparing action.
6. Carbohydrate is used by the body in the synthesis of non-essential amino acids.
7. Carbohydrate is essential for the oxidation of fat. Excess carbohydrate is converted to fat.
8. Carbohydrate provides flavour and variety to the diet. It also retains water content in the colon. Cellulose adds bulk to the diet.

c. Sources

Important sources of carbohydrates are cereals and millets, sugar and jaggery, roots and tubers, pulses and dried fruits.

List the food containing carbohydrate included in your daily diet.

B. Proteins

Which nutrient is needed for our growth?

- .....

Do you know!

The term protein is derived from the Greek word 'Proteos' meaning "to take the first place".

Proteins play a significant role in all activities of living organisms. It is present everywhere in our body. Proteins are present in our skin, hair, nails, muscles, skeletons, cells and in body fluids.

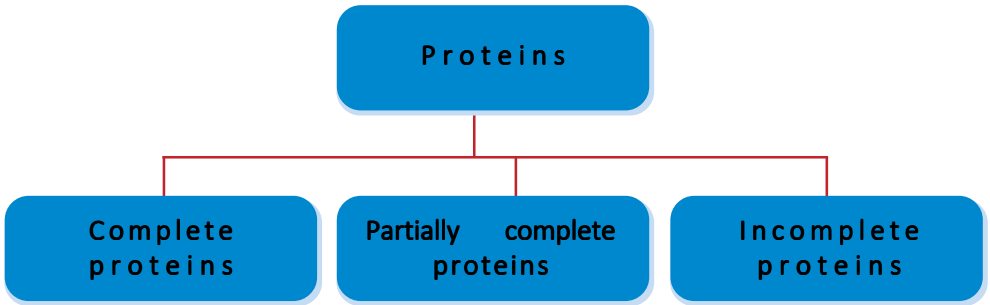
Proteins are made up of units that are amino acids, in various proportions and arrangements. They include carbon, hydrogen, oxygen, nitrogen and sulphur. The presence of nitrogen makes protein different from carbohydrates and fats.

There are twenty amino acids in proteins. They are grouped into essential amino acids and non essential amino acids based on their biological importance. Nine of the amino acids are termed as essential amino acids as they have to be supplied through food every day. Eleven of the amino acids are known as non-essential amino acids as they can be synthesized by the body itself.

The essential amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine threonine, tryptophan and valine. Non-essential amino acids are alanine, arginine, aspargine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine and tyrosine. Arginine is essential for growing children and patients recovering from injury or surgery.

a. Classification of proteins

Based on the proportion of amino acids, proteins are classified into complete proteins, partially complete proteins and incomplete proteins.



i. A complete protein (first class protein/ high biological value) has a good proportion of essential amino acids to promote the normal growth rate and to maintain the body. eg. proteins in milk, fish, egg etc.

Do you know!

Biological value of protein is the extent to which food protein can be used to replace tissue protein.

ii. Partially complete protein (proteins of lower biological value) lacks sufficient amount of some essential amino acids. These proteins can maintain life. eg. plant proteins like dhal and cereals.

iii. Incomplete proteins completely lack one or more essential amino acids and cannot even maintain life eg. gelatin and zein of corn.

b. Functions of proteins

- Proteins are the building blocks of our body. The most important function of protein is to supply amino acids to the cells for the continuous replacement throughout life.
- Protein with iron forms haemoglobin in the blood. Haemoglobin carries oxygen to the tissues and eliminates carbon dioxide from tissues.
- Plasma proteins like globulin and albumin regulates osmotic pressure and water balance in the body.
- Proteins supply raw materials to the body for the synthesis of enzymes like pepsin and trypsin.
- Hormones like insulin and thyroxine are protein in nature. Digestive juices and antibodies are protein in nature.
- When the diet is insufficient in carbohydrates and fats for fuel, proteins are used to give energy for the body.
- Proteins provide 5.56 KCal of energy.
- Actin and myosin are contractile proteins of muscle.

c. Sources

Milk, meat, fish, poultry and eggs are the best sources of proteins. Cereal grains and pulses are known as second class proteins. Pulses are known as 'poorman's meat'. All essential amino acids are not present in either cereals or pulses. But mutual supplementation of cereals and pulses rectify this limitation.

Lysine, an essential amino acid, is seen less in cereals. But lysine is seen more in pulses. Pulses are poor in methionine, an essential amino acid. Rice is rich in methionine. Thus cereals and pulses or cereals with little animal food can mutually supplement to the growth of the body.

Identify protein rich food through market survey.

Effects of the deficiency of carbohydrates and proteins

Read the news given below.

What are the causes of this condition?

- .....

PALAKKAD:In the last 15 months, as many as 29 children died of malnutrition, 13 of them this year. Two more deaths were reported from the area over the past two days. The number might be higher, for all deaths are not from the Kurumba tribal hamlets in the remote forest areas of Anavai, Edavani, etc., too are getting reported. Four tribal children and a woman have died of malnutrition in the Attappady hills during the past month, and two children are undergoing treatment for the condition.

The lack of the above said two macronutrients namely carbohydrates and proteins together is responsible for the deficiency disease namely Protein Energy Malnutrition (PEM) , which is discussed below.

The term Protein Energy Malnutrition covers a wide spectrum of clinical stages ranging from the severe forms like kwashiorkor and marasmus to the milder forms in which the main detectable manifestation is growth retardation. Protein Energy Malnutrition is due to the 'food gap' between the intake and the requirement.

There are 3 clinical forms of acute protein energy malnutrition.

1. Kwashiorkor
2. Marasmus
3. Marasmic-kwashiorkor

Do you know!

The term kwashiorkor was first introduced by Cicely Williams in 1935. This is a local name used by the Ga Tribe in Accra, West Africa and means ' disease of the displaced child'.

a. Kwashiorkor

Kwashiorkor is one of the serious forms of PEM. It is seen most frequently in children of one to three years of age, but it may occur at any age. It is found in children who have a diet that is usually insufficient in energy and protein and often in other nutrients.

Observe Figure 1.2 and identify the signs and symptoms of kwashiorkor.

Fig. 1.2 - Kwashiorkor

The signs and symptoms of kwashiorkor are:

- Low body weight inspite of oedema showing growth failure and some degree of muscle wasting which is masked by oedema
- Oedema appears first on the feet and legs and later spreads to the whole body. The face looks puffy with sagging cheeks and swollen eyelids. Puffiness of oedema is known as moon face
- Mental changes like apathy and irritability are common
- Mental development is affected
- Scaly pigmentation of the skin
- The hair becomes thin, dry and brownish or reddish
- Anorexia is common in making it difficult to feed the child
- Diarrhoea may occur due to defective digestion and absorption.
- Vitamin A and B complex deficiencies are observed.

b. Marasmus

Marasmus, another severe form of PEM, is now much more prevalent than kwashiorkor. It may occur at any age, most commonly up to about three and a half years, but in contrast to kwashiorkor it is more common during the

first year of life. Nutritional marasmus is in fact a form of starvation, and the possible underlying causes are numerous. For various reasons, the child does not get adequate supplies of breast milk or any alternative food.

Fig 1.3 Marasmus

Observe the child with marasmus (Fig 1.3) and identify its signs and symptoms.

Signs and symptoms of marasmus are the following:

- Severe growth retardation
- Loss of subcutaneous fat
- Severe muscle wasting
- The child looks appallingly thin and limbs appear as skin and bones
- Shrivelled body
- Wrinkled skin
- Bony prominence
- Associated vitamin deficiencies
- Failure to thrive
- Irritability, fretfulness and apathy
- Frequent watery diarrhoea and acid stools
- Mostly hungry but some are anorectic
- Dehydration
- Sub normal temperature
- Weak muscles
- Oedema and fatty infiltration are infrequent.

c. Marasmic-kwashiorkor

Marasmic-kwashiorkor is a mixed form of both marasmus and kwashiorkor and is characterized by the presence of both wasting and oedema. Both Kwashiorkor and Marasmic-kwashiorkor are very serious conditions and are classified as forms of severe acute malnutrition.

C. Lipids

Lipids include fats, oils and other fat like substances. They are composed of fatty acids and glycerol. In lipids carbon, hydrogen and oxygen are present. Compared to carbohydrates fats have a very lower proportion of oxygen.

- What are the oils /lipids that we use in our kitchen?
- .....

Fatty acids are classified as saturated or unsaturated depending on the number of hydrogen atoms attached to each carbon atom. In the case of saturated fatty acids each carbon atom has two hydrogen atoms attached to it, other than two carbon atoms attached eg. coconut oil and animal fat. In unsaturated fatty acids one hydrogen atom is missing from each of the two adjoining carbon atoms due to which a double bond is formed between the two carbon atoms. They are liquids at room temperature.

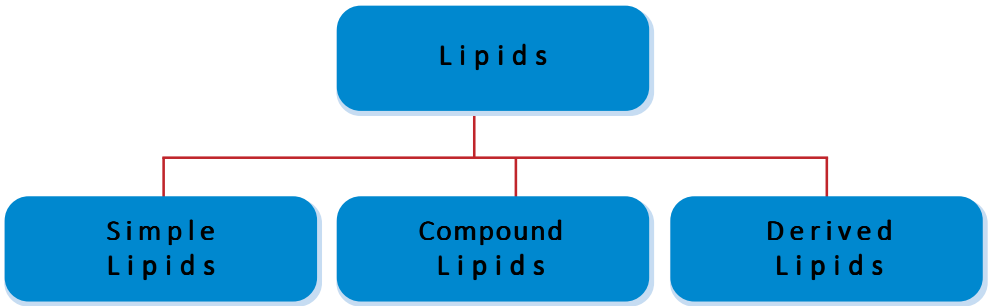
Fat is the common household name given to lipids. Lipids that are solid at room temperature are called fats and those that are liquid are called oils.

Fat is present naturally in many food. This fat can be visible or invisible. Food like meat, poultry, fish and dairy products, eggs, nuts and oil seeds are rich in invisible fat. Lard, vegetable oils, butter, ghee and margarine are examples of visible fats.

Essential fatty acids

These are fatty acids which are nutritionally very important, essatial for life and are to be supplied through our diet. These cannot be synthesized in our body.

a. Classification of lipids



Based on chemical composition, lipids are classified into simple lipids, compound lipids and derived lipids.

i. Simple lipids are esters of glycerol and fatty acids eg. oils and fats.

ii. Compound lipids are the esters of glycerol and fatty acids with substitution of other compounds such as carbohydrate, phosphoric acids etc. eg. glycolipids, phospholipids, lipoproteins.

iii. Derived lipids are the substances derived from simple and compound lipids by hydrolysis eg. cholesterol

b. Functions of lipids

- Fat is high in calorie (energy) content. One gram of fat supplies 9.3 K cals
- Fats are the carriers of fat soluble vitamins like vitamin A, D, E and K.
- Fats have a protein sparing action
- Fats contain essential fatty acids which help to form components of cell membranes and tissues
- Adipose tissue where fat is stored serves as an insulation material. Adipose tissue protects the vital organs too
- In the growing stage fat promotes growth. It also enables proper sexual maturity
- Fats are slow in digestion and thus retards digestion
- Fats provide flavour and palatability to food. Food prepared in fat enhances satiety.

c. Sources

Most of the fats used in the preparation of food are 100% visible fat. Food of animal origin like meat, fish, milk, butter, cheese, eggs and fish liver oils contain varying amounts of fat. Food of plant origin with the exception of nuts contains very little fat.

Effects of deficiency

- Deficiency of fat in diet leads to the deficiency of essential fatty acids resulting in cessation of growth
- It also results in flaky skin, development of itchy sores on the scalp

- The common disorder in adults and children in India is phrynoderma or toad skin.

An article taken from a leading daily is given below . Identify the problems caused by the excessive use of oils and fats.

KILLER FAT

The major cause of high cholesterol is eating items rich in fat, especially saturated fat. High cholesterol is a major risk factor for heart disease. It isn't something which should cause concern only to overweight, middle-aged people. It's something we should all be aware of. Heart disease is the biggest killer, and cholesterol is a major risk factor. Levels of artery clogging often rise with age, and cardiologists say that everyone age of 20 or older should be screened for high cholesterol, at least once every five years, with more frequent screening for anyone deemed to be at a high risk for heart disease.

D. Minerals

Minerals are inorganic substances. The mineral element found in the body forms only 4 to 6 percent of the weight of adult body. This means that about 2 to 3 kgs of our body weight consists of minerals. Of this 90 percent is accounted by seven minerals. They are calcium, phosphorous, sodium, sulphur, potassium, chlorine and magnesium. These minerals are required over 100 mgs/ day. They are called major mineral elements. Iron, molybdenum, zinc, selenium, fluorine, copper, manganese, iodine, cobalt and chromium are known as trace mineral elements, as these add together to about 10 percent of the total mineral content of the body and these minerals are required less than 100 mgs/day. However, the deficiency of only few of these elements is observed in humans. Iron and Iodine deficiencies are widespread while the deficiency of Cu, Zn, Cr and Se has been reported only in recent years.

The largest concentration of minerals is found in the bones and teeth as calcium and phosphorous are deposited on them. Minerals are also found in soft tissues such as nerves and muscles and in blood and other body fluids. Iron is found in blood as part of the red pigment, haemoglobin.

Minerals occur in food as salts and also in combination with organic substances.

The minerals which are significant in maintaining our health are discussed here.

a. Calcium

Calcium tablets are sometimes prescribed for patients on teeth treatment. Why?

- .....

Calcium is the most abundant mineral element in the body. Bones and teeth contain about 99 percent of calcium in the body. The remaining one percent of calcium is present in the soft tissue and blood and is responsible for many regulatory functions.

i. Functions of calcium

- It is involved in normal muscle contraction, including the heartbeat
- Coagulation of blood takes place only in the presence of calcium
- It is essential for the normal nerve impulse transmission
- Maintains permeability of cell membranes to permit the movement of materials in and out of the cells
- Ensures the absorption of vitamin B_{12}
- It activates the action of enzymes
- It reduces LDL cholesterol in blood.

ii. Sources

Milk and milk products are the best sources of calcium. Ragi is the cheapest source of calcium. So it is known as "poor man's milk". Sesame seeds and vegetables, small fishes consumed along with its bones, dried fruits, beans, peas and molasses are good sources of calcium.

iii.Effects of deficiency

The deficiency of calcium leads to the following conditions:

- **Osteoporosis:** Osteoporosis is a condition found primarily among middle aged and elderly woman, where the bone mass of the skeleton is diminished.

- **Osteomalacia:** Osteomalacia is a condition in which the quality, but not the quantity, of bone is reduced.
- **Tetany:** Tetany occurs when calcium in the blood drops below the critical level.

b. Iron

Though the amount of iron in the body is only about 2 to 3 grams, its presence is very important. 90% of the iron is found in the red blood cells as the haem portion of haemoglobin. Another 5% of the total body iron is part of the muscle component –myoglobin. The remaining 5% of the total body iron is distributed throughout the cells as a major component of oxidative enzyme systems. About 20% of the total iron is stored as ferritin. It is an intracellular protein that stores iron and releases it in a controlled fashion. Iron is stored in the spleen, bone marrow and liver in the form of ferritin. Men have higher stores of ferritin than women.

i. Functions of iron

- It has specific regulatory function
- It is present in the nucleus of cells. It is very necessary for the oxidation in the tissues
- It is an essential constituent of haemoglobin which is responsible for carrying oxygen.

ii. Sources

Liver, kidney, heart, lean meat, egg yolk and shell fish are the best sources of iron. Dried beans, legumes, dried fruit, nuts, and green leafy vegetables, whole cereals and enriched grains also contain iron.

iii. Effects of deficiency

State any disease caused by the deficiency of iron.

- .....

Dietary iron deficiency leads to nutritional anaemia. Anaemia occurs when the haemoglobin level falls below 12 gm /dl in adult man and woman. The normal haemoglobin level in male is 13.8 to 17.2 gm/dl and female is 12.1 to 15.1 gm/dl (decilitre). Haemoglobin is the pigment in red blood cells that gives red colour to blood. It is made of protein with iron linked to it.

Haemoglobin carries oxygen in the blood to all parts of the body. In anaemia either the amount of haemoglobin in each red blood cell is low (hypo-chromic anaemia) or there is a reduction in the total number of red cells in the body.

b. Iodine

Iodine is present in very minute quantity in our body, about 25-30 mg. Of this, about 33 percent of iodine is present in the thyroid gland.

i. Functions of iodine

- Thyroxin is the hormone produced by the thyroid gland. Iodine combines with a binding protein and forms thyroxin. Thyroxin plays an important role in carbohydrate metabolism.
- During the growing period thyroxin is essential for the normal skeletal and physical development.
- Iodine helps tissues in oxygen consumption

.ii. Sources

Iodine is present in minute quantities in all food. The iodine content of food depends on the iodine content of the soil. The soil of mountain regions are usually iodine poor. Sea food, common salt and vegetables are good sources of iodine. Cereals and pulses are poor source of iodine. Leafy vegetables and flowers of vegetables are good sources of iodine.

iii. Effects of deficiency

Iodine deficiency is responsible for endemic goitre and cretinism.

When the body does not get enough iodine for its needs, the thyroid gland enlarges to overcome the deficiency and this causes the swelling known as simple or colloid goitre.

In children, severe iodine deficiency may result in serious retardation of growth. This condition is known as cretinism.

c. Zinc

Zinc is primarily an intracellular substance. Its total quantity in the body

is 2.3 gm. The largest store of Zinc is present in the bones. It is a constituent of blood. Zinc is an important element performing a range of functions in the body, as it is a co-factor for a number of enzymes.

i. Functions of zinc

1. It is a constituent of enzymes.
2. It is a constituent of hormone insulin.
3. It plays a major role in the synthesis of DNA and proteins.

ii. Sources

Meat, un milled cereals and legumes are good sources. Fruits and vegetables are poor sources.

Apart from the above said minerals, copper, selenium and fluorine are essential trace elements.

Copper is an essential element for the absorption of iron.

Selenium is an essential element along with vitamin E for maintaining integrity of the liver cells.

Fluorine is required in minimum amounts to prevent dental caries. Its excessive consumption leads to mottling of teeth.

iii. Effects of deficiency

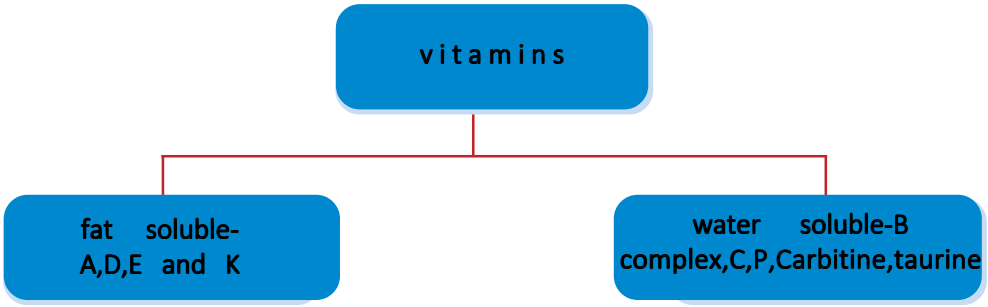
Deficiency of zinc leads to retardation of growth and genital development.

E. Vitamins

Vitamins are a group of potent organic compounds other than carbohydrate, protein and fat, that are necessary in minute amounts. Vitamins are necessary for maintenance, growth and reproduction.

Vitamins are usually classified into two groups on the basis of their solubility, stability, occurrence in food stuffs and distribution in body fluids. They are fat soluble vitamins and water soluble vitamins. About 15 vitamins are isolated in pure state from natural food.

Fat soluble vitamins are soluble in fats and fat solvents. They are insoluble in water. Therefore these vitamins are utilized only if there is enough fat in the body. Vitamin A, D, E and vitamin K are fat soluble vitamins.



Water soluble vitamins are soluble in water and so they cannot be stored in the body. Therefore, a day to day supply of these vitamins is essential. The nutritionally significant fat and water soluble vitamins are discussed below

Do you know!

Vitamin P, more correctly called flavonoids or bioflavonoids, is a class of substances that are used for many different purposes in plants and are important for human health. It is found in a number of food and herbs, ranging from red pepper to tea.

a. Fat soluble vitamins

1. Vitamin A (Retinol)

The first fat soluble vitamin to be recognized was vitamin A. Vitamin A in its pure form is a pale yellow substance soluble in fat which occurs in the food of animal origin.

Vegetable sources of vitamin A are carotenoids. Carotenoids are organic pigments that are found in the chloroplasts and chromoplasts of plants and some other photosynthetic organisms. Fish, animals and humans consume plant carotene which is converted to vitamin A and is stored in the liver.

i. Functions of vitamin A

- It is essential for building cells
- It enables growth of all cells especially of skeletal cells
- It helps normal tooth formation
- It is essential for the normal reproductive function in males

- It plays a major role in maintaining normal vision
- It plays an important role in maintaining the myelin sheath of nervous tissues
- It is also known as anti-infective vitamin, as it provides resistance to infection. Diarrhoea, respiratory tract infections and morbidity are more common among children with severe vitamin A deficiency
- Vitamin A and carotenoids fight against cancer of skin
- Carotenoids with its antioxidant property reduce the risk of heart diseases.

ii. Sources

The best sources of vitamin A are shark, liver of animals like sheep, goat and cow. Egg yolk, milk and milk products are very good sources of vitamin A.

Vegetable sources of vitamin A are leafy vegetables, yellow vegetables like carrot, sweet potato, pumpkin and yellow fruits like papaya and mango.

iii. Effects of deficiency

Vitamin A deficiency is due to low intake of vitamin A in the diet. During infectious diseases vitamin A is lost from the body. The following are the disease conditions related to the deficiency of vitamin A.

- **Night blindness:** Deficiency of vitamin A shows delayed adaptation to darkness on coming from the lighted area. This is because rhodopsin formation is poor. In dim light vision is poor and if neglected it develops into xerophthalmia. During this condition the conjunctiva becomes dry and lustreless. The transparent appearance of the eye and its opacity is lost. The eye becomes grey and opaque. If this condition persists eye becomes infected and ulcerated. It leads to blindness. Advanced softening of cornea results in its degeneration and develops to Keratomalacia.

- **Bitots Spots:** Grey coloured spots in triangular shapes are located in the conjunctiva during vitamin A deficiency. This is called Bitot's spots.

- **Phrynoderma:** In vitamin A deficiency, the skin becomes rough due to the damage of epithelial cells. This condition is known as follicular keratosis or toad skin or phrynoderma.

2. Vitamin D

Vitamin D is otherwise known as 'Sunshine vitamin'. Vitamin D is a group of sterol compounds. Vitamin D itself is an inactive form. It is stored in the liver.

i. Functions of vitamin D

- It promotes the absorption of calcium and phosphorus from the small intestine
- It also helps the deposit of calcium phosphate in the bone
- It increases renal excretion of phosphate
- It promotes mineralization of bones.

Vitamin D also reduces the risk of breast cancer, colon cancer, bone and skin cancer and prostate cancer.

ii. Sources

Sun light is the natural source of vitamin D. Fish liver oils, egg yolk, milk, butter and ghee are the best sources of vitamin D. Fishes like sardines and salmons are the best sources of vitamin D. Fortified items are also available in the market.

iii. Effects of deficiency of vitamin D

Deficiency of vitamin D leads to inadequate absorption of calcium and phosphorous from the intestinal tract which ultimately results in faulty mineralization of bones and tooth. Deficiency of vitamin D causes rickets, delayed and malformed teeth in children, osteomalacia in adults and osteoporosis in old age. These disease condition can also occur due to deficiency of calcium too.

- **Rickets**: It occurs in children**.** It is characterised by bone deformities (fig 1.4)
- **Osteomalacia:** Osteomalacia literally means bone softening. Osteomalacia is the adult counterpart of rickets.

Figure 1.4 Rickets

3. Vitamin E

Vitamin E is known as antisterility vitamin because it is required for normal reproduction in animals and human beings.

i. Functions of vitamin E

- It prevents the oxidation of beta carotene and vitamin A
- It helps to maintain cell membrane integrity and protect RBC against haemolysis
- It reduces platelet aggregation
- It is essential for the iron metabolism and the maintenance of nervous tissues and immune function
- It is an anti-aging vitamin. Vitamin E prevents accumulation of lipid breakdown.

ii. Sources

Vitamin E is present in high concentration in vegetable oils and in cereal grains. Wheat germ, sunflower seeds, almonds, eggs and butter are good sources. Meat, fruits and vegetables contain small amounts of vitamin E.

iii. Effects of deficiency vitamin E

- Prolonged intake of vitamin E deficient diets produces uncoordinated movements, weakness and sensory disturbances
- It causes haemolytic anaemia in low birth weight infants
- Defective functioning of the retina leads to permanent blindness in premature infants
- It leads to reproductive failure in humans.

4. Vitamin K

Vitamin K is recognized as the anti haemorrhagic factor owing to its vital role in blood clotting mechanism.

i. Functions of vitamin K

Helps in the synthesis of blood clotting proteins.

ii. Sources

Dark green leafy vegetables are good sources of vitamin K. Fruits, tubers, seeds, dairy and meat products contain vitamin K.

iii. Effects of deficiency

Primary deficiency arises in infants resulting in delayed blood clotting and haemorrhage. This is because new born babies have a sterile intestinal

tract which lack in the colonic bacterial colonies that produces vitamin K.

b. Water soluble vitamins

B-complex vitamins [Thiamine (B_1), Riboflavin (B_2), Nicotinic acid or Niacin (B_3), Pyridoxine (B_6), Folic acid, etc.] Ascorbic acid or Vitamin C, Vitamin P (Bioflavonoid), Carbitine and Taurine are water soluble vitamins. Of the above said vitamins those which are nutritionally more significant are discussed here.

I. B complex vitamins

1. Thiamine (B_1)

Thiamine is a white crystalline powder with faint yeast like odour and salty nut like taste. It is readily soluble in water and stable until 120° C in acid medium. It is destroyed in alkaline or neutral medium.

i. Functions of Thiamine (B_1)

- It helps in carbohydrate and protein metabolism
- Daily supply of thiamine is essential for normal nervous function
- Movements in the gastro intestinal tract take place smoothly only in the presence of day to day supply of thiamine
- It is essential for normal heart function
- Thiamine is also called "Morale vitamin" because it helps the transmission of nerve impulses and maintains the stability of nerves.

ii. Sources

Rich sources of thiamine are rice polishing, dried yeast and wheat germs. Whole cereals like grains, wheat, oats etc. and legumes and oilseeds are good sources of thiamine. On milling thiamine is lost from cereals. Milled grain flour and maida are the poor sources of thiamine.

iii. Effects of deficiency

Clinically thiamine deficiency is of three types:

- **Infantile Beriberi:** Infantile beriberi occurs in the first few months of life if the mother has thiamine deficiency. Vomiting, green coloured diarrhoea, oedema, loss of appetite and restlessness are the symptoms.

- **Dry Beriberi**: In dry beriberi, involvement of peripheral nerves of legs and arms is seen. Numbness in the ankles and tenderness in the calf muscles are the symptoms.
- **Wet Beriberi**: Along with the symptoms of dry beri beri, oedema is also seen.

2. Riboflavin (B_2)

Riboflavin was discovered after thiamine. It is less soluble in water than thiamine and more stable to heat, especially in acid solutions. Adding baking powder to B-complex sources destroys riboflavin.

i. Functions of Riboflavin (B_2)

- It is a co-enzyme which takes part in biological oxidation in cells
- It helps cellular growth and cell respiration
- It takes part in carbohydrate and protein metabolism
- It is also essential for the health of skin, mucous membrane etc.
- It is required for good vision as it stimulates optic nerves.

ii. Sources

Fleshy food like liver, egg, skimmed milk powder and other milk products are rich sources of riboflavin. Meat, fish, legumes, whole grain cereals, oilseeds, nuts and leafy vegetables are good sources of riboflavin. Milled cereals, flours, roots and tubers, and other vegetables are fair sources.

iii. Effects of deficiency

Riboflavin deficiency is characterized by

- Soreness and burning of the mouth and tongue
- Lesions at the angles of the mouth called Angular Stomatitis
- The inflammation of the tongue called glossitis
- Dry chapped appearance of the lip with ulcers termed cheilosis
- The skin becomes dry and results in dermatitis
- Photophobia, lacrimation, burning sensation of the eyes and visual fatigue
- Decreased motor co-ordination
- Normocytic anaemia

3. Niacin or Nicotinic acid (B_3)

Niacin or Nicotinamide (amide form) is required by all the cells of our body. Like thiamine and riboflavin, it plays a vital role in the release of energy from carbohydrates, protein, fat and alcohol.

i. Functions of Niacin

- Nicotinic acid is essential for the normal functioning of the skin, intestinal tract and the nervous system.

ii. Sources

Dried yeast, liver, rice polishing, peanut, whole cereals, legumes, meat, and fish, are good sources.

iii. Effects of Deficiency

Deficiency of nicotinic acid causes a disease known as pellagra. It is characterized by three Ds, Dermatitis, Diarrhoea and Dementia.

Do you know!

The word pellagra comes from the terms 'pelle'-skin and 'agra'-rough

- **Dermatitis:** Marked changes occur in the skin especially in the area exposed to sun and friction areas like elbows, surfaces of arms and knees. Lesions are symmetrically distributed, in the affected parts. At first there is reddening, thickening and pigmentation of the skin. Later on, there is exfoliation leading ultimately to the parchment of the skin – butterfly-like appearance.
- **Diarrhoea:** Diarrhoea enhances the deficiency state. There are structural and absorptive defects in the small intestine.
- **Dementia:** There is irritability, depression, poor concentration and loss of memory.

4. Pyridoxine (B_6)

Pyridoxine is unique among B – complex vitamins which functions primarily in protein metabolism.

i. Functions of Pyridoxine (B_6)

- Vitamin B6 in the form of pyridoxal phosphate functions as a co-enzyme in many biological reactions

- It is involved in several biochemical steps for the conversion of the amino acid tryptophan to niacin
- In carbohydrate metabolism it aids in the release of glycogen from liver and muscle.

ii. Sources

Meat, pulses and wheat are rich sources. Other cereals are fair sources of this vitamin.

iii. Effects of deficiency

- Vitamin B_6 deficiency leads to abnormalities in protein metabolism which is manifested as poor growth, convulsions, anaemia, decreased antibody formation and skin lesions
- Severe deficiency leads to microcytic hypochromic anaemia. Symptoms such as weakness, nervousness, irritability, insomnia and difficulty in walking is predominant.

5. Folic Acid

Folic acid was first extracted from dark green leafy vegetables. It forms yellow crystals and is a conjugated substance made up of acids.

i. Functions of folic acid

- It is essential for the maturation of red blood cells.

ii. Sources

Green leafy vegetables, liver, kidney, gingelly seeds, cluster beans etc. are rich sources of folic acid.

iii. Effects of deficiency

Simple folate deficiency results in the bone marrow producing immature cells (megalo-blast cells) and few matured red blood cells. This results in reduced oxygen carrying capacity causing anaemia termed - Megaloblastic anaemia.

Folate deficiency during pregnancy causes neural tube disorders of the foetus.

Folate deficiency impairs the ability of the immune system to fight infection.

II. Vitamin C (Ascorbic Acid)

Ascorbic acid closely resembles glucose in structure. Vitamin C is a white crystalline odourless compound readily soluble in water. It is a strong reducing agent. It is comparatively stable in acidic medium but it is destroyed by the action of heat, oxygen and catalyst like copper.

i. Functions of vitamin C

- It takes part in oxidation and reduction reactions in the tissues
- It is also essential for the formation of collagen present between cells. Bones and muscles are fixed tighter by the collagen activity, like cement
- It is also necessary for the formation of red blood cells
- It also takes place in cholesterol metabolism
- For rapid healing of wounds vitamin C is necessary
- Folic acid is used properly only in the presence of vitamin C
- Vitamin C is a good antioxidant
- It helps in absorption of calcium.

ii. Sources

Citrus fruits like lime, orange, pineapple, mango, papaya, cashew fruit and tomatoes are excellent sources of vitamin C. Amla or the Indian gooseberry is the richest source of vitamin C. Pulses contain very little vitamin C, but if allowed to germinate the vitamin content rapidly increases.

iii. Effects of Deficiency

Prolonged deficiency of ascorbic acid produces a disease condition called ' scurvy' in both infants and adults.

- **Infantile scurvy**

- There is a loss of appetite, failure to gain weight, irritability, defective growth of bones.
- Haemorrhage occurs under the skin. Defective formation of teeth and gums become swollen.

- **Adult Scurvy**
  - General manifestation is fever, susceptibility to infection, and delayed wound healing. Gums become spongy and bleed easily
  - Gums become swollen and ulcerated
  - The blood vessels become fragile and porous due to defective formation of collagen. Joints become swollen and tender
  - Clinical symptoms appear when total body pool of ascorbic acid decreases. Skin becomes rough and dry.

Complete the following table with the help of the information given above.

Name of nutrients	Functions	Effects of deficiency	Sources
Carbohydrate			
Proteins			
Fat			
Calcium			
Iron			
Iodine			
Vitamin A (Retinol)			
Vitamin D			
Vitamin E			
Vitamin K			
Thiamine (B 1)			
Riboflavin (B 2)			
Niacin			
Pyridoxine (B6)			
Vitamin C (Ascorbic acid)			
Folic acid			

Know your progress

1. Define nutrients.
2. Explain the functions of the following nutrients
   a) Carbohydrates
   b) Proteins
   c) Iron
3. List the sources of the following nutrients
   a) Calcium
   b) Iodine
   c) Vitamin A
   d) Thiamine
   e) Vitamin C
4. Expand the term PEM.
5. Write any three symptoms of the following diseases.
   a) Marasmus
   b) Kwashiorkor

F. Water

How many litres of water are we supposed to consume per day?

- .....

Water is the major component of our body. Water is an important nutrient also. Approximately 55-70 percent of the total body weight is made up of water. The percentage of water tends to decrease as a person gets older. Deprivation of water even for a few days can lead to death. Water is an essential component of the cells of our body. The water content of various tissues varies. Metabolically active tissues such as brain, liver, muscles and blood contain more water than the less active bones and fat tissues.

Water holds innumerable body components in the form of solution or suspension. Therefore it is more appropriate to refer to these as fluids. The fluid which exists inside the cells is called intracellular fluids, which form about 55 percent of water in the body. The rest is found as extracellular fluids. Blood, lymph and interstitial fluid (fluid between cells or tissues) are part of extracellular fluids.

Kidneys and lungs carry out water from the body. Water is also lost as perspiration through the skin and as part of excreta from the bowel. The volume of urine voided depends on the intake of fluids.

The body maintains a water balance precisely, i.e. the amount of water ingested is equal to the water excreted or lost from the body. Certain regions of hypothalamus are believed to regulate the intake. The Table 1.4 indicates water intake and loss from the body.

Water intake	ML	Daily excretion	ML
All fluids	1500-1750	Urine	1200 – 1500
Water in solid food	600 – 900	Perspiration	700 – 900
Water from oxidative fat metabolism	300 – 350	Faeces	100 – 200

Table 1.4 Water intake and loss from the body

1. Functions of water

- It serves as a building material for each cell of the body
- It is a universal solvent and is able to dissolve all the products of digestion
- It helps in the transport of the products of digestion to the appropriate organs
- It is needed for many chemical reactions in our body
- It acts as a lubricant preventing friction between the moving parts of the body
- The body temperature is regulated through the evaporation of water from the skin and lungs.

ii. Effects related to water in our body

- **Dehydration**: When the intake of water and other fluids is less than the body requirements, dehydration occurs. Dehydration results from excessive loss of water due to vomiting, diarrhoea and perspiration. Any loss of more than 10 percent of fluid from the body can be dangerous.
- **Oedema**: Oedema is the accumulation of excess fluid in tissues. It occurs when the sodium content in the extracellular fluid increases due to the inability of the kidneys to excrete sodium. Water is retained with excess sodium resulting in oedema.

In addition to the above mentioned nutrients, dietary fibre also play a significant role in maintaining health. Let us understand its significance.

1.3 Importance of Dietary Fibre

Why should we include salads in our daily diet?

- .....

Fibre is made up of different components. Dietary fibre only comes from plants. Fibre is the part of a plant that is not digested and absorbed in the small intestine. It passes into the large intestine. What happens to fibre in the large intestine depends on the type of fibre.

There are two types of dietary fibres-soluble (i.e. soluble in water) and insoluble (that does not dissolve in water) . Usually both types of fibre occur in the same food. For example the skin of an apple is high in insoluble fibre, and the flesh of the apple is high in soluble fibre in the form of pectin. Since soluble and insoluble fibres have different actions in the body, it is important to eat food containing both types.

Good sources of soluble fibre are apple, banana, citrus fruits, carrot, barley, oats, dates, peaches, potatoes, rice bran and kidney beans. Good sources of insoluble fibre are most fruits and vegetables, nuts, seeds, wheat bran and whole grain cereals.

Functions of Dietary Fibre

- One of the most important functions of insoluble fibre is the prevention of constipation. By adding bulk and softness to the stool, fibre eases its passage out of the body
- Insoluble fibre is important in preventing and treating diseases of the digestive system
- Fibres have some preventive or therapeutic benefits in irritable bowel syndrome
- Dietary fibre helps to maintain natural friendly bacteria in the large intestine
- High fibre food indirectly influence in weight control. They promote a feeling of fullness and satisfaction

- Fibre slows down the absorption of glucose from food.

Know your progress

1. Define fibre.
2. What is the importance of water in our daily diet?

Let us conclude

Nutrients are defined as the constituents of food which help us to perform the functions of the body. There are six major nutrients. They are carbohydrates, proteins, fats (lipids) vitamins, minerals and water. Vitamins are a group of chemical substances with different structures and qualities. They are grouped into fat soluble and water soluble vitamins.

Kwashiorkor and Marasmus are the two conditions related to protein energy malnutrition. These are found among children. Nutritional anaemia is a condition in which there is reduction in the haemoglobin content of the blood. Night blindness, Bitot's spot and phrynoderma are the major disease conditions due to deficiency of vitamin A.

Water is an important nutrient. About 60-70 percent of the total body weight is due to water. Water is present inside the cells of tissues and it is known as intracellular water. Water outside the tissue is known as extracellular water. Fibre is the skeletal remains of plant cells that are resistant to digestion by the enzymes. There are two types of dietary fibres-soluble and insoluble. Polysaccharides, cellulose, hemi-cellulose, pectin, gum and mucilage are soluble fibres.

Lab activity

Evolve recipes containing each of following nutrients.

1. Carbohydrate
2. Protein
3. Calcium
4. Iron
5. Vitamin A
6. Vitamin C

Make the dish and calculate the nutritive value of the prepared dish.

Let us assess

1. Describe the functions of carbohydrates, proteins and fats.
2. Match the following

A	B	C
Iron	Collagen formation	Lean meat
Vitamin C	Thyroxine formation	Sea food
Iodine	Haemoglobin	Indian gooseberry

3. List the symptoms of vitamin C and vitamin A deficiency?
4. Classify proteins with examples.
5. Evaluate the importance of dietary fibre and water in our daily diet.
6. Health is multi dimensional. Justify.
7. Explain the significance of essential fatty acids.
8. Classify the following into groups and name the group.
   Pectin, glucose, sucrose, galactose, glycogen, lactose

2 A Guide to Healthy Living

Key Concepts

Significant Learning Outcomes

After the completion of this chapter, the learner:

- classifies foods
- identifies food pyramid
- evaluates the loss of nutrients and take steps to minimize nutrient loss during preparation and cooking
- explains healthy food habits
- distinguishes different methods of enhancing nutrient availability
- develops a positive attitude towards healthy living

In the previous chapter we learned about various nutrients present in different foods. We know that food is vital to life. It can be defined as any solid or liquid substance which provides the body necessary materials to enable growth, to replace worn-out and damaged parts and to function normally. We saw that our body is made up of many nutrients we get from the food we eat. Food not only fills the stomach but also provides energy to do work, helps in the growth and repair of tissues, gives strength to fight against disease causing germs, helps the body to function normally and satisfies

hunger. Man must eat to live and what he eats will influence his ability to keep well, to work and to live long. Food are of different kinds and they perform many functions in the body. Let us learn it in detail.

2.1 Classification of Food

Food classification can be done based on the following factors

A. Based on its functions

B. Based on its keeping quality

C. Based on the various food groups.

Let us discuss this in detail.

Why do we classify food into various heads?

- .....

A. Classification of food based on its functions

According to the function, food is classified into Energy yielding food, Body building food, Protective and Regulatory food.

What might be the difference between these categories?

- .....

a. **Energy yielding Food**: Our body needs energy to carry out life processes like respiration, circulation, digestion and absorption of nutrients. Energy yielding nutrients are carbohydrates and fats. Food containing carbohydrates include cereals like rice, wheat, ragi, jowar, maize and barley and its flours. Sugar, molasses and jaggery are good sources of carbohydrates. Fats are the concentrated form of energy. They supply double the amount of energy compared to carbohydrates. Fat sources are butter, ghee, vegetable oils like coconut oil, groundnut oil, gingelly seed oil, peanut butter, vanaspathy, palm oil and soyabeans oil. Nuts and seeds are store houses of fat. These foods are used by the body to provide energy for all activities both voluntary and involuntary.

b. **Body building food**: Body undergoes constant metabolic activities. As a result of these activities the tissues wear out and need to be repaired. New tissues are also added on during the period of rapid growth and development. Protein is the important nutrient responsible for the repair

and maintenance of tissues in the body. Foods rich in protein are called body building foods. Milk, meat, egg and fish are rich in proteins of high biological value. These proteins have all the essential aminoacids in the correct proportion for the synthesis of body tissues. Pulses, oil seeds and nuts are rich in protein but may not contain all the essential amino acids required by the human body.

c. **Protective and regulatory food**: Food rich in minerals and vitamins are known as protective and regulatory foods. These regulate the various bodily functions and protect it from ill health and disease. They are essential for health and for the normal functioning of human body. Water is a regulatory food. It helps in digestion, excretion and maintenance of body temperature. Milk, egg, liver, fruits and green leafy vegetables are protective foods.

B. Classification of food based on its keeping quality

Based on keeping quality, food is classified into perishable foods and non perishable foods.

Can you list some food belonging to these categories?

- .....

a. **Perishable food**: Perishable food stuffs have relatively shorter life span. i.e., within a short period of time undesirable physical and chemical changes start taking place. Perishable food items are easily damaged due to their high water content, bacterial action and enzymatic reaction. Vegetables and fruits, milk and milk products, eggs, fish and tender pear are easily damaged unless properly preserved. Most fresh vegetables keep their top quality for only a few days.

b. **Non perishable food**: Non perishable food items lack water content and hence microbial action is not possible in them. The shelf life of food products can be increased by using proper sanitation procedures during storage. Temperature, humidity and the atmosphere of the storage place and containers decide the shelf life of a product. Cereal grains, flours, legumes and pulses, spices and condiments, sugar and jaggery can be stored in proper form for many months.

C. Classification of food based on various food groups

Food is also classified into different categories depending upon the various food groups. Indian Council of Medical Research (ICMR) grouped all our food items into five food groups based on their nutrient content. They are cereal grains and products, pulses and legumes, milk & meat products, fruits and vegetables and fats and sugars. Table 2.1 shows the ICMR classification of food.

Food	Nutrients Supplied
Group – I	
Cereal grains and Products:	
Rice, Wheat, Ragi, Maize, Bajra, Jowar, Rice flakes, Puffed Rice etc.	Energy, protein thiamine, folic acid, riboflavin, iron, fibre and invisible fat
Group II	
Pulses and Legumes	
Bengal gram, Black gram Cowpea, Horse gram, Pea, Rajma, Soya Bean etc.	Energy, protein, thiamine, folic acid, iron and fibre riboflavin and calcium
Group III	
Milk & Meat Products	
Milk, Curd, Skimmed milk Cheese Chicken liver, Fish, Eggs, Meat etc.	Proteins, fat, riboflavin and calcium
Group IV	
Fruits and Vegetables	
Mango, Guava, Tomato, Papaya, Orange, Sweetlime, Water melon etc.	Carotenoids, vitamin 'C' riboflavin, folic acid and iron,

Green Leafy Vegetables	
Amaranth, Spinach, Drumstick leaves, Coriander leaves, Fenugreek leaves etc.	Riboflavin, folic acid iron, fibre and carotenoids.
Other Vegetables	
Carrots, Onion, Brinjal, Ladies finger, Beans, Capsicum, Cauliflower, Drumstick etc.	Carotenoids, folic acid, calcium and fibre
Group V	
Fats and Sugars	
Butter, ghee, hydrogenated fats Cooking oils, Sugar and Jaggery etc.	Energy, fat, soluble vitamins, essential fatty acids and iron.

Table 2.1 ICMR classification of food.

Know your progress

1. Expand ICMR.
2. What do you mean by perishable food?
3. Classify food based on nutrient availability.

2.2 Food Pyramid

The food guide pyramid is the foundation for a healthy living. There is no single food stuff which can contribute all the nutrients. Only a judicious selection can provide all the nutrients in required quantity. Food pyramids provide a guide for the selection of food in our diet.

The food guide pyramid helps us to choose what and how much to eat from each food group in order to obtain the proper balance of nutrients you need without taking in too much calories, fat, cholesterol, sugar or sodium.

The food pyramid shows the kind of healthy food found in each of the pyramid's six categories. The size of the compartment in pyramid containing each type of food, indicate the relative proportion of our diet it should represent. Grains, vegetables and fruits should make up the bulk of our diet while servings of dairy products and protein should be fewer. Oil, sweets and fats should be eaten sparingly.

The general recommendations of food pyramid are:

- Eat variety of foods to get the energy, proteins, vitamins, minerals and fibre for good health.
- Balance the food that we eat with physical activity. Maintain or improve your weight to reduce the chances of having high blood pressure, heart diseases, stroke, certain cancers and diabetes.
- Choose a diet with plenty of grain products, vegetables and fruits which provide the necessary vitamins, minerals, fibre and complex carbohydrates.

Observe the food pyramid given in Fig 2.1.

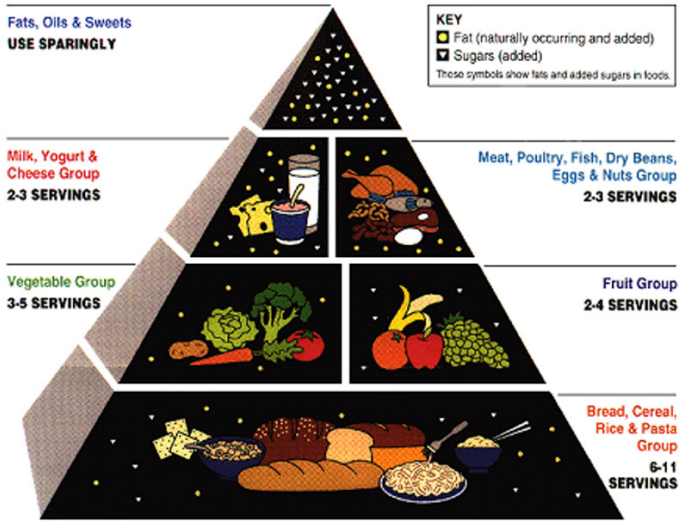


Fig 2.1 Food Pyramid

Know your progress

1. What do you mean by food pyramid?
2. What are the general recommendations of food pyramid?

2.3 Cooking

Why do we cook our food?

- .....

Food preparation helps in combining food ingredients in various ways with

delicate flavours, textures and colours which appeal to the senses. Food should be pleasing in appearance and taste as to be consumed. The process of subjecting food to the action of heat is termed as cooking.

A. Objectives of cooking food

a. **Improves the taste and quality**: Cooking improves natural flavour and texture of food. eg. roasting coffee seeds, ground nuts etc. will improve the flavour. However cooking for a long time lowers the flavour as flavouring compounds are volatile.

b. **Destruction of microorganisms**: Microorganisms are present everywhere and some are useful in making curd, cheese and bread. Some are harmful and cause infections or produce toxins. One of the most important methods to protect food against harmful microorganisms is the application of heat. Cooking food to the required temperature for a required length of time can destroy all harmful microorganisms in food.

c. **Improves digestibility**: Cooked food is easily chewed and swallowed. It is easily acted on by digestive juices.

d. **Increases variety**: Through cooking, the same food items are rendered into different dishes which makes eating a pleasure.

e. **Increases consumption of food**: Improvement in texture and flavour by cooking increases the consumption of food to meet our nutritional requirements. For example cooking improves the texture and makes the food chewable.

f. **Increases availability of nutrients:** Cooking increases the quality of protein by making some amino acids available to the body.

B. Principles of cooking

Application of scientific principles for our daily cooking ensures better family health and individual health. It is very important to learn these principles for better understanding and for higher degree of consumer awareness. The principles of cooking are:

a. **To keep 'flavour in':** When you cook food with or without a covering in a fatty medium, eg. cutlets, the aroma of the food is enclosed inside the crisp covering. It makes the food tasty and stimulates the digestive secretions for better utilization of nutrients.

b. **To keep 'flavour out':** Sometimes food is cooked to draw out its flavour into the gravy eg. mixed vegetable stew. Slow and steady cooking brings out changes in the texture. The water soluble nutrients are drawn into the broth, which is tasty besides being nourishing.

c. **To get maximum nutritive value by using appropriate cooking methods:** Cooking destroys most of vitamin C and B group vitamins because they are degradable by heat. Minerals are lost when large quantity of water is used for cooking. The loss further increases if the water is discarded. Prolonged and fierce cooking methods reduce the digestibility of proteins. Likewise most of the cooking methods affect the nutritive value of foods. We can adopt appropriate cooking methods to get maximum nutritive value.

C. Methods of cooking

The methods of cooking can be classified on the basis of the medium used for heat transfer. The medium normally used are water as such or in the form of steam, oil and air. It is presented in Table 2.2

No.	Medium	Cooking methods
a.	Water	i) Boiling ii) Simmering iii) Stewing iv) Poaching
b.	Steam	i) Steaming ii) Pressure cooking
c.	Fat	i) Deep fat frying ii) Shallow frying or pan frying
d.	Air	i) Roasting ii) Baking iii) Grilling
e.	Combination	Braising-roasting and then cooking in water. Any two methods coming together from the above four groups.
f.	Electromagnetic waves	Microwave cooking

Table 2.2 Methods of cooking

a. Water

Water is the most commonly used medium of cooking. Boiling, simmering and stewing are the methods in which moist heat is used.

i. **Boiling:** Boiling is cooking food in water at 100°C and maintaining the water at that temperature till the food is made tender. When food items

are cooked by boiling, the food should be brought to a vigorous boil first and the heat is then turned down, as violent boiling throughout tends to break the food. Boiling can be done with excess amount of water or sufficient amount of water. eg. boiling is the traditional method of cooking rice.

Advantages of boiling

- The simplest method. It does not require special skill and equipment
- Soluble starches can be removed and rice grains are separated
- Protein gets denatured, starch gets gelatinized and collagen gets hydrolysed
- Uniform cooking can be done.

Disadvantages of boiling

- Loss of nutrients: If excess water is used in cooking and if it is discarded, 30-70 % water soluble nutrients like vitamin C may be lost. To prevent this type of losses, cooked water should be used in soups, rasams etc. Some proteins may be lost, if vegetables are cooked in water containing salt and the stock is discarded. There is considerable loss of minerals especially sodium, potassium and calcium due to leaching
- Loss of colours: Water soluble pigments like betanin from beetroot may be lost. Beetroot should be cooked along with the skin to prevent the loss of colour
- Time consuming: Boiling may take time and fuel may get wasted
- Loss of flavour and texture: Boiled foods are not considered tasty because flavour compounds are leached into water. Over boiling may make the food mushy.

ii. **Simmering**: When food items are cooked in a pan with a well fitting lid at temperature just below the boiling point, ie, 82-99°C of the liquid in which they are immersed, the process is called simmering. It is a useful method when food items have to be cooked for a long time to make it tender.

Advantages of simmering

- Food gets cooked thoroughly
- Scorching or burning is prevented
- Loss due to leaching is minimum.

Disadvantages of simmering

- Loss of heat-sensitive nutrients, due to long period of cooking
- Takes more time and more fuel.

iii. **Stewing**: This is a gentle method of cooking in a pan with a tight fitting lid, using small quantities of liquid to cover only half of the food. The food above the liquid is cooked by the steam generated within the pan. The liquid is brought to a boiling point and then the heat applied is reduced to maintain the cooking at simmering temperature i.e. 98°C. Stewing is a slow method of cooking. Most vegetables and meat are prepared by this method.

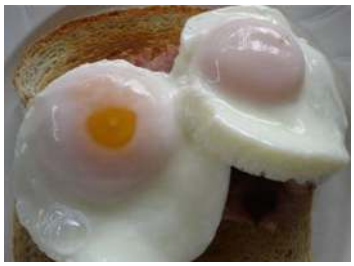
Advantages of stewing

- Prevents leaching of nutrients
- Flavour is retained.

Disadvantages of stewing

- Time consuming.

iv. **Poaching**: This involves cooking food in minimum amount of liquid at a temperature of 80-85°C, that is below boiling point. Food items generally prepared by this method are poached eggs, fish and fruits.



Advantages of poaching

- Very quick method of cooking
- Easily digestible since no fat is used.

Disadvantages of poaching

- It is bland in taste

- Water soluble vitamins may be leached into the water.

b. Steam

Steaming of food involves the use of moist heat. When food is cooked in water vapour with or without pressure it is said to be steamed.

i. **Steaming**: This is generated from vigorously boiling water or liquid in a pan so that the food is completely surrounded by steam and not in contact with the water or liquid. Here the food is cooked at 100°C.

Advantages of steaming

- It does not require constant attention
- Nutritive value is maintained because there is no leaching and cooking time is less
- Easily digestible since no fat is added
- There is less chance of burning and scorching
- In double boilers, sudden increase in temperature can be avoided while making custards and boiling milk
- Texture of food is better and becomes light and fluffy
- Steamed foods have good flavour.

Disadvantages of steaming

- Special equipment (steamer) is needed
- Many foods cannot be prepared by this method.

ii. **Pressure cooking**: When steam under pressure is used, the method is known as pressure cooking and the equipment used is known as pressure cooker. In the food cooked with steam under pressure temperature is elevated quickly and the cooking period is reduced.

In pressure cooking, escaping steam is trapped and kept under pressure so that the temperature of the boiling water and steam can be raised above 100°C.

Advantages of pressure cooking

- It takes less time to cook
- Different items may be cooked at the same time
- Fuel is saved
- Requires less attention
- Nutrient or flavour loss may be less
- There is an indication when the cooking is completed
- There are less chances of burning or scorching.

Disadvantages of pressure cooking

- Thorough knowledge of using the equipment (pressure cooker) is required. Otherwise accidents may occur
- There may be mixing of flavours
- Food may get undesirably soft.

c. Fat

Here oil or fat is used as a medium of cooking. The fat cooking methods are:

i. **Deep fat frying**: Here food is totally immersed in hot oil and cooked by vigorous convection currents and cooking is uniform on all sides of the food. Cooking can be rapidly completed in deep fat frying because the temperature used is 180-220°C.

Advantages of deep fat frying

- Taste is improved along with texture
- Increases calorific value
- The fastest method of cooking.

Disadvantages of deep fat frying

- Sometimes the food may become oily or soggy with too much absorption of oil
- More attention is required while cooking and care should be taken to avoid accidents

- The food becomes very expensive
- Fried food takes more time to digest
- Repeated use of heated oils may produce harmful substances and reduce the smoking point.

ii. **Shallow fat frying:** Here food is cooked in large amounts of fat but not enough to cover it. Heat is transferred to food partially by conduction by contact with the heated pan and partially by the convection currents of the foods. Only a thin layer or thin pieces of food are cooked in this manner. The food must be turned from one side to another to ensure complete cooking.

Advantages of shallow fat frying

- In shallow fat frying, the amount of oil used can be controlled
- Improves the taste of the food
- Improves the flavour and texture of food.

Disadvantages of shallow fat frying

- These foods are not digested easily due to the fat absorbed during frying
- This method is limited to certain foods.

d. Air

Methods in which air is used as a main cooking medium include roasting, baking, grilling or broiling.

i. **Roasting**: It is traditionally carried out over an open fire, with meat being rotated on a spit. Nowadays, roasting is generally described as the cooking of meat or vegetables in the oven, smeared with hot fat to prevent drying and to enhance colour and flavour.

Advantages of roasting

- Flavour can be enhanced

- Little attention is required while the meat is roasted
- Fuel can be saved if other items are roasted at the same time.

Disadvantages of roasting

- Moisture loss by evaporation is quite marked and can cause undesirable drying of food
- Fat from the meat will spatter at high temperatures
- Food items may shrink in size as a result of moisture loss and protein denaturation
- High temperatures may cause toughening of protein and reduce digestibility.

ii. **Baking:** Here food gets cooked by hot air. Baked foods items are generally brown and crisp on the top, soft and porous at the centre. The temperatures that are normally used for baking are 120-260°C.

Advantages of baking

- Flavour and texture are improved
- Variety of dishes can be made
- Uniform and bulk cooking can be achieved.

Disadvantages of baking

- Special equipment and skill are required.

iii. **Grilling or broiling**: Grilling consists of placing the food below or above or in between a red hot surface. This refers to cooking of food by exposing it to direct heat.

Advantages of grilling

- Quick method of cooking
- Less or no fat required
- Flavour is improved.

Disadvantages of grilling

- It requires careful timing to prevent over cooking
- Grilled foods may be expensive.

e. Combination- Braising

Braising is a combination of stewing and roasting in a pan with a tight fitting lid. It prevents loss of liquid, while the food is cooked in the steam rising from the stock. During cooking, the liquid should simmer, not boil to prevent toughening of food.

Advantages of braising

- A whole meal can be cooked in one pan, which saves time and fuel.
- Tough cuts of meat can be used.

Disadvantages of braising

- Food may not develop a good colour.

f. Electromagnetic waves

Electromagnetic waves from a power source magnetron are absorbed by the food and the food gets heated at once. Thus microwaves do not require any medium of transfer of heat in cooking. The microwaves can be absorbed, transmitted or reflected. They are reflected by metals and absorbed by food. When food is kept in the cavity of the microwave oven for cooking, the microwave generated by the magnetron strikes the food and the metal walls of the oven. Microwave that strikes the metal walls are reflected and bounced back, so they disperse throughout the oven and accomplish uniform heating of the food.

Advantages of microwave cooking

- Food is cooked very quickly
- There is less destruction of nutrients as cooking time is short
- Food gets cooked uniformly
- Preserves the natural colour of vegetables and fruits.

Disadvantages of microwave cooking

- It is easy to overcook the food; so careful attention must be paid to timing
- Deep frying cannot be done
- The short cooking time may not give a chance of blending of flavours as in conventional methods.

Whatever may be the method of cooking, some basic principles of cooking may help to keep the nutrients of food.

Try to cook food with the different methods mentioned above and prepare a note on these.

Know your progress

1. List the main objectives of cooking.
2. What are the advantages of pressure cooking?
3. Define Broiling.
4. List the different methods of cooking.

2.4 Loss of Nutrients and Steps to Minimize Nutrient Loss

It is better to eat raw vegetables rather than cooked. Why?

- .....

Nutrient loss is a consequence in all cooking process. Exposure to heat, light or oxygen will alter the nutrients found in food, and methods that involve water often reduce the amounts of nutrients as these get 'washed out' and left behind.

A. Loss of nutrients during cooking

Nutrients are lost during the various processes in cooking. They are:

1. Over washing: Vitamin B and minerals are lost when pulses and cereals are over washed.
2. Over peeling: If vegetables are over peeled, the vitamins and minerals are lost. Vitamin B is lost when potatoes are peeled without boiling.
3. Washing after cutting: Water soluble vitamins and minerals of vegetables especially green leafy vegetables are lost when washed after cutting.
4. Over soaking: If pulses are soaked in water for too long i.e., more than

2-3 days, it can lead to severe food poisoning.

5. Discarding leaves: Green leaves of turnip, broccoli, carrots etc when discarded results in loss of calcium, iron and carotene.
6. Throwing stock: Water soluble vitamins dissolve in water; so the stock left after boiling if thrown results in their loss.
7. Preparation: Using excessive water for cooking rice and draining the excess water leads to the loss of vitamin B.
8. Cooking uncovered: Vitamin B and C are water soluble and can easily evaporate along with water vapour, if the container is not covered.
9. Using cooking soda: Cooking soda is mostly used to cook pulses like channa, destroys Vitamin B.
10. Over frying: All fat soluble vitamins A, D, E, and K are lost in the oil when fried or fried repeatedly.
11. Over cooking: Eggs, meat, cheese become leathery upon overcooking which makes them indigestible. When vegetables are over cooked, they burst and vitamin B leaks into the water.
12. Reheating: Reheating food after cooking also destroys nutrients.

Maximum nutrient loss takes place in vegetables while cooking. When vegetables are cooked in water using boiling methods 15-32% of thiamine, 9-20% of riboflavin and 23-45% of vitamin C are lost. In steam cooking the loss is lesser. Table 2.3 shows the loss of vitamins in some vegetables during cooking.

Name of vegetables	Method of cooking	Loss of thiamine	Vitamin C	Riboflavin
Beans	Boiling	29%	20%	42%
Cabbage	Boiling	32%	18%	45%
Carrot	Boiling	20%	10%	30%
Pear	Boiling	28%	17%	40%
Spinach	Boiling	15%	10%	28%
Potato	Boiling	25%	9%	25%

Sweet potato	Boiling	20%	17%	24%
Beans	Steaming	22%	14%	32%
Cabbage	Steaming	18%	9%	38%
Carrots	Steaming	15%	10%	25%
Potato	Steaming	20%	12%	25%

Table 2.3 The loss of vitamins in some vegetables during cooking

B. Conservation of nutrients

The following practices should be adopted for saving nutrients during cooking.

a. Do not over soak pulses.

b. Wash in minimum water.

c. Wash vegetables before cutting, do not scrub more than necessary.

d. Use unsifted flour as it contains bran which is rich in fibre, iron, vitamin B and minerals.

e. Cut vegetables in large pieces lengthwise to minimize exposure to heat.

f. Peel the skin of carrots with a peeler. Peel potatoes after boiling.

g. Use minimum water to cook the vegetables.

h. Do not throw stock but use it for further cooking.

i. Use boiling water if vegetables are to be cooked in water.

k. Cover food while Cooking.

l. Avoid overcooking or reheating repeatedly.

m. Serve cooked food immediately.

Make an awareness poster to retain vitamins and other nutrients in vegetables while cooking.

Know your progress

1. Name the nutrients that are lost when pulses and cereals are over washed.
2. List some practices that should be adopted for saving nutrients during cooking.

2.5 Healthy Food Habits

Now we know the nutrients available in different vegetables and how to keep it while cooking. Our health is related to proper utilisation of nutrients in our food.

Health is related to the food consumed. To maintain good health, ingesting a diet containing the nutrients in correct proportion is essential. The human body is like a complex piece of machinery which is prone to faults and weaknesses if it is poorly maintained. This can happen if too little or too much food is eaten or if the daily food intake is in any way unbalanced. So we should eat food which can give all the nutrients and keep us healthy. Have you observed how people eat their food? Some people like sweets, while others like savouries. All these describe the food habits of people. Food habits is therefore the way in which people select, cook, serve and eat foods that are available to them. Food habits differ from one ethnic group to another. These differences come about because of many influences on people. For a healthy living, one should know something about healthy food habits.

List some of the healthy food habits.

- .....

Buying good food items ensures good health. Each and every step in handling, cooking and serving food, decides the quality of food.

A. General Guidelines for a Healthy living

a. **Maintain regularity in routine:** Our body can adapt to changes, but it has its own biological clock which is adapted to our daily routine and also changes with seasons. Once we have conditioned our body to a certain routine, it is necessary to maintain it. Regularity in maintaining our routine presents certain advantages in determining regular sleeping habits, elimination habits and taking at least two proper meals.

b. **Eat as much natural foods as possible:** Most natural foods are more nutritious than preserved foods. For example, a glass of fresh lime juice contains more vitamin C than lemon squash which is artificially flavoured.

c. **Adapt yourself to seasonal variations:** Changes in seasons have tremendous impact on our body and this affects our health. If the diet is modified according to the climatic conditions, our body suffers minimum shock and adapts very easily to seasonal variations. During summer, since sweat loss is greater, more water and electrolytes have to be taken to replace the lost fluid.

d. **Eat well but do not 'overeat':** Eat three to four meals a day and at each meal eat well but do not overeat. A meal should be eaten at the right time. Its quantity also should be in such a way that two parts of the stomach are occupied by the food, one part by water and one part should be left empty in order to permit the flow of gastric juices and the contents of the stomach to be churned so as to avoid indigestion.

e. **Avoid excessive salt and spices:** Anything that is done in moderation cannot harm the body, but a slight excess everyday can be harmful for the body in the long run. A simple example: salt is a substance the daily intake of which varies from person to person. Salt which contains large amounts of sodium must be carefully handled by people who have a tendency towards high blood pressure. Foods which are highly salted and spiced such as peanuts, potato chips, salted popcorn, masalas, pickles etc should be minimized in our daily diet. Very spicy foods must be avoided since they are harmful to the delicate lining of the gastro intestinal tract.

f. **Avoid too much sweets :** Sucrose has been proved to be one of the causative agents of dental problems. Consumption of concentrated sugars such as jam, jellies, marmalades etc must be minimized.

g. **Eat foods which contain carbohydrates especially starch and fibre:** Consumption of complete carbohydrate such as starches present in cereals is more advisable than that of simple sugars found in honey, fruits, table sugar and milk. This is because the digestion of complex sugars is relatively slower than that of simple ones. Foods rich in fibre like whole grain cereals, green leafy vegetables, etc should be included in the diet as they help in the proper digestion of foods.

h. **Avoid food which contain large amounts of cholesterol and saturated fats**: This can be achieved by eating food low in cholesterol content. It is essential to restrict consumption of fried food and high

sugar food for this. Moderate consumption is the key to good health.

i. **Check weight regularly and maintain ideal weight:** It is always better to be underweight than to be overweight. Every gram of excess weight is a burden on the heart and vital body organs. The process of reducing weight depends on good eating habits. It is important to increase certain physical activities which help you to reduce weight. Weight loss should never be drastic as it leads to major health problems and can be fatal.

j. **Avoid eating the same kind of foods all the time:** Eat a variety of food. Most foods contain several nutrients, but no single food provides nutrients in the right quantity for good health. For example, milk is a complete food yet it is a poor source of vitamin C and iron. So it is necessary to include citrus fruits which are rich sources of vitamin C. This example only goes to show that the more the variety of food in the diet, the better is the nutritional status and lesser is the chance of nutritional deficiency.

B. Junk foods

Do you like to have pizzas, burger and soft drinks like cola? Is it advisable to eat such food items? Why?

- .....

Observe the poster given below.

What is the message in the poster?

Increasing urbanization, changing life styles and diminishing gender specific roles in the family and the society are the major forces that contribute to changes in the dietary patterns. Fast food joints are sprouting up like mushrooms. Processed and semi processed food industry is blooming and spreading like wild fire. Convenient food is the trend of the day. Choice of foods, cooking methods and meal patterns of the family are also changing. This has a profound bearing on nutrition. Wholesome food consumption is replaced by junk food.

Junk food contains artificial colours, sweeteners and gluing agents which provide variety to drinks and snacks. Softness and smoothness, crisp and cool food items are mines of chemicals. Shelf life or the keeping quality of food items are enhanced by adding chemicals.

a. Harmful effects of junk food

Read the extract from one of the articles that appeard in a health related magazine.

RISING OBESITY AMONG CHILDREN

The fast food bomb

Obesity among children due to rampant consumption of junk food has reached epidemic proportions. With India already in the grip of this dangerous global trend, the government needs to remove its blinkers on the processed food industry.

One of the first declarations of the newly elected government in June was a proposal to ban unhealthy or junk food (defined as food high on fat, sugar and salt) in school canteens across the country. This was followed up with an increase in the prices of soft drinks in the recent budget.

What is the impact of junk food among children?

Junk food lacks many nutrients. Nutrition deprivation is the result of consumption of junk foods. Junk food often creates damage to nerves, digestive organs, brain, liver, heart and kidneys. Methanol gives cooling effect to tongue. Bitter taste and sour taste is created to food items by adding 'sinmalohide'. Citral bensalolitude gives lime's flavour and taste to food and drink. Peach flavour and pineapple taste is produced to foods by adding diacetyle formite or ethyl acetate, methyl salicytate or menthol.

FAO/WHO has banned some of these chemicals. Fizzy drinks have sodium and ammonium bicarbonate in them. Tartaric acid gives bitter taste. These chemicals damage mucous membranous structures of intestine and liver. A burning sensation in the oesophagus, gas formation in the stomach and stomach pain are caused by these. Soft drinks have more phosphorus and this upsets calcium phosphorus ratio in the blood. Bones are often damaged by the over indulgence of cool drinks. Cola consumption results in skeletal depletion of calcium and pain in the legs.

Artificial sweeteners are 300 times sweeter than cane sugar. Dulcin, saccharine, cyclamates are the artificial sugars used in soft drinks and bakery items. The constant use of this causes many diseases.

To enhance the keeping quality of fried items and sweets and pastries, dalda is used. Use of trans-fats in the diet may results in heart diseases. Many processed food manufacturers use stabilizers, colour, aromatic flavours and preservatives above the safe level and its consumption results in liver and kidney diseases.

Wholesome and natural food items are far better than junk food. Junk food also has high concentration of fats which makes one obese and leads to cardiac diseases. More sugar consumption damages brain and results in emotional disturbance.

Prepare a notice and circulate among your friends about the healthy food habits.

Know your progress

1. What are the general guidelines for a healthy living?
2. What are the disadvantages of consuming junk food?

2.6 Methods of Enhancing Nutrient Availability

The term 'enhancing nutrient availability' means improving the nutritive quality of a food item at no additional cost. The common methods are detailed below:

A. Germination: In this method, pulses and grains are soaked overnight, usually for 8-16 hours in minimum water, enough to get absorbed by the grain. When the seeds swell upto their maximum size, they are tied to a moist muslin cloth, for another 12-24 hours depending on the atmospheric temperature in a warm well –lit place. This results in the sprouting of white shoots. Soya bean, green gram, black gram etc can be easily germinated. It may become longer at low temperature.

Germinated foods have the following advantages:

- The grains and pulses become enriched in vitamin C
- Proteins and carbohydrates are broken down into easily digestible forms
- The food becomes softer, chewable and more digestible
- Niacin, riboflavin and folic acid content increases by 60-100%
- Iron gets loosed from its bound form and becomes easily available
- Fenugreek seeds lose their bitterness
- It is an economical way of increasing the nutrient content of food
- It also reduces cooking time.

Sprouted food can be used in salads, chaats, pulao, filling for snacks and as garnishing in soups.

List some fermented food.

- .....

B. Fermentation: It is a process in which microorganisms added to the food brings desirable physical and chemical changes in them. Carbon dioxide is mostly produced, making the mixture rise 2-3 cm and making it porous, spongy and sour. Curd and yeast are mostly used to ferment foods.

Fermented food has the following advantages.

- The food becomes porous, light and digestible
- Vitamin C content increases
- Thiamine, riboflavin and niacin content also doubles
- Iron gets released from its bound form and is easily available. Texture and flavour of foods are enhanced.

Dals, rice flour, wheat flour etc are fermented to make delicious foods.

C. Combination: It is a process in which commonly available food from different food groups are mixed in one dish to enhance nutrients and get a better taste.

Since different food groups give different nutrients, when combined together, they contribute to the meal with their respective nutrients.

The most common examples are combining pulses and cereals, rice and green gram, wheat and dal etc. eg. Idli, dosa mix

Combining food has the following advantages:

- Cereals, pulses and vegetables supply a very good amount of proteins, minerals and carbohydrates
- Cereals are rich in methionine but lack lysine, which is abundant in pulses, so when these two are combined, the protein quality of the combination is superior to either cereals or pulses when taken alone
- Combination of cereal and milk improves the protein and calcium content of food
- Cereal and vegetable combination enhance the vitamin A, calcium and iron content of the foods
- It also helps to provide a balanced diet to all family members
- More variety can be brought to meals.

D. Fortification: Food fortification is commonly defined as the addition of one or more essential nutrients to food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated nutrient deficiency. eg. Fortified atta, Iodised salt.

Fortified food has the following advantages.

- Fortified food items are likely to contain micronutrients
- It maintains body stores of nutrients more efficiently and effectively
- It improves the nutritional status of a large proportion of the general population
- Food fortification is more cost effective than any other methods.

Know your Progress

1. List the methods of enhancing nutrient availability.
2. Suggest some examples of combination of foods as a means of enhancement of nutrients.
3. What do you mean by fortification?

Collect more details about different kinds of foods, its methods of cooking and methods of enhancing its nutrient availability from internet.

Let us conclude

Food is obtained from plants and animal resources. Food is classified into energy yielding food, body building food and regulatory food based on functions. Based on the keeping quality of food they are classified into perishable and non perishable food. Perishable food becomes stale easily due to its high water content, bacterial action and enzymatic reaction. Non perishable food items lack water content and hence microbial action is not possible. Using proper sanitation procedures during storage improves the shelf life of products. Grilling, frying, boiling, poaching, steaming, stewing, braising, broiling, microwave cooking and pressure cooking are the different methods of cooking. Germination, combination, fermentation and fortification are the methods of enhancing nutrient availability of foods.

Lab activity

Prepare a dish involving the following methods:

a. Germination

b. Fermentation

c. Combination

Let us assess

1. Nutrient deprivation is the result of continuous consumption of junk food. Justify.
2. Classify food based on their functions and explain.
3. Nutrients are lost during the various processes used in cooking. Substantiate the statement with valid arguments.
4. Name a method to enhance nutrient availability. Write its advantage.
5. Choose the incorrect answer from the following statements.
   a. Food fortification is cost effective than any other methods.
   b. Combination of cereal and milk improves the protein and calcium content of the food.
   c. The grains and pulses become enriched in vitamin D after germination.
   d. Enhancing means improving the nutritive quality of food at no additional cost.

3 Nutrition for Self and Family

Key Concepts

3.1 Meal planning-importance, principles, factors affecting

3.2 RDA of nutrients by ICMR for various age groups - Factors affecting RDA and food allowances

3.3 Diet during pregnancy, lactation and adolescence

Significant Learning Outcomes

After the completion of this chapter, the learner:

- defines meal planning and identifies importance of meal planning
- explains the importance and the factors affecting meal planning
- differentiates Recommended Dietary Allowance of nutrients for various age groups
- describes factors affecting RDA and food allowance
- plans diet for pregnancy, lactation and adolescence
- develops a positive attitude in the selection of proper food for specific health conditions

We have seen in the previous chapter the various nutrients present in food, their functions and the grouping of food based on their nutrient content. Good food which contains nutrients is necessary for optimum health. A diet which contains all the nutrients required by the body in the correct proportion is needed. Now let us see how this can be achieved through careful planning of meals. We shall learn how an adequate diet can be made available for family members by including food from various food groups.

3.1 Meal Planning

Do you consume the same amount of food as your father?

Who needs more food?

- .....

The amount of nutrients required for each person varies. In a family there may be members of various ages whose nutritional requirements also vary largely. Each person may have different preferences for food. Some may like sweet food but some may like savoury food. A careful planning is needed to maintain optimum nutrition for the whole family.

Meal Planning is the technique of providing the family with meals that will meet the nutritional requirements. It can be defined as the implementation of the principles of nutrition in one's daily diet in an appetizing way. It is often considered as an art as well as a science. Meals should be served artistically in an attractive way by skilful blending of colour, taste, flavour and texture to stimulate one's desire to eat. It also involves the knowledge of the scientific principles of nutrition which helps in making wise choices between the varieties of food available. Food choices made over the years influence the body's health and poor choice increases the risk of developing chronic diseases.

A. Importance of Meal planning

Why is it necessary to plan meal for the family?

- .....

It is important to give serious attention to the nutritional requirements of the members of the family. It helps us to decide what to eat each day and for each meal. Hence it can be called our 'daily food guide'.

Meal planning helps us to:

- fulfil the nutritional needs of all members of the family
- serve well planned and attractive meals
- make the food economical
- cater to the food preferences of individual members of the family
- save energy, time and money
- use left over food
- combine different food to increase the nutrient content.

B. Principles of Meal Planning

As we have already seen, a well-planned meal is one that is nutritionally adequate, aesthetically pleasing and economically feasible. Knowledge of the principles which govern meal planning is necessary to make well planned meals. The principles are:

a. **To bring nutritional value**: A meal plan should be based on the principles of nutrition. A family consists of members of various age groups and physiological states like infants, adolescents, pregnant women, old persons etc. The nutritional requirement for each person varies. The requirement for a pregnant woman is different from that of an adolescent boy. In order to get the required nutrients in the correct proportion, food from various food groups should be included in the diet. For eg. including cereals, milk, fruits etc., can meet the requirement for energy, protein, vitamins and minerals. Food selected from one food group will be rich in one nutrient but deficient in the other nutrients. Therefore wise choice is needed to ensure adequate nutrition.

b. **To consider personal preferences and food habits:** Families differ in their nutritional needs, number of family members, their likes and dislikes, number of meals taken etc. Food should be in accordance with the requirement of the different members of the family. Separate dish need not be prepared for each family member. It can be served to meet the requirements of each person by making few changes in the meal. For eg. when dal is cooked, dal water can be served as soup, dal can be served with reduced salt for a hypertension patient, non fried dal can be given for patients and fried dal can be given to the rest of the family.

c. **To bring variety in meals:**

Do you like to have the same food every day?

- .....

Even if the food is tasty or nutritious, we do not like to eat the same food every day. Variety in food is a must so that all members of the family enjoy it. This can be ensured by selecting food from various food groups, by blending colours, flavours, textures and by using different cooking methods.

i. **Selection of food from different food groups**: Food should be selected from different food groups to make them balanced and acceptable to

the family members. For eg. If the lunch contains plain rice, green gram curry, sprouted green gram salad and bengal gram it will not be acceptable. Instead rice, vegetable salad, bengal gram curry and a fruit is more balanced and appealing. It will bring variety and enhance the taste and nutritive value of food.

ii. **Variety in colour combinations**: Blending of different colours make food attractive and appetizing. Food appears dull if it is of the same colour. For eg. A tri coloured sandwich is more appealing that a plain sandwich. Such meals enhance appetite.

iii. **Variety in texture**: Texture of food refers to the state of being soft, solid, crisp or liquid. Contrasting textures may be provided by the selection of soft vegetables, juicy fruits and crispy bites. A meal should have a few solid food item which can be consumed raw, like salads, fruits etc., some crispy food like pappads, chips etc., soft food like pudding, dal etc. and liquid food like rasam, buttermilk etc.

iv. **Variety in taste and flavour**: Meal should contain different tastes like salty, sour, sweet and pungent. This gives novelty to food. Taste differences occur when sour foods like lemon, oranges and tomatoes are used. Bitter food like bitter gourd may be prepared into crispy bites. Nothing is really tasty without salt and people take natural sodium through foods like amaranth, milk, sea fish etc. Blending of different flavours is essential for meal planning. Good combinations like idli and sambar, puttu and bengal gram curry, tapioca and fish curry help to enhance the flavour of food.

v. **Variety in the method of cooking**: Texture, taste and flavour of food can be changed by using different methods of cooking. In addition to traditional cooking methods like frying, boiling, roasting, baking, steaming etc. novelty can be introduced by adopting fermentation and sprouting.

d. To provide satiety value

Satiety is the feeling of fullness after eating. Meals which produce inadequate satiety will lead to hunger prangs, which will in turn affect the

working capacity of a person. Fats and proteins have high satiety value than carbohydrates. While planning, consider the interval between two meals; if the interval is longer, protein and fat may be given. If the interval is shorter, carbohydrate food can be given.

e. To save time, energy and money

The meal plan should be in such a way that it involves the minimum amount of time, energy and expenditure. Simple methods of cooking can be adopted to save time and energy and it also minimises nutrient loss. Food costs can be reduced especially for the low and middle income groups, by using seasonally available fruits and vegetables and cultivating them in their own kitchen garden. Instead of using high cost food items, we can use low cost cereals, dal, fruits, vegetables and fish to get high nutritional value. Using ragi in the place of cornflakes, small fish in the place of meat/chicken and using combination of foods like rice and dal prove to be beneficial and helps to improve nutrition. A refrigerator may aid to lower food wastage and left over foods may be stored for the next day or modified to be used as new dishes.

C. Factors affecting Meal Planning

Do all the families have the same meal pattern? Why?

- .....

Apart from the principles that govern meal planning certain factors should also be considered in planning meals for the family. These are:

a. Economic factor

The amount and the kind of food for a family depend on the available income. While planning a meal for the family the income available should be considered. Foods such as milk, meat, fruits, nuts etc. are costly. However alternative sources like toned milk, seasonal and locally available fruits and vegetables, which are low cost and at the same time nutritious can be used. Therefore, it is desirable to adopt such measures that provide nutritious food at a low cost. Some such measures are as follows:

- In place of expensive cereals like rice and wheat, use low cost cereals like ragi, jower, barley, etc.
- Use seasonal and locally produced fruits and vegetables

- Use methods like sprouting, fermentation, and combination of food to enhance nutritive value
- Use methods like pressure cooking to retain nutritive value of food
- Use cheap nuts like groundnuts
- Utilise left-over food properly.

b. Size and composition of the family

A family may vary in its size and composition. These should be considered while planning meal for the family.

i. Size of the family

Size of a family refers to the number of its members. The amount of food served is largely determined by the number of family members. More members mean more food for the family. The nature of the family whether nuclear or joint also affects the meal planning to a large extent.

ii. Family composition

Family composition refers to the age, sex, activity, occupation and different physical conditions of its members.

- **Age:** Age determines the nutritional requirements of all family members, eg. Growing children need more protein and minerals. Adults require food according to their activities.
- **Occupation:** A heavy worker needs more calories whereas more proteins are required for people doing mental work. Various professions can be categorised on the basis of their activity as follows:

(a) Sedentary worker-Teacher, Lawyer, Doctor, Nurse etc.

(b) Moderate worker-Driver, Potter, Carpenter etc.

(c) Heavy worker-Player, Labourer, Iron smith etc.

- **Sex:** Normally women require less food as compared to men because of their lesser height, weight, body composition, and physical activity.
- **Physical condition:** Some specific body conditions affect the nutritional requirements, eg. during pregnancy and lactation the body requires more nutrients. A diabetic patient requires less carbohydrates. A person with high blood pressure requires less salt.

c. Season

Meals should be in accordance with the season. With the change in season, the availability of foodstuffs and our tastes also change. In summer, bottle gourd, ridge gourd, pumpkin, bitter gourd etc. are in abundance whereas carrots, radish, tomato, peas, cauliflower etc. are readily available in winter. Seasonal food is more nutritious and preferable.

Physical requirements also change with the change in season. Cool drinks like lime juice, butter milk, ice creams etc. are relished in summer and hot drinks like tea, coffee and high calorie foods like peanuts etc. are preferred in winter. Therefore, selection of vegetables, fruits, and other foodstuffs should be done according to the season.

d. Food availability

Availability of food also affects meal planning. A maximum use of locally produced foodstuffs should be made because they are cheap, tasty and compatible with the climate. For eg. sea food is easily available and cheap in coastal areas as it is the staple food of the people living there.

Mango or watermelon can be included in the diet when they are available in plenty. Today with increasing means of transportation, preservation and storage, the availability of foodstuffs has increased.

e. Food acceptance

Acceptance or rejection of food by a person is dependent on one's likes and dislikes, religious and social traditions and customs. All these factors are to be kept in mind while planning a meal. Some basic facts are as follows:

- **Traditional and regional foods:** Food becomes more acceptable with the addition of regional food in the diet because people of a region are familiar with these foods and their tastes have developed

accordingly, eg. Idly and Dosa is a special food of South Indians and Dal and Roti are preferred by North Indians.

Try to collect pictures of traditional Kerala food and make an album.

- **Religious beliefs:** Religion plays an important role in the acceptance of food, eg. non-vegetarian foods are prohibited in certain religions, whereas garlic and onions are prohibited by some other religions. Some special dishes are prepared on religious festivals like Diwali, Christmas, Id, Onam etc. Sweets are also made on auspicious occasions.

f. Food habits

Food habits of the family members have to be considered while planning meals. Food habits change with environment, economic, geographic, social, cultural background and religious customs. Some people are vegetarians while others are non-vegetarians. Some people show intolerance to certain foods like milk while others may like it. Some people take heavy breakfast while others prefer heavy dinner, some people like rice, while others prefer chapattis. But the nutritional requirements of a person should be fulfilled irrespective of his food habits. For eg. those who have a dislike for milk can have curd, custard, paneer, milk puddings or soufflés.

Conduct a debate on vegetarian and non-vegetarian food habits and prepare notes.

g. Lifestyle

Every family has its own life style. Therefore, the number of meals taken varies accordingly. In some families 2-3 meals are taken in a day, whereas in some it may be 4-5 meals per day. Meal time also varies in every family because the time and the number of meals are affected by the member's activity, income and physical state.

During meal planning, emphasis should be laid on the main meal of the day. 'Nutritional deficiencies' of other meals should be compensated in the main meal. For example, students who are in the habit of having inadequate breakfast should compensate for the loss of nutrients in the other meals of the day.

h. Availability of time, energy and labour saving devices

Meal planning is greatly affected by the availability of time, energy and labour saving devices. Simple meals which can be prepared easily and quickly can be selected instead of meals which require elaborate processes. Simple methods of cooking like pressure cooking, steaming, boiling, stewing, sautéing and baking save time and energy. With the help of energy saving devices, different foods can be prepared on time and variety can be added to the meals.

D. Factors influencing selection of food

Our food habits are influenced by our cultural background, religious beliefs, social norms, our geographical location and the availability of particular food items.

The non-vegetarian diet may include large quantity of animal food, cereals and dairy products and insufficient quantity of fruits and vegetables.

A vegetarian diet may include cereals, dairy products, vegetables and fruits and exclude all animal food including egg.

Many religions, rituals and ceremonies surrounding food, consider food as nourishment for the spirit as well as for the body. Islam, Hinduism and Buddhism prohibit some dietary practices while promoting some others. During certain days prior to Christmas and Easter, many Christians eat only vegetarian dishes. Jains are strict vegetarians and they restrict the use of anything that grows below the soil and do not permit the use of such food items like onion and garlic.

The society is by and large influenced by the media where manufacturers spend a lot of money to lure and attract the public through advertisements. Children are influenced by their peers and they resort to snacks and fast food. Most snacks and fast food are high in energy and fat value and low in proteins, vitamins and minerals. Nowadays people prefer fast food because it is quickly available at outlets, convenient, and suitable to their tastes and cost.

Every region of the country has its own typical ways of combining food into meals eg. the people of the coastal areas may include more fish and cereals, the people of North India may include more wheat and dal and those of South India may include more rice and vegetables.

Many people make food choices depending upon seasonal and local availability eg. the people of Kerala may include tapioca, rice, mangoes, jackfruits, plantains, bananas and small fish for many meals and most seasons.

Know your progress

1. Define meal planning.
2. List the principles of meal planning.
3. What are the factors affecting meal planning?

3.2 Recommended Dietary Allowance (RDA) of Nutrients

How much food should we eat daily?

- .....

Do you require the same amount of food as your 5 year old brother?

- .....

To estimate a balanced diet, there is a need to know Recommended Dietary Allowance (RDA) of nutrients for different age groups prescribed by the Nutrition Expert Committee of ICMR(Indian Council of Medical Research). The Recommended Dietary Allowances are now referred to as Recommended Dietary Intakes. The recommended Dietary Intake for Indians suggested by ICMR, 2010 is given in Table-3.1

A. Recommended dietary allowances(RDA) of nutrients by ICMR for various age group.

The Recommended Dietary Allowances suggested for adults are for a reference man weighing 60 kg and for a reference woman weighing 55 kg.

a. Reference Man

A reference man is between 20-39 years of age and weighs 60 kg. He is free from disease and physically fit for active work. On each working day he is employed for eight hours in occupation that involves moderate activity. While not at work he spends eight hours in bed, 4-6 hours sitting and moving around, and two hours in walking and in active recreation or in household duties.

RECOMMENDED DIETARY ALLOWANCES FOR INDIANS

Group	Particulars	Body Wt. kg	Net energy kcal/d	Protein g/d	Visible Fat g/d	Cal-cium mg/d	Iron mg/d	Vit. A µg/d		Thia mine mg/d	Ribo flavin mg/d	Niacin eqivalent mg/d	Pyri-doxine mg/d	Ascor-bic Acid mg/d	Dietary folate µg/d	Vit.B_{12} µg/d	Magnes ium mg/d	Zinc mg/d
								Reti-nol	β-caro-tene									
Man	Sedentary work	60	2320	60.0	25	600	17	600	4800	1.2	1.4	16	2.0	40	200	1.0	340	12
	Moderate work		2730		30					1.4	1.6	18						
	Heavy work		3490		40					1.7	2.1	21						
Woman	Sedentary work	55	1900	55.0	20	600	21	600	4800	1.0	1.1	12	2.0	40	200	1.0	310	10
	Moderate work		2230		25					1.1	1.3	14						
	Heavy Work		2850		30					1.4	1.7	16						
	Pregnant woman		+350	82.2	30	1200	35	800	6400	+0.2	+0.3	+2	2.5	60	500	1.2		12
	Lactation 0-6 m		+600	77.9	30	1200	25	950	7600	+0.3	+0.4	+4	2.5	80	300	1.5		
	6-12 m		+520	70.2	30					+0.2	+0.3	+3	2.5					
Infants	0 - 6 months	5.4	92 kcal/kg/d	1.16 g/kg/d	--	500	46µg/kg/d	350	---- 2800	0.2	0.3	710 µg/kg	0.1	25	25	0.2	30	---
	6 – 12 months	8.4	80 kcal/kg/d	1.69 g/kg/d	19		05			0.3	0.4	650 µg/kg	0.4				45	---
Children	1-3 years	12.9	1060	16.7	27	600	09	400	3200	0.5	0.6	8	0.9	40	80	0.2-1.0	50	5
	4-6 years	18.0	1350	20.1	25		13			0.7	0.8	11	0.9		100		70	7
	7-9 years	25.1	1690	29.5	30		16	600	4800	0.8	1.0	13	1.6		120		100	8
Boys	10-12 years	34.3	2190	39.9	35	800	21	600	4800	1.1	1.3	15	1.6	40	140	0.2-1.0	120	9
Girls	10-12 years	35.0	2010	40.4	35	800	27			1.0	1.2	13	1.6				160	9
Boys	13-15 years	47.6	2750	54.3	45	800	32			1.4	1.6	16	2.0	40	150	0.2-1.0	165	11
Girls	13-15 years	46.6	2330	51.9	40	800	27			1.2	1.4	14	2.0				210	11
Boys	16-17 years	55.4	3020	61.5	50	800	28			1.5	1.8	17	2.0	40	200	0.2-1.0	195	12
Girls	16-17 years	52.1	2440	55.5	35	800	26			1.0	1.2	14	2.0				235	12

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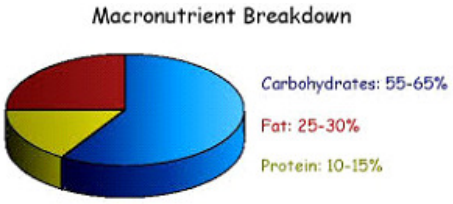
Source: ICMR 2010

Table 3.1 Recommended Dietary Allowances for Indians

b. Reference Woman

A reference woman, is between 20-39 years of age, healthy and weighs 55 kg. She may be engaged for eight hours in general household work, in light industry or other moderately active work. Apart from eight hours in bed, she spends 4-6 hours sitting or moving around only through light activity, and two hours in walking or in active recreation or in household duties.

RDA are recommendations of the average daily amount of nutrients that population groups should consume over a period of time but the nutrient requirements for specific individuals may vary. For example, a person with chronic diseases and using of medications would require special diet therapy and nutrients specific to the condition. An obese hypertensive person would require a low calorie, normal protein, low fat, low sodium diet unlike a normal person. The RDA covers fifteen nutrient factors such as energy, protein, fat, calcium, iron, vitamin A, thiamine, riboflavin, niacin, pyridoxine, ascorbic acid, folic acid, vitamin B_2, magnesium and zinc.



Let us discuss the RDA briefly.

i. **Energy:** Energy requirements are based on the body weight of the reference man and reference woman. The energy allowance recommended for Indian children and adolescents is made for the age and not for the actual body weight. Energy is stored as carbohydrates in foods. About 70% of the total calorie requirements may be met through the intake of carbohydrates.

ii. **Protein:** The protein allowance recommended is about 1 gm per kg body weight for adults. This protein is assumed to be derived from a mixture of vegetable food. Proteins of animal origin have superior biological value as compared to vegetable proteins and are desirable for infants, children, pregnant and nursing mothers. Fifteen percentage (15%) of the total calories can be derived from proteins.

iii. **Fat:** The total invisible fat of cereal based diets eaten in India and the minimum essential fatty acid requirement of various groups are considered in RDA. The visible fats which enter the diet are those such

as butter, ghee, vegetable oils and vanaspathi. All fats are concentrated sources of energy and give the same amount of calories per gram. Vegetable oils provide the body with the essential fatty acids. Energy derived from fats should not exceed 15% of the total calories.

iv. **Minerals:** The iron requirement for a woman is 4 mg higher than that of a man. Iron requirements have been arrived at, taking into account the basal loss in the case of men, basal loss + menstrual loss in the case of women, basal loss + growth requirement in the case of children. Iron loss through menstruation in woman of reproductive age groups is 0.6 mg/day on an average over a month.

The requirement of calcium prescribed by ICMR is the same for both men and women ie 600 mg. It is suggested that calcium phosphorous ratio in the diet should remain 1:1. Hence the RDA of phosphorus is 600 mg. During infancy the calcium phosphorous ratio suggested is 1:5. The bone mass increases during childhood and adolescence and peaks between the ages of 20 and 30 years. Peak bone mass is influenced by calcium intake.

v. **Trace elements:** Desirable daily intake of some trace elements have been suggested for an adult: chromium 65 μgm, copper 2.2 mg, manganese 5.5 mg, zinc 12 mg, molybdenum 500 μgm and magnesium 340 mg.

vi. **Vitamins:** The requirement of vitamin A is the same for both men and women.

B. Factors affecting RDA and food allowance

The RDA of an individual depends on several factors.

1. Age (child/adolescent): A growing child requires more calories and protein per kilogram body weight than an adult. A growing adolescent boy may require more nutrients in terms of calories, proteins, minerals and vitamins compared to an adult officer or a retired teacher.
2. Sex (male/female): Girls require more iron than boys at the onset of menarche.
3. Body size and frame: A tall well-built man needs more calories than a small statured man because of his larger body surface area and the greater weight of his bones.
4. Physiological status (Pregnancy, Lactation): During pregnancy and

lactation the nutrient requirements are increased.

5. Type of work (sedentary, moderate, heavy): A heavy worker requires more calories and B vitamins compared to a sedentary worker because he expends more energy during hard physical work.

Know your progress

1. List the factors affecting RDA and food allowance.
2. Define reference man and reference woman.

3.3 Diet during Adolescence, Pregnancy and Lactation

We have seen that the nutritional requirement of a person changes with age, sex, physiological state etc. Now, let us examine the nutritional requirement and the diet for adolescence, pregnancy, and lactation.

A. Diet during Adolescence

Which age group do you belong to?

- .....

What are the characteristics of this age?

- .....

Children between ten and nineteen years are considered as adolescents or teenagers and the period of transition from childhood to adulthood is called adolescence. With the onset of adolescence, the steady growth of childhood speeds up abruptly and the growth patterns of females and males become distinct.

Hormones direct the intensity of the adolescent growth spurt, profoundly affecting every organ of the body, including the brain. In general, the adolescent growth spurt begins at the age of 10 or 11 for females and at 12 or 13 for males. Before puberty, male and female body composition differs only slightly. During the adolescent period, differences between the sexes become apparent in the skeletal system; lean body mass for boys and fat stores for girls. In females, fat assumes a larger percentage of the total body weight, and in males, the lean body mass – principally muscle and bone mass increases much more than in females. Growth velocity is maximum for boys between 12-15 years and for girls 10-13 years. They attain their adult stature between 18- 20

years but bone mass continues to increase up to 25 years. In boys, the height gain during this period is about 20 cm and weight gain is about 20 kg. On the average, females grow 15 cms taller and gain approximately 15 kg which is slightly less compared to boys. Thus the adolescent period is characterized by heavy demands of calories, proteins, minerals and vitamins.

a. Nutritional Requirement

i. **Energy:** The appetite of the adolescent increases and he tends to consume more carbohydrate foods. Girls consume fewer kilo calories than boys. Boys need 2750 – 3020 Kcal a day. Increased growth and physical activity contribute significantly to the total energy requirement. An adolescent girl requires all nutrients in good quantities not just for the rapid growth but also to obtain optional storage for later requirements during pregnancy and lactation.

ii. **Proteins:** Protein intake usually exceeds 1 gm/ kg body weight. This meets the need for skeletal growth, muscular development, increase in blood volume and rapid tissue growth.

iii. **Vitamins:** The RDA for most vitamins increases during the adolescent years. The B vitamins are required in greater amounts by boys than girls to meet their extra demands of energy and muscle tissue development. Skeletal growth requires vitamin D, while the structural and functional integrity of newly formed cells depends on the availability of vitamins A, C and E. The ICMR expert committee also recommends the intake of vitamin B_6 (pyridoxine) to reduce premenstrual tension. Folic acid is required to prevent megaloblastic anaemia and vitamin B_{12} is required for DNA Synthesis.

v. **Minerals:** The need for iron during adolescence differs for males and females. Iron requirement increases in females as they start to menstruate and in males as their lean body mass develops. Iron intakes often fail to keep pace with the increasing needs, especially for females, who typically consume less iron rich foods. Iron is necessary for haemoglobin synthesis which is essential for the expansion of blood volume and for myoglobin synthesis which promotes muscle growth.

Bone growth demands calcium. Adolescents who have less bone mineral density are susceptible to osteoporosis later in their life. Elemental calcium phosphorous ratio of 1:1 should be maintained.

Zinc is necessary for the development of muscles and sexual organs.

b. Food choices and habits of adolescents

What kind of food do you like most?

- .....

Teenagers have the worst eating habits. They may skip a meal particularly breakfast. Missing breakfast may be due to irregular eating habits, peer pressure, lack of time and sometimes due to the desire to lose weight. Some teenagers may lack nutritional awareness and they may eat fast food or snacks which are high in fat and sodium and low in calcium, iron, vitamin A, vitamin C, and folate. A person who is figure conscious may follow some crash diets which will predispose the person to malnutrition.

Adolescents eat about one third of their meals away from home and their nutrition is enhanced or hindered by the choices they make. Excessive intake of soft drinks, chocolates, burgers and the other convenient food is not advisable and it decreases appetite. If the physical activity of the person does not match with his intake it may result in excessive fat deposits and obesity.

Peer group approval is very important for the adolescents. Many of the food choices adolescents make reflect the opinion and actions of their peers. Advertisements which appear on TV, magazines and newspapers have a tremendous influence on the dietary habits of adolescents. Eating high calorie snacks while watching TV results in obesity.

Physical maturity and growing independence prevent adolescents with new choices to make in food selection. The consequences of these choices will influence their nutritional health throughout their life. It becomes necessary to include foods from all the basic food groups to make a balanced eating habit.

Composition of Balanced Diets for Adolescents at Moderate cost is given in Table 3.2. **Food Stuff** **Adolescents**

Food Stuff	Adolescents					
	Boys				Girls	
	13-15 yrs	13-15 yrs	16-18 yrs		13 – 18 yrs	
	V	NV	V	NV	V	NV
Cereals	400	400	420	420	320	320
Pulses	70	50	70	50	70	50
Green leafy vegetables	100	100	100	100	150	150
Other vegetables roots & tubers	150	150	175	175	150	150
Fruits	100	100	100	100	100	100
Milk	600	400	600	400	600	400
Fats and oils	30	30	40	40	30	30
Meat, fish and eggs	-	80	-	80	-	80
Sugar and jaggery	30	30	30	30	30	30
Peanut	50	-	50	-	50	-

V – Vegetarian, NV – Non vegetarian. (given by ICMR)

Table 3.2 the *Composition of Balanced Diets for Adolescents at Moderate Cost*

A sample Menu for an Adolescent Girl / Boy at moderate cost is given in table 3.3.

Time	Meal	Menu
7 am	Bed Tea	Tea
8 am	Breakfast	Puttu, bengal gram curry, plantain
12.30 pm	Lunch	Vegetable pulao, dal curry, Amaranth cutlet, Tomato-cucumber raita, Lime pickle.
4.30 pm	Tea	Ragi ada with aval and jaggery, Tea
8 pm	Dinner	Chapathi, soyabean curry, ladies finger saute, fruit salad
9 pm	Bed time	milk

Table 3.*3 A sample menu for an adolescent girl / boy (moderate cost)*

Conduct a survey among students of your school and find out the food habits and food related disorders among them and conduct an awareness campaign and prepare a report.

B. Diet during Pregnancy

Have you heard that a pregnant woman needs more food compared to others? Why?

- .....

Observe the news and identify the concept explained in it.

Malnutrition related death toll in Attapadi touches 54

THIRUVANANTHAPURAM: As the death toll touches 54 in Attapadi, a tribal hamlet in Palakkad, with one more infant succumbing to malnutrition on Saturday, advisor to the Prime Minister, TKA Nair, along with Kudumbasree officials who are on a two-day visit to Attappadi are set to issue a set of recommendations to revive the area

"There is no dearth of funds, yet the condition of the women and children in the tribal hamlet is appalling," TKANair said.

A woman's body changes during pregnancy. Her uterus and its supporting muscles increase in size and strength. Her blood volume increases to carry the additional nutrients. Her joints become more flexible in preparation for child birth. Her breast grows in preparation for lactation. Inorder to prepare herself to these changes, she can have a nutritious diet, do physical activity, take plenty of rest and be with caring companions. A healthy pregnancy depends on sufficient weight gain. Women who begin their pregnancies at a healthy weight need to gain about 10 to 12 k g, which covers the growth and development of the placenta, uterus, blood, breasts and foetus.

a. Problems encountered during pregnancy

Women usually encounter many problems related to pregnancy. They are:

i. Nausea and vomiting

Nausea or morning sickness ranges from mild discomfort to debilitating

nausea and vomiting. Severe and continued vomiting may require hospitalization if it results in acidosis, dehydration or excessive weight loss. The hormonal changes of early pregnancy seem to be responsible for women's sensitivities to the smell of food. To alleviate the problem, women are asked to arise slowly on waking up, to eat dry toast, to eat small frequent meals, avoid food with offensive odours, fried food, coffee in large amounts and strongly flavoured vegetables.

ii. Constipation

As pregnancy progresses, this condition occurs as the enlarged uterus presses against the large intestine and prevents the normal peristaltic movement necessary for evacuation. To prevent constipation, foods high in fibre such as fruits, vegetables and whole grain cereals may be eaten. Drinking at least 8 glasses of water and exercising regularly helps to avoid constipation.

iii. Heart burn

Heart burn in later pregnancy is due to the increased pressure on the woman's stomach by the growing foetus and the entry of gastric contents into the lower oesophagus. This creates a burning sensation near the heart. To relieve these symptoms the pregnant woman has to eat slowly, chew food thoroughly, eat small frequent meals, avoid spicy and greasy foods, wait an hour after eating before lying down and drink liquids between meals.

iv. Toxaemia

The symptoms of toxaemia is accompanied by hypertension, oedema, protein in urine (albumin) and in severe cases convulsion and coma if treatment is delayed. Toxaemia accounts for maternal and new born infant deaths. Malnutrition is the cause of toxaemia and if toxaemia is present in a pregnant woman, adequate quantities of proteins of high biological value may be included in her diet. Vitamins and minerals are particularly needed to avoid the general state of malnutrition.

v. Anaemia

Anaemia is common during pregnancy. Iron deficiency anaemia is common because the requirement of iron by a pregnant woman far exceeds her reserves and hence anaemia may result if her diet is not

enriched with iron rich foods. Megaloblastic anaemia is a condition where large immature red blood cells containing little or no haemoglobin are formed and this malformation in red cells is the result of folic acid deficiency. Most of the morning sickness symptoms characteristic of pregnancy could be due to deficiency of folic acid and pyridoxine.

b. Nutritional requirements

The increase in the nutritional requirements (refer table 3.1) of a pregnant woman can be attributed to the rapid growth of the foetus, development of the placenta, enlargement of maternal tissues namely the breast and the uterine tissues, increase in maternal circulating blood volume and formation of amniotic fluid.

To meet the additional nutritional requirements, food items which supply all nutrients in greater amounts to sustain and support pregnancy must be eaten by the pregnant woman.

i. Energy

The energy requirements of a pregnant woman are mostly increased in the latter half of pregnancy. The calories should be sufficient to meet energy and nutrient demands and to spare protein for tissue building. The Recommended Dietary Intake (RDI) includes an increase of about 350 kilo calories in the second half of pregnancy. The recommended energy requirements for a sedentary worker during pregnancy would be 1900 + 350 = 2250 Kcals.

ii. Protein

The requirements of protein, in pregnancy increases by 27.2 g /day. The

Diet for a healthy pregnancy

normal protein requirements of an adult woman is 55 g/day. During pregnancy it is 55 + 27.2 = 82.2 g/day. If protein requirements are not met the foetus may grow at the expense of the mother and maximum growth of the baby cannot be obtained. Good quality protein can be obtained from milk, fish, eggs, whole grains, legumes and nuts.

iii. Minerals

Calcium requirement during pregnancy is 1200 mg/ day. Recommendations to ensure an adequate intake of calcium during pregnancy are aimed at conserving the maternal bone while supplying foetal needs. Calcium is required for the growth and development of bones as well as teeth in the growing foetus. It is also an important constituent of the blood clotting mechanism. During early pregnancy the mother's bone stores the mineral. During the last trimester of pregnancy, as the foetal bones begin to calcify, over 300 mg of calcium is transferred from the mother to the foetus across the placenta. So a pregnant woman has to use more dairy products, legumes and leafy vegetables. Insufficient intakes may produce abnormal foetal bones and teeth. The doctor may advice the intake of calcium tablet in addition to diet. Vitamin D plays a vital role in calcium absorption and utilization. Besides phosphorus, magnesium and fluoride are in great demand during pregnancy.

iv. Iron

Pregnant women need iron to support their enlarged blood volume and to provide for placental and foetal needs. During pregnancy, the body makes several adaptations to meet the exceptional high need for iron. Menstruation, the major route of iron loss in woman ceases and also iron absorption triples. Few women enter pregnancy with adequate iron stores, so a daily iron supplement is recommended during the second and third trimesters for all pregnant women. To enhance absorption, the supplement should be taken between meals or at bed time with liquids other than milk, coffee or tea which inhibit iron absorption.

The normal iron requirements of an adult woman is 21 mg /day ICMR recommendations during pregnancy is 35 mg / day. Liver, dried beans, green leafy vegetables, eggs, enriched cereals and iron fortified salt provide additional sources of iron.

Zinc is required for DNA and RNA synthesis and cell development. Zinc deficiency leads to adverse effects on the newborn including foetal mortality, foetal malformations and reduced intrauterine growth rate.

v. Vitamins

All vitamins are required in additional quantities during the gestation period especially vitamin A, B complex, C, D and folic acid.

Vitamin A requirement increases by about 25 % over the usual adult intake. These requirements can be met by consuming good sources of food which include liver, egg yolk, butter, dark green and yellow vegetables and fruits.

B –vitamins especially thiamine, riboflavin and niacin are required in large quantities since they are co-enzymes in a number of metabolic activities and in the functioning of muscles and nerve tissues. Folic acid is required for normal foetal growth and for the synthesis of essential components of DNA and RNA. Folic acid is also essential for the development of RBCs which increases in the mother's blood. Folic acid deficiency can cause malformation in the offspring. So all women of child bearing age should take folic acid supplementation foods such as dark green vegetables, legumes, orange juice, soya beans, wheat germ, almonds and peanuts.

Low maternal intake of vitamin C is associated with increased neonatal death rates.

For a pregnant woman whose diet has conformed to the basic five food pattern, emphasis should be given to the choice of more nutrient dense foods or those foods that give the most nutrients per calorie consumed. The consumption of small and frequent meals at regular intervals is helpful to many women,when discomfort is experienced after large meals, due to overcrowding by foetus in the abdominal cavity. Plenty of water at least 8 to 10 glasses in addition to other beverages should be taken daily throughout pregnancy. This will help to keep bowels regular. Composition of balanced diet for a pregnant woman given by ICMR sedentary worker at moderate cost is given in Table 3.4.

Food stuff	V	NV
	gm	gm
Cereals	260	250
Pulses	80	50
Green leafy vegetables	100	100
Other vegetables	75	75
Roots and tubers	50	50
Fruits	110	110
Milk	800	450
Fats and oils	30	35
Sugar and jaggery	30	30
Meat and fish	-	85
Eggs	-	30

Table 3.4 Composition of Balanced Diet for a Pregnant woman given by ICMR sedentary worker (Moderate cost)

A sample menu in pregnancy (moderate cost) is given in Table 3.5.

Time	Meal	Menu
6.30 am	Bed coffee	Tea, biscuits
8.30 am	Break fast	Appam, egg curry, dates
10.30 am	Mid-morning	Ragi porridge
12.30 pm	Lunch	Rice, cluster beans sauté, sambar, fish curry, amaranth pugath, butter milk.
2.30 pm	Afternoon	Guava milk shake
4.30 pm	Tea	Tea, ragi ada with jaggery
6.30 pm	Evening	Vegetable soup
8.30 pm salad)	Dinner	Chapati, paneer vegetable curry, mixed salad (tomato, cucumber, sprouted green gram
10 pm	Bed time	Milk

Table 3.5 *Diet in pregnancy*

C. Diet during lactation

Lactation is an automatic physiological process that virtually all mothers are capable of doing. Breast feeding on the other hand, is a learned behaviour that not all mothers decide to do.

A mother derives great satisfaction if she is able to nurse her baby for at least 6 months. Breast milk has several advantages for the baby and for the mother. Nature has designed it to be a complete food for the first few months of a baby's life. Breast milk gives immunity to the baby against infection, especially the colostrum which is rich in antibodies.

Breast milk is safe for the baby unlike bottles which have to be sterilized. For the mother, it helps her uterus regain its normal size from the enlargement during pregnancy. It promotes an emotional bonding between the mother and the infant as she holds the child close to her body while feeding. Proper emptying of breasts reduces the chances of breast cancer or malignancy. Ideally the mother who chooses to breast feed her infant will continue to eat nutrient dense foods throughout lactation. Nutritional needs of a lactating mother are higher than that of a pregnant mother.

a. Nutritional requirements

i. **Energy:** A nursing mother produces about 680 ml of milk per day during the first 6 months. Severe energy restriction may hinder milk production. The metabolic work involved in producing this amount of milk requires around 570 Kcal for the first six months. For this reason the ICMR has recommended an additional 600 Kcal for 0-6 months and an additional 520 K cals from 7 to 12 months. So the energy requirement for a sedentary worker would be

1900 + 600 = 2500 Kcal (0-6 months lactation)

1900 + 520 = 2420 Kcal (7-12 months lactation)

ii. **Protein:** An increase in protein intake is recommended for women during lactation. The average protein content of breast milk of Indian women is 1.2 g/100 ml. ICMR has recommended an additional daily intake of 22.9 gm for the first six months and 15.2 gm during 7-12 months of lactation. So the protein requirement for a sedentary worker would be

55 + 22.9 = 77.9 gm (0-6 months lactation)
55 + 15.2 = 70.2 gm (7-12 months lactation)
If energy or protein is lacking, there will be a reduction in milk volume rather than in milk quality.

iii. **Fat:** The level of fat in the diet would provide adequate energy to enable nursing women to meet their higher energy needs.

iv. **Minerals** – Dietary calcium has no effect on the calcium concentration of breast milk, but maternal bones lose some of their density during lactation. Breast feeding is associated with transfer of approximately 200 mg/ day of calcium from mother to the infant. During lactation ICMR has prescribed 1200 mg of calcium for mother's milk production.
Iron is not secreted much into the milk so the iron requirement during lactation is 25 mg/day.

v. **Vitamins:** The quantity of retinol present in 680 ml of human milk is 50 μg, so the ICMR recommends an additional allowance of 350 μg. As calorie requirements are high during lactation, Vitamin B requirements are also high. Nutrients in breast milk which are most likely to decline in response to prolonged inadequate intakes are the vitamins – especially vitamin B_6, B_{12}, A and D. Vitamin C requirements are 80 mg per day considering the vitamin C secreted in human milk and cooking losses incurred.

vi. **Fluids:** A lactating mother must drink plenty of fluids (at least 2 litres a day) to protect herself from dehydration. A sensible rule of the thumb is to drink a beverage like soup, juice, milk or water at each meal and each time the baby nurses.

b. Exercise

Women often exercise to lose weight and improve fitness. Intense physical activity can raise the lactic acid concentration of breast milk which affects the taste of milk. Infants may prefer milk produced prior to exercise which has lower lactic acid content.

c. Medication

All drugs taken by the mother will be excreted in breast milk in low concentrations up to less than 1 percent. So medications should be taken only on physician's advice.

Composition of a balanced diet (given by ICMR) at moderate cost for a lactating mother is given in Table 3.6.

Food Stuffs	Sedentary Worker	
	V (g)	NV (g)
Cereals	370	350
Pulses	100	50
Green leafy vegetables	100	100
Other Vegetables	75	75
Roots and tubers	50	50
Fruits	110	110
Milk	1000	550
Fats and oils	50	55
Sugar and jaggery	50	50
Meat and Fish	-	100
Eggs	-	30

V- Vegetarian N V – Non Vegetarian

Table 3.6 *Composition of a balanced diet at moderate cost for a lactating mother*

Since the nutrient requirements are more during lactation more frequent feeds may be given. A sample diet for a lactating mother is given in Table 3.7.

Time	Meal	Menu
6 am	Bed Coffee	Coffee
8 am	Breakfast	Idiappam, peas-potato curry, Ripe papaya
10.30 am	Midmorning	Lime juice, gingelly seed balls
12.30 pm	Lunch	Rice, cucumber pulliseri, cow gram pugath, fish curry, beans saute
2pm	Afternoon	Aval payasam
4 pm	Tea	Tea, kozhukatta
6 pm	Evening	Amaranth soup
8 pm	Dinner	Rice & Chapathi, Soyabean curry, fish fry, vegetable salad, carrot, beetroot saute
9.30 pm	Bedtime	sooji porridge

Table 3.7 *A Sample diet for a lactating mother (moderate cost)*

Let us conclude

Every individual requires a balanced diet for optimum health. This can be achieved by careful planning of meals. Meal planning is a technique for providing the family with meals that will meet nutritional requirements. It helps us to have meals at low cost, taking into consideration the food preferences of each family member. Meal planning should be based on the principle of nutrition; it should suit the family, give satiety value and should be economical. It should consider the economic factors, size and composition of the family, season, food availability, food acceptance, lifestyle and availability of time, energy and labour saving devices. The family's food habits are influenced by the cultural background, religious belief, social norms, geographical locations, and the availability of particular food items. Meal planning should be based on Recommended Dietary Allowance (RDA) for each age group. The RDA of a person is depended on age, sex, body size and frame, physiological state and the type of work.

Lab activities

1. Plan a day's menu for the following categories, prepare a dish from the planned meal and calculate the nutritive value (energy, protein, calcium and iron) of the prepared dish.
   - A pregnant woman (Sedentary)
   - Lactating mother (Sedentary 0-6 months)
   - Adolescent Boy/Girl (16-18 years)

Let us assess

1. Expand the following
   a. RDA
   b. ICMR
2. The protein allowance recommended for an adult is_____ per kilogram body weight.
3. Explain to a group of working mothers about the importance of planning meals for a family.

4. The meal patterns for one family may be different from another. Explain the factors which affect meal planning.
5. While selecting food for the family, Reetha's family prefers non vegetarian food while Rema's family likes vegetarian food. What are the other factors which influence the selection of food?
6. The adolescence period is characterized by the heavy demand of calories, protein, minerals and vitamins. Justify the statement.
7. Differentiate between Reference Man and Reference Woman.
8. Reena, a pregnant woman, was advised by the doctor to have a balanced diet based on RDA. Explain the reason for her increased nutritional requirements.
9. Plan a diet for a lactating woman (0 to 6 months) and discuss her nutritional needs.
10. Fill in the blanks appropriately:

Age Group	Energy (KCal)	Protein (g)	Iron (mg)	Calcium (mg)
Adolescent girl (13 to 15yrs)	2330	.....	27	.....
Lactating woman (0 to 6 months)	.....	77.9	.....	1200
Pregnant woman	+350	.....	35	.....

4 Diet Therapy

Key Concepts

Significant Learning Outcomes

After the completion of this chapter, the learner:

- identifies diet therapy, explains its principles, objectives and factors to be considered
- describes the modification of diets
- identifies and compares the diets in common diseases
- develops an attitude to take diet as a method for the prevention of diseases

We are familiar with the concept of balanced diet and its importance in maintaining a healthy living. Unhealthy eating practices are a major reason for many diseases. A change in diet or a special diet can often help in treating or preventing the occurrence of ill health. A diet which is specially designated for people with particular medical conditions, by adding or limiting certain food, in order to improve a specific health condition is called a 'therapeutic diet'. Changes in diet can help or even relieve some medical conditions. It is usually a

modification of a regular diet. It is modified or tailored to fit the nutritional needs of a particular person. Let us examine the principles of diet therapy and dietary modifications in common diseases.

4.1 Principles and Objectives of Diet Therapy

What is the role of a dietician in a hospital?

- .....

Diet therapy means implementing a specific diet (food and drink) not only for the care of the sick, but also for the prevention of diseases and maintenance of health. It is usually done under the observation of a dietician in hospitals. It is concerned with the use of food as an agent in effecting recovery from illness.

A. Principles of diet therapy

A well planned diet which provides all the specific nutrients to the body helps to achieve nutritional homeostasis in a normal, healthy individual. However, in disease conditions, the body tissues either do not receive proper nutrients in sufficient amounts or cannot utilize the available nutrients owing to faulty digestion, absorption or transportation of food elements, thus affecting the nutritional homeostasis. The diet therefore needs to be suitably modified. Therefore, diet therapy is concerned with the modification of the normal diet to meet the requirements of the sick individual.

B. General objectives of diet therapy

The general objectives of diet therapy are:

- to maintain a good nutritional status
- to correct nutrient deficiencies that may have occurred due to the disease
- to afford rest to the whole body or to the specific organ affected by the disease
- to adjust food intake to suit the body's ability to metabolize the nutrients during disease
- to bring about changes in body weight whenever necessary.

C. Factors to be considered in planning therapeutic diets

1. The disease condition which requires a change in the diet
2. The possible duration of the disease
3. The factors in the diet which must be altered to overcome these conditions
4. The patients' tolerance for food.

In planning meals for a patient, his economic status, food preferences, occupation and time of meals should also be considered.

The four attributes of a therapeutic diet are:

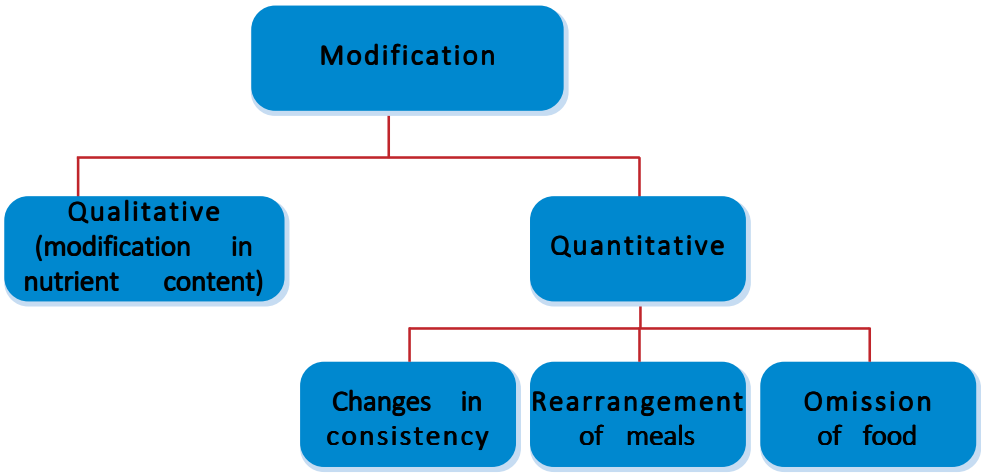
- adequacy
- accuracy
- economy
- palatability.

Know your progress

1. Define diet therapy.
2. What are the general objectives of diet therapy?
3. Explain the factors to be considered while planning therapeutic diets.

4.2 Modification of Therapeutic Diets

Therapeutic diets can be modified in terms of quality and quantity.



A. Qualitative modification: Qualitative modification of diet includes restriction or excess of nutrient in the diet. Modifications are usually brought about in the following ways:

a. High calorie diet: This is a normal diet with an increase in the calorie level to 3000 calories or more. If appetite is poor, small servings of highly reinforced food is given. The diet may be modified in consistency and flavour, according to specific needs. Excessive amounts of bulky low calorie food, fried food or others which may interfere with appetite should be avoided.

These diets are prescribed for

- under weight
- fever
- hyperthyroidism
- burns.

b. Low calorie diet: This is a normal diet with energy values reduced to 1500, 1200 or 1000 calories. Protein levels should be at 65 to 100 g. Supplements of vitamin A and thiamine are usually required for diets below 1000 calories. These diets are prescribed for weight reduction in

- diabetes mellitus
- cardiovascular diseases
- hypertension
- gout
- gall bladder disease
- preceding surgery.

c. High protein diet: High protein diet of 100 – 125 g per day may be prescribed for a variety of conditions like:

- fever
- hyperthyroidism
- burns
- nephrotic syndromes
- haemorrhage
- after surgery

- diarrhoea
- infective hepatitis
- old age
- alcoholics.

d. **Low protein diet:** Low protein or complete withdrawal of proteins from diets is usually prescribed for conditions like:

- hepatic encephalopathy
- acute and chronic glomerulonephritis
- nephrosclerosis
- acute and chronic renal failure
- inborn errors of metabolism.

e. **Fat controlled diet:** Fat controlled diets regulate the amount and type of fat allowed. The calories from fat should provide about 30% - 35% of the total calories with 10% from saturated fat and 12 – 14% from poly-unsaturated fats. Even the intake of cholesterol is reduced from the average daily intake of 600 to 300 mg.

Usually fat controlled diets are prescribed for:

- gall bladder diseases
- atherosclerosis
- myocardial infarction
- hyperlipidemia etc.

f. **High fat diet**: A moderately high fat diet is used in the treatment of severe undernutrition.

g. **Low sodium diet:** In this diet, four levels of sodium restrictions are most often used — 250, 500, 1000 and 2400 – 4500 mgs. The first diet is a severe restriction that excludes salty food and salt in cooking and at the table. This diet is used both to prevent and treat oedema. Therefore, it is prescribed for congestive heart failure, hypertension, toxaemia of pregnancy, liver and renal diseases. Some renal patients may not be able to regulate sodium excretion and become hypo-natremic. Then sodium must be supplemented by means of the diet. In renal patients with chronic uraemia it may be necessary to restrict potassium and phosphorous.

h. **High calcium/low calcium diet:** High calcium diet is essential in the treatment of rickets and osteo-malacia, while a diet restricted in calcium and phosphorous is desirable in renal calculi.

i. **High vitamin diet:** Increase in the content of vitamins can be easily achieved by the addition of synthetic vitamins. This is essential as most of the therapeutic diets may be partially lacking in one or more vitamins.

B. **Quantitative modification**: Quantitative modification of diet can be made in consistency, rearrangement of meals or omission of food.

a. **Changes in consistency:** Such a diet is used in the treatment of gastro intestinal tract. They can be from a very low residue diet to a very high fibre diet. Method of feeding is by mouth, unless otherwise indicated. They are of three types:

i. Diet without solids (liquid diets)

ii. Diet with solids

iii. High fibre diet

i. **Diet without solids (liquid diets):** Liquid diet consists of a variety of food that are liquid at room temperature. Such a diet is used in:

- febrile states
- post operative conditions
- wherever the patient is unable to tolerate solid food

Liquid diet is of two types namely.

- Clear fluid diet
- Full fluid diet.

- **Clear Fluid Diet:** A clear fluid diet is usually used for 1 or 2 days. After that a more liberal liquid diet is given. The amount per feeding is 30 – 60 ml/hour. As the patient's tolerance improves, the amount can be increased.

This diet is indicated in:

- acute illness
- surgery
- gastrointestinal disturbances.

Food permitted in a clear fluid diet are:

- tea with lemon and sugar
- coffee
- fat free broths.
- carbonated beverages
- cereal waters.

- **Full fluid diet:** Full fluid diet includes food items which are liquid at room temperature**.** It is free from cellulose and irritating condiments. In this diet, iron is provided at inadequate levels. Six or more feedings can be given daily. The protein content of the diet can be increased by incorporating whole egg, egg white, non-fat dry milk in beverages and soups.

  The calorie value of the diet can be increased by adding butter to cereal gruels and soups, glucose in beverages and using creams in dessert. If decreased volume of fluid is desired, non fat dry milk can be substituted for the part of the fluid milk. This diet is indicated when a patient is:

  - acutely ill
  - unable to chew or swallow solid food.

Food allowed in a full fluid diet are:

Beverages — Cocoa, coffee or tea.

Cereal — Fine or strained gruels.

Dessert — Soft custard, gelatin.

Eggs — Raw in broth with fruit juices or milk.

Fruit — All strained juices.

Meat — Strained in soups.

Vegetables — Puree, soups.

Miscellaneous — Butter, cocoa, sugar, salt.

ii. Diet with solids

- **Soft and low fibre diet**

Soft diet is between liquid diet and normal diet. Soft diet includes both liquid and solid food which contain restricted amount of indigestible carbohydrates

and no tough connective tissues. The diet can be made mechanically soft by cooking, mashing, pureeing the food used in a normal diet. Further reduction in indigestible carbohydrate can be achieved by the use of refined breads, cereals, immature vegetables and fruits. The skin and seeds of fruits have to be removed.

Soft fruits like banana can be used as it is. Tough connective tissue can be reduced, by selecting tender meat and cooking which makes it very soft. Meat and meat broths have to be restricted because non protein nitrogen products such as creatine, creatinine, purines and other products which are present in muscle tissue are extracted into the gravy which stimulates gastric juice. Strong flavoured vegetables such as onions, radish, dried beans, cabbage, and cauliflower have to be omitted if necessary. It is not necessary to eliminate all spices. Only gastric irritants like black pepper, chillies, cloves etc. are to be eliminated. This diet is nutritionally adequate. It is soft in texture and bland in flavour.

- **Low residue diet**

Low residue diet is made up of food which can be completely absorbed, thereby leaving a little or no residue for the formation of faeces. This diet provides insufficient minerals and vitamins and therefore it must be supplemented. Food high in fibre should be omitted. Food which contains residue but not fibre such as milk are also omitted or restricted. Two cups of milk may be permitted per day. Strained fruits and vegetables without skins are usually permitted. Meat should be tender or ground to reduce connective tissue.

The diet is usually used in

- severe diarrhoea to afford rest to the gastrointestinal tract
- ulcerative colitis in initial stages
- operations
- partial intestinal obstruction
- Reducing the bulk in the gastrointestinal tract whenever necessary.

iii. High fibre diet

Dietary fibre plays a significant role in colonic function. High fibre diet is mainly used for constipation and diverticulosis. This is a normal diet with fibre increased to 15–20 mg. daily.

Fluid intake is also increased. Concentrated food should be replaced by those of greater bulk.

Food items which can be included in the diet are plenty of long fibred vegetables, salads, fruits and whole cereal grains. Highly refined and concentrated food, excessive amount of rough bran and excessive seasoning should be avoided. Intervals of feeding should be three meals daily.

b. **Rearrangement of meals:** Increasing or decreasing the frequency of meals depending on the health condition of the patient.

c. **Omission of food:** Specific food may cause an immunologically mediated response in certain individuals. Food which causes a known reaction is eliminated from the diet. Common offenders are milk, egg, wheat, chocolate and such other foods. Diagnosis of food to which the individual has an allergic response can be accomplished through diaries, use of elimination diets, use of skin tests and use of laboratory tests. Food intolerance results in symptoms associated with the intake of that food but not any immunological responses. A common example of food intolerance would be lactose intolerance. Food with milk is eliminated from the diets. Lactose deficient subjects can tolerate lactose pre-digested milk products.

Modification in nutritional requirements in therapeutics does not occur in isolation. In some disorders, based on the patient's condition many nutrient modifications need to be done.

Know your progress

1. Classify the modification of therapeutic diets.
2. Name the food allowed in a full fluid diet.
3. Differentiate clear fluid diet and full fluid diet.

Complete the following table:

Sl.no	Diet consistency	Example
1		
2		
3		
4		

4.3 Diet in Common Diseases

A. Diarrhoea

What type of food do you use commonly while suffering from diarrhoea?

- .....

There is a deep relationship between good digestion and body nutrition. Sometimes our body cannot have the desired benefit from the food (even if it is a balanced meal) because of digestive disturbances. This is because of incomplete digestion and problems of absorption of the food. Diarrhoea is one of the digestive disorders.

In diarrhoea, a patient passes loose, watery and unformed stools from the body. In diarrhoea absorption and digestion of nutrients is lowered considerably. This disease is very common among children and old persons.

a. Causes of diarrhoea

The following factors are the main causes of diarrhoea

i. **Malnourishment:** Malnourished children develop many deficiencies like protein-calorie deficiency, vitamin deficiencies etc. Under such conditions the body is more susceptible to infections because of lower immunity and weak digestive system. Diarrhoea is very common in such conditions.

ii. **Unhealthy environment:** Contaminated food and water are the main causes of diarrhoea. Flies are the carriers of this disease. They carry germs from dirty places and settle on food and contaminate it. Such food when consumed causes diarrhoea. This disease is common in summer and rainy season.

iii. **Food allergy:** Sensitivity to a particular food is known as food allergy, eg., if a person is allergic to egg, spinach, brinjal; their intake may lead to acute diarrhoea.

iv. **Drugs:** Some people are sensitive to certain drugs and the use of such drugs leads to diarrhoea, eg., sensitivity to antibiotics, drugs etc.

v. **Psychological factors:** The emotional sensitivity of a person in a particular situation can also be the cause of diarrhoea, eg., tension during an examination, immense happiness or sorrow etc.

b. Types of diarrhoea

Diarrhoea is of two types:

i. Acute diarrhoea

ii. Chronic diarrhoea.

i. **Acute diarrhoea:** It is caused by eating unhygienic, infected, and stale food. Its duration lasts for 1-3 days. It is characterized by loose, watery stools, abdominal pain, fever, vomiting and weakness in the body. Water electrolyte balance is disturbed because of excessive loss of water from the body and may lead to dehydration.

ii. **Chronic diarrhoea:** It lasts for a much longer period. It is caused by the intake of some irritant or stale food. Nutritional deficiencies may develop in chronic diarrhoea. Water electrolyte balance is also disturbed. There is the loss of water-soluble vitamins due to excessive loss of water from the body which may lead to vitamin deficiencies.

c. Nutritional requirements of a diarrhoea patient

Maintaining nutritional status is a big problem in diarrhoea. Considerable loss of energy, liquids, minerals, serum, protein, etc. is caused by diarrhoea. Hence all these factors play a vital role in the diet therapy of this disease. Normally, the diet should meet the requirements of the following nutrients:

i. **Energy:** Considerable loss of energy demands sufficient intake of calories. To meet the calorie requirements, easily digestible carbohydrate rich food like fruit juices, suji kheer, boiled rice, etc. should be given to the patient.

ii. **Proteins:** Proteins are lost in considerable amounts in diarrhoea. Hence, sufficient amount of proteins are required by the diarrhoea patient. Protein rich food like boiled eggs, toned milk etc. should be given to the patient with the improvement in his condition.

iii. **Fats:** Fats and fat rich foods are restricted to the diarrhoea patient because the intestine is incapable of absorbing them. Butter and light fats like cream can be given to the patient after the improvement in condition.

iv. **Vitamins:** Deficiency of water soluble vitamins like vitamin B complex and C in the body is caused by the loss of water in diarrhoea. Hence, fruit juices must be added in the diet of the patient.

v. **Minerals:** Loss of sodium and potassium leads to their deficiency diseases, like loss of appetite, vomiting, restlessness, loss of flexibility in the muscles of the alimentary canal, etc. Their deficiency can be met by giving fruit juices to the patient after adding salt.

vi. **Water:** Excess amount of water is excreted during diarrhoea. Hence, it is very important to make up for this deficiency. Patients should be given liquids in the form of mineral water, juices, soups, lemon water, barley water, etc. Oral Rehydration Solution (ORS) should be given to prevent dehydration.

d. Diet planning

During diarrhoea, total rest should be given to the digestive system of the patient. Patient should avoid the intake of solid food for 12-36 hours. Full liquid diet should be given to him to prevent dehydration, like salted water, glucose water, strained fruit juices, lemon water, whey water, barley water etc.

After improvement in the patient's condition, semi-liquid diet without fibre should be given eg. tea, coffee, fruit juice, milk, jelly, lassi without fat, thin custard, strained vegetable soups, dal water etc.

After considerable improvement in the patient's condition, soft foods like boiled rice, half boiled egg, custard, boiled vegetables, fibreless fruits, food made up of skimmed milk, khichadi, porridge etc. should be given.

Patient should be served normal diet by the improvement in his condition.

Points to be considered

- small amount of food should be given to patient at regular intervals. In the beginning, food should be served at an interval of one and a half to two hours
- avoid use of extremely hot and cold food
- food should be simple and without spices
- fibrous food should be avoided in diet
- fried food should be avoided in diet
- more liquids should be given.

A sample menu for diarrhoea patient is given in the Table 4.1.

Time	Meal	Menu
6 am		Light tea
8 am	Breakfast	Cornflakes or rava porridge without milk, poached eggs, papaya
10 am	Mid time	Boiled banana
12.30 noon	Lunch	Rice gruel, mashed potato, strained vegetable soup
2.30 pm	Mid time	Strained spinach soup
4 pm	Tea	Arrowroot porridge
6 pm	Mid time	Sago gruel
8 pm	Dinner	Strained vegetable soup, double boiled rice, dal mashed, mashed tomato puree

Table 4.1 A sample menu for diarrhoea patient

Know your progress

1. What are the causes of diarrhoea?
2. State the nutritional requirements of a diarrhoea patient.
3. What are the points to be considered while planning meals for a diarrhoea patient?
4. Explain different types of diarrhoea.

B. Fever

How do you manage your diet during fever?

- .....

An increase in the body temperature above normal is generally referred as fever. There is an increase in the rate of metabolic activities in fever. Fever is the result of an imbalance between the heat produced and heat eliminated in the body. It is not a disease in itself but an indication of some disease. Infections and malnutrition are the main causes of fever. Nutrition during fever is affected by the following important changes:

- Increase in temperature in fever increases the rate of metabolism in the body. For every 1° F rise in temperature, energy requirement is increased by 7%

- Energy is stored as glycogen in the body. Amount of glycogen is gradually depleted in fever
- Loss of tissues in fever leads to increased demand of proteins
- At the time of fever, acute deficiency of water and minerals occur due to excessive sweating and urination
- Digestion is disturbed in fever. It leads to less absorption of nutrients in the body from food.

a. Types of fever

i. **Short duration fever:** Such fever is acute but short in duration eg., common cold, cough, throat infection, influenza, measles, pneumonia etc.

ii. **Long duration fever:** Such fever lasts for longer duration with low temperature, eg. tuberculosis.

iii. **Intermittent fever:** Such fever occurs in intervals, eg. malaria, typhoid etc.

i. Diet for fever of short duration

The diet in fever depends upon the type, severity of condition and the length of convalescence. Normally, the diet should meet the requirements of the following nutrients:

a. Nutritional requirement

- **Energy:** Calorie requirement increases approximately by 50% during fever, sometimes even higher. The calorie needs depend upon the loss of tissues and the temperature. It is difficult to meet the energy requirements of the body during high fever. But as soon as the patient is in a position to eat something, calorie rich liquids should be given, eg. fruit juices, glucose water, honey water etc.
- **Carbohydrates:** To meet the increased demand of energy and to restore glycogen in the body, increased amount of carbohydrates should be given to the patient. For this, glucose, honey, sugar etc. can be added to the diet. Glucose is the best source of carbohydrate during acute fever because it is easily digested and absorbed in the body
- **Fats:** Fried and fat rich food should be avoided in fever. But to meet the energy requirements, easily digestible simple fats like butter, cream etc. should be given to the patient.

- **Proteins:** Breakage of tissues during fever leads to high requirement of protein. This demand is more in chronic fever as compared to acute fever. 100gm or more of proteins should be given to the patient to make up this loss
- **Minerals:** In fever, considerable amount of salt like sodium and potassium are lost from the body due to the excretion of water. Loss of sodium is made up by adding salt to juices, soups, vegetables etc. Fruit juices, vegetable soups and milk are good sources of potassium
- **Vitamins:** Increased amount of vitamin A, ascorbic acid (vitamin C) and vitamin B-complex should be included in the diet because of the increased metabolic activities and decreased vitamin synthesis due to antibiotics in the body. Ascorbic acid increases immunity in the body
- **Liquids:** Two and a half to five litres of liquids per day should be given to the fever patient. For this, plain water, soup, fruit juice, sharbat, tea, coffee, milk etc. should be given to the patient. Requirement of liquid is more in summer as compared to winter.

b. Diet planning

Small amount of food should be given to the fever patient at short intervals. High calorie and high protein diet should be given to the fever patient. During acute fever, the patient should not be forced to eat because either he is unable to eat or there is a loss of appetite. But for patients of chronic fever, care should be taken in planning meals. The patient must be given full diet by all possible means, otherwise he will become weak.

The patient suffering from fever should be given liquid, semi-liquid or soft food according to his/her condition. Apart from this, food should be easily digestible. Sometimes excessive use of liquid leads to aversions and nausea in the patient. Soft food are easily digestible to such patient. Low fibre diet without spices may be given to the patient.

Food allowed: Soup, juice, milk, tea, coffee, barley water, whey water, lemon water, glucose, honey, porridge, cornflakes, sago, bread, rice, biscuits, curd, cream, custard, pudding, mild food, egg etc.

Food not allowed: Flour with bran, whole pulses and cereals, all fruits (juices can be given), fried and spicy food, nuts, sticky food, fibrous vegetables, pastries, sweets etc.

ii. Diet in fever of long duration

In long duration fever, metabolic rate is low but it increases a bit when temperature of the body rises. Loss of appetite and digestive disturbances may start appearing. Apart from medicines, diet control is also very important in such fever.

c. Nutritional requirements

- **Energy:** In the case of tuberculosis, temperature is not very high as compared to other fever. Therefore weight loss can be prevented by an intake of 2500-3000 calories per day.
- **Protein:** Protein is very important to replace worn out cells by new cells and tissues. Amount of albumin in serum is reduced drastically. Hence, there is the requirement of more proteins
- **Minerals:** Calcium is very important for healing up of wounds in tuberculosis; this demand of calcium can be met by taking one litre of milk daily. Intake of iron should be increased if there is blood in sputum
- **Vitamins:** In the case of tuberculosis carotene is not converted into vitamin 'A' in the body. Therefore food containing more vitamin A and less carotene should be included in diet. For this, liver should be added to the diet at least once a week along with vitamin 'A' tablet.

Requirement of vitamin C is also increased. To meet this demand, food rich in vitamin C along with a tablet of vitamin C should be given to the patient. Vitamin D is important for the absorption of calcium. Requirement of vitamin B complex rises in proportion to the requirement of calories. These help in increasing appetite too.

b. Diet planning

During high fever in tuberculosis, liquid diet, rich in protein and calories should be given to the patient. There is a loss of appetite but still he should be given food for 5-6 times per day. Food should be simple, digestible and fat free. When the patient has high fever due to any other causes, the same diet recommended for high fever is to be followed. With the fall in temperature, gradually give soft food, semisolid and normal food to the

patient. Food should be given in small proportions at short regular intervals and in a congenial and comfortable environment.

A sample menu for fever patients is given in the Table 4.2.

Time	Meal	Menu
6AM	Bed coffee	Milk
8AM	Breakfast	Milk, poached egg, bread, fruit cup
10AM	Mid time	Cornflakes in milk
11AM	Mid time	Orange juice
12:30AM	Lunch	Double boiled mashed rice, mashed carrot, mashed dal, biscuit pudding
2 PM	Mid time	Egg
3PM	Mid time	Lime juice with glucose
4PM	Mid time	Egg and cheese sandwich, light tea
6PM	Mid time	Tomato juice
8PM	Dinner	Wheat gruel, mixed vegetable puree, soft chapatti, pineapple cocktail
9PM	Bed time	Milk

Table 4.2 *A sample menu for a fever patient*

Know your progress

1. Which are the types of fever?
2. List the food allowed during fever.
3. Specify the nutritional requirements of a fever patient.

4.4 Diet in Nutrition Related Problems

Name a health problem due to inadequate intake of nutrients.

- .....

A. Obesity

Obesity is a state in which there is a generalized accumulation of excess adipose tissue in the body leading to more than 20% of the desirable weight. In simple terms, obesity is a consequence of an energy imbalance where energy intake has exceeded energy expenditure over a considerable period.

a. Causes of obesity

i. **Genetic factors:** Several studies show that there is a high correlation between obesity in parents and their children. By age of 17, the children of two obese parents are 3 times fatter than children of two lean parents.

ii. **Physiological factors**: Men are more prone to subcutaneous fat deposition in the central part of chest and abdomen, while women show a greater proportion of fat at peripheral sites i.e., hip and thighs.

iii. **Dietary factors**: Dietary factors particularly the levels of fat and energy intake are strongly and positively associated with excess body weight.

iv. **Physical activity**: Reduced energy expenditure in adults has been shown to correlate with subsequent weight gain.

v. **Psychological factors**: Obese people seem to be affected more by taste and appearance of food rather than hunger and satiety. Hunger is a physiological (inborn) instinct. Appetite is a psychological (learned) response to food. Satiety is the feeling of satisfaction and fullness of food. It occurs in response to gastric distension, presence of nutrients in the small intestine and gastrointestinal hormones. Tension, anxiety, fear and even humiliation associated with being obese, may further make a person resort to food for emotional satisfaction.

vi. **Social influence**: Attending parties and eating out due to social pressure is a common cause of excessive intake of food and energy. The various communication media including television, radio and print play a major role in promoting fat/energy dense food and thus have a pervasive influence on the food choice of a consumer.

vii. **Cultural influence**: These include peer group pressures, social conventions, religious practices, and the status value afforded to different food. These are often reflected in children adhering to peer pressure by selection of high fat food choices.

viii. **Endocrine factors:** Certain genetic disorders as well as some endocrinal conditions such as hyperthyroidism, PCODs (Poly Cystic Ovarian Disease) and tumours also cause weight gain.

b. Nutritional requirements for obese condition

i. **Energy:** The level of energy intake is adjusted to meet individual weight reduction requirements. One kg of adipose tissue provides energy of 7000 kcal. Hence a decrease of 1000 kcal daily is required to lose about

1kg a week and a reduction of 500 kcal daily brings about a weight loss of 0.5 kg/week.

ii. **Protein:** It is advisable to give slightly higher than normal protein as it gives a feeling of satiety and also helps to maintain BMR. Include good quality proteins in the form of low fat milk and milk products, lean meats, egg white, whole pulses and whole cereals.

iii. **Fat:** 15-20% of total energy should be provided by fats. Total visible fat intake recommended / day is 10 g (2 tsp) equivalent to mustard oil/ corn oil/olive oil/sunflower oil etc.

iv **Carbohydrates:** 60-65% of total calories should be provided by carbohydrates. Simple forms like sugar should be limited. Dietary fibre provides bulk and satiety.

v. **Minerals and vitamins:** Reducing diets should provide adequate amounts of essential nutrients like minerals and vitamins to maintain good nutritional status. Fruits and vegetables should be amply included in the meals, as they are low in energy, a good source of vitamins and minerals and provide roughage which helps to relieve constipation.

vi. **Water:** Water is a key part of any weight loss programme. It is very necessary for helping the body remove fat and for general overall health.

c. Diet planning

Theoretically, obesity can be treated either by reducing energy intake or by increasing energy expenditure. The diet should be well balanced, nutritionally adequate and based on the basic food groups. The desirable rate of weight loss is 0.5 kg/week or 2 to 4 kgs/month. The satiety value of diet is extremely important so as to give a feeling of fullness and well being. Adequate amount of protein food, fibrous fruits and vegetables, whole grain cereals and pulses provide satiety and thus help to cut down on food intake.

Fluid and salt restriction is not needed unless obesity is accompanied by oedema and hypertension. A minimum intake of 10-12 glasses of water per day is recommended for rehydration and flushing out of toxins from the body. Small frequent meals at regular intervals are advisable here. Obese people should not eat late at night because during sleeping the body's metabolism slows down, fewer calories are burnt and much of the food goes in storage as fat. Dinner should be the smallest and not the largest meal of the day.

Food to be avoided

- fats like vanaspathi, coconut oil, margarine
- sweets like puddings, kheer, burfies, desserts, ice creams
- bakery products like cakes, pastries, biscuits etc.
- high calorie fruits like banana, grapes, mango, custard apple, chickoo etc.
- raw banana and root vegetables like potato, yam etc.
- nuts like pista, peanuts, cashewnuts, dried fruits like dates, raisins etc.
- egg yolk, bacon, mutton, sausages, cheese etc.
- all aerated drinks
- fruit juices with sugar, squashes etc.
- fried food like chips, bondas, samosa, and food containing a lot of fat.

Food allowed

- raw vegetables as salad like cucumber, tomato, lettuce, celery, capsicum, raddish and carrot, freshly boiled vegetables and green leafy vegetables at every meal
- whole pulses, grams and cereals in preference to refined ones. eg. ragi, barley, whole wheat flour and its products
- raw sprouted grams as salads may be included at least once in a day
- inclusion of wheat flour with black channa flour or barley flour is advisable.

A sample menu for an obese person is given in Table 4.3.

Time	Meal	Menu
6 am		Coffee or tea without sugar
8 am	Breakfast	2 idli, spinach sambar, one guava.
10am	Mid time	One glass butter milk
12.30 pm	Lunch	Chapathi (50 g flour) fish curry ½ cup, tomato cucumber beetroot onion salad, butter milk ½ cup
4 pm	Tea	Tea(without sugar). 2 baked vegetable cutlet, tomato puree, papaya
6 pm	Midtime	Vegetable soup (without seasoning)
8 pm raita.	Dinner	Wheat dosa 3 nos, vegetable curry, cucumber
Nutritive value of the diet		Energy-1185 kcls; Protein - 48 g; Fat - 27 g

Table 4.3 A sample menu for an obese person

Know your progress

1. What are the causes of obesity?
2. What is the importance of water during obesity?
3. How does psychological factor affect obesity?

B. Anaemia

What is the condition that may occur due to lack of blood in our body?

- .....

Anaemia is a condition that develops when blood lacks enough healthy red blood cells or haemoglobin. Haemoglobin is the main part of red blood cells that binds oxygen. If the count of RBC is too low or haemoglobin is abnormal or low, the cells of the body will not get enough oxygen. Symptoms of anaemia occur because organs aren't getting enough oxygen to function properly.

a. Types and causes

Anaemia can be classified in groups according to the morphological characteristics of erythrocytes and according to aetiology.

i. Morphological classification of anaemia

- Normocytic anaemia: the size of erythrocytes is normal, hence the prefix 'normo'. This type of anaemia is called normocytic anaemia if the haemoglobin content is normal. It occurs as a result of haemorrhage or when erythropoiesis is suppressed by ionizing rays or toxins.
- Macrocytic anaemia: as indicated by the prefix 'macro', the erythrocytes are abnormally large because they are saturated with haemoglobin. It is caused by the deficiency of vitamin B_{12} and folic acid deficiency.
- Microcytic anaemia: the erythrocytes are smaller or normal and sometimes contain little haemoglobin. An example is anaemia due to the deficiency of iron.

ii. Aetiological classification of anaemia

- Nutritional anaemia: this type of anaemia develops because of the inadequate intake and/or absorption of nutrients like iron, vitamin B12 and folic acid.
- Anaemia due to excessive loss of red cells: due to haemorrhage or haemolysis.

b. Diet planning

Diet is of utmost importance in the treatment of anaemia. Refined foods like white bread, polished rice, sugar and desserts rob the body of the much-needed iron. Iron should always be taken in its natural organic form in food, as the use of inorganic iron can prove hazardous. Intake of inorganic iron may cause destruction of protective vitamins and unsaturated fatty acids, serious liver damage, miscarriage during pregnancy and delayed or premature births. The following factors should be considered while planning diet for anaemia.

i. The diet should be predominantly alkaline. The emphasis should be on raw fruits and vegetables, which are rich in iron. Iron rich vegetables are spinach, onions, carrots, radishes, beet roots, celery, yams, tomatoes and potatoes (with jackets).

ii. Fruits rich in iron include bananas, apples, dark grape, apricots, plums, raisins and strawberries. Bananas are particularly beneficial as they contain folic acid and vitamin B_{12} both of which are extremely useful in the treatment of anaemia.

iii. Other iron-rich food items are whole wheat, brown rice, beans, soyabeans, sunflower seeds, molasses, eggs and honey. Honey is also rich in copper, which helps in iron absorption. The diet should also be adequate in proteins of high biological value such as milk, homemade cottage cheese and eggs.

iv. Vitamin B_{12} is a must for preventing or curing anaemia. This vitamin is usually found in animal protein and especially in organic meats like kidney and liver. Consumption of meat comes with its own set of disadvantages as all meats are becoming increasingly dangerous due to widespread diseases in the animals, which are slaughtered. Other equally good sources of vitamin B_{12} are the various dairy products like: milk, eggs and cheese.

v. Peanuts and soya bean also contain vitamin B_{12}. Vegetarians should include adequate amount of milk, milk products and eggs in their diet. For the prevention of anaemia it is essential to take the entire B complex range which includes B_{12} as well as the natural food mentioned above.

vi. A liberal intake of ascorbic acid is necessary to facilitate absorption

of iron. At least two servings of citrus fruits and other ascorbic acid rich food should be taken daily.

vii. Beet roots can also be incorporated in the diet, which are extremely important in curing anaemia. Beet root juice contains potassium, phosphorus, calcium, sulphur, iodine, iron, copper, carbohydrates, protein, fat and vitamins like B_2, B_6, C, P and niacin. With its high iron content beetroot juice regenerates and reactivates the red blood cells and supplies the body with fresh oxygen.

A sample menu for anaemic patients is given in the Table 4.4.

Time	Meal	Menu
6 am		Tea or coffee
8 am	Breakfast	Chapathi, liver saute
10 am	Midtime	Leafy vegetable soup 5 dates
12.30 noon	Lunch	Mixed vegetable rice with soya beans, fish curry, cucumber raita
4 pm	Tea	Gingely seed laddu, chikku fruit, tea.
6 pm	Mid time	Steamed ada, water melon juice
8 pm	Dinner	Rice, sprouted dhal curry, roasted cow pea chutney, raisins pudding.

Table 4.4 A sample menu for anaemic patients

By using the information given above complete the following table.

Nutritional health problem	Food allowed	Food not allowed

Know your progress.

1. Define anaemia.
2. Classify anaemia.

Let us conclude

Diet therapy means implementing a specific diet not only in the care of the sick, but also in the prevention of disease and maintenance of health. Diet therapy is concerned with the modification of the normal diet to meet the requirements of the sick individual. It can be modified in terms of quality and quantity. Qualitative modification of diet includes restriction of excess nutrients in the diet. Quantitative modification can be made in consistency, rearrangement of meals or omission of food. Certain conditions like diarrhoea, fever, obesity and anaemia need certain modifications in the diets of the patients to correct the above conditions.

Lab activity

Plan a day's diet for the following conditions:

1. Fever
2. Diarrhoea
3. Obesity
4. Anaemia

Prepare a dish from the planned diet and calculate the nutritive value (energy, protein, calcium and iron) of the prepared dish.

Let us assess

1. Why do we prefer high calorie diets?
2. Name the conditions when high protein diet is prescribed.
3. Differentiate between qualitative and quantitative modification of diets.
4. Suggest some food allowed in a full fluid diet.
5. Explain the causes of diarrhoea.
6. Differentiate between acute and chronic diarrhoea.
7. Suggest some nutritional recommendations for a diarrhoea patient.
8. Distinguish the types of fever.
9. List the causes of obesity.
10. Elaborate the dietary management of anaemia.

5 Food Preservation

Key Concepts

5.1 Food spoilage

5.2 Causes of food spoilage

5.3 Food preservation-definition, principles, methods

Significant Learning Outcomes

After the completion of this chapter, the learner:

- defines food spoilage and identifies the causes
- describes food preservation and explains the principles and their importance
- differentiates the methods of food preservation
- appreciates the traditional methods of food preservation

You have already learnt that a balanced diet is very important and consists of a variety of food stuffs. What are they? Certain food substances are not available throughout the year. We like to eat certain vegetables and fruits always. How can we get mangoes in the winter season too? All of us wish to have fresh mangoes throughout the year. Is it possible? We cannot enjoy fresh mangoes as such but preserved mango products like pickle, chutney, juice, squash and jam can be enjoyed at any time. This is possible through

the technique known as food preservation. Thus, preservation of food is important as it enables to make certain food stuffs available throughout the world even during off seasons. Thereby it improves the nutritional content and gives variety to the diet. Before learning food preservation let us know how food gets spoiled.

5.1 Food Spoilage

Milk union penalised for contaminated milk: The Karnataka State Consumer Disputes Redressal Commission has directed the Managing Director of Kolar-Chickballapur Cooperative Milk Products, Societies Unions Ltd. to pay Rs. 5,000 as compensation to a customer for having supplied contaminated milk and its failure to withdraw milk produced in the same batch from the market.

What happens to milk if it is not properly stored?

- .....

We know that natural food has a limited life. Food such as fish, meat, milk, bread, fruits, vegetables etc. are perishable food as they have a short life span. Oils, sugars and dried food like cereals, grains, pulses have a longer lifespan and decompose eventually. Once food is harvested (crops) or slaughtered (meat, poultry), it begins to decompose rapidly and becomes unsafe for consumption. This deterioration is known as 'food decay' and this leads to 'food spoilage'.

Food spoilage refers to the deterioration of the physical and chemical properties of food by the influence of air, heat, light, moisture etc. which foster the growth of micro organisms, making it unfit for consumption. When food gets spoiled, it emits a foul odour and moulds may appear on it (Fig 5.1). When food is spoiled its colour may change, for example orange juice becomes darker. Oil smells rancid and tastes different when it gets spoiled.

Fig 5.1

5.2 Causes of Food Spoilage

The main causes of food spoilage are listed below.

A. **Improper handling:** It refers to workers who are not careful in stransporting and handling the food resulting in cuts, bruises and blemishes. It also refers to the handling of food materials with dirty hands, in dirty containers and at dirty places.

B. **Improper storage:** Different food requires different places and temperatures for storage. For instance, fresh meat, fish and poultry are stored in cold storage and freezers. Fruits and vegetables are placed in airy and cool places or in the vegetable compartment of the refrigerator. Bulbs like onion, garlic and root crops are placed in baskets at room temperature

C. **Inadequate preparation and cooking:** If foods like meat or fish is not prepared or cooked properly it will lead to spoilage.

D. **Careless packaging:** Packaging is important as it keeps bacteria and moisture away and maintains the quality of food. When meat, fish, fruits or vegetables are not properly wrapped before they are stored, it is easily contaminated by microorganisms causing its spoilage.

E. **Invasion of harmful micro organisms:** The micro organisms responsible for food spoilage are:

a. Moulds

Moulds are seen in the form of threads developed on decayed foods and are easily visible to the eye. Observe a piece of damaged bread under microscope and identify the growth of moulds. They contain spores which can spread through the air. When these moulds find a favourable environment, they germinate and produce a fluffy growth. They are often white or grey but sometimes bluish green, red, orange or some other colour depending on the variety of mould. Some of the moulds are not harmful but some of them can cause illness. The main symptoms are nausea or vomiting. Many species of moulds produce toxins

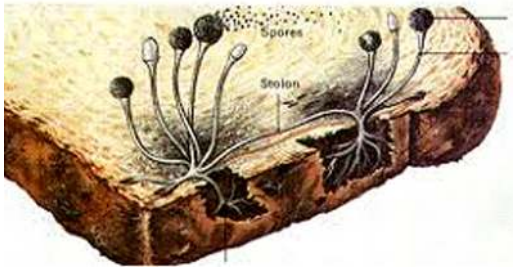


Fig 5.2 *Moulds on piece of bread*

called mycotoxins which are harmful to the human body. **Aflatoxin,** a mycotoxin produced by Aspergillus species of fungi, is commonly seen on the outer surface of food like peanuts, spices, cauliflower etc.

b. Yeasts

What are yeasts? What is the use of yeast in our daily life?

- .....

Yeasts are unicellular organisms coming under the kingdom fungi. They multiply very fast and cause fermentation on perishable food like fruit juices, syrups etc. During yeast fermentation, the sugars present in the food are broken into alcohol and carbon dioxide. This process is called food fermentation. Yeasts are beneficial agents used in various food preparations like appam, naan, bread etc. Fermentation is a desirable change brought about by the action of yeast, which results in the batter or dough to rise. But there are some yeasts termed as "false yeast" which is harmful to humans. It grows as a dry film on the surface of very acidic and high sugar content food items such as pickle, jams etc. They survive at very low pH. During their growth, they produce certain metabolic end products that cause physical and chemical changes in foods resulting in food spoilage.

Do you know!

Yeasts and moulds are easily destroyed by heat. Processing high acid foods at a temperature of 100°C (212°F) in a boiling water canner, for the appropriate period of time destroys yeasts and moulds.

c. **Bacteria:** Bacteria are unicellular organisms and are smaller in size than yeasts or moulds. Bacteria are the most widespread microorganisms present in food. They are single celled with varying shapes; round, rod or spiral. (Fig. 5.3)

Fig 5.3 Different shapes of bacteria

They grow under a variety of conditions and multiply very quickly. Millions of them are produced within a short period of time and contaminate food. They are more dangerous than yeast and moulds because they can spoil food without causing any change in the smell, appearance and taste. Bacteria generally prefer low acid foods like vegetables and meat. There are many types of bacteria that cause spoilage and they are called pathogens. Pathogens can survive in temperatures as low as 5 °C and at temperatures as high as 75 °C. When bacteria are exposed to unfavourable conditions like excess acidity or alkalinity or extreme temperature, they protect themselves by forming spores which can resist harsh conditions. These bacteria resume normal activity when the conditions become favourable and cause food spoilage. Eating food spoiled by bacteria results in food poisoning. This is due to toxins which are produced and released by bacteria into the food. Food poisoning outbreaks are recognised by the quick and widespread onset of illness amongst individuals within a short period of time.

Some of the common bacteria that cause food poisoning include Clostridium perfringens, Clostridium botulinum, Salmonella species and Staphylococcus species.

In order to destroy bacterial spores in a short period of time, it should be processed at 116 °C in a pressure canner.

F. Spoilage by enzymes

Food spoilage can occur by the action of enzymes which are naturally present in the food. Enzymes are organic catalysts present in living cells. Enzymes can cause food spoilage due to chemical reactions. These chemicals are found in animal and plant food. When fresh food substances are kept at room temperature for a specific period of time, enzymes cause undesirable changes in colour, texture and flavour. These changes in food enable micro-organisms to contaminate the food leading to food spoilage.

Haven't you noticed the colour change on the piece of cut apple after a short period of time? This is due to enzyme action. Likewise a tomato develops a black scum after a short while. Enzymes are sensitive to heat and are easily destroyed by heat. They can act from 0 °C to 60 °C. The optimum temperature of their reaction is usually 37 °C. Therefore enzyme activity can be prevented by heating food to temperatures which inactivate the enzymes. It can also be

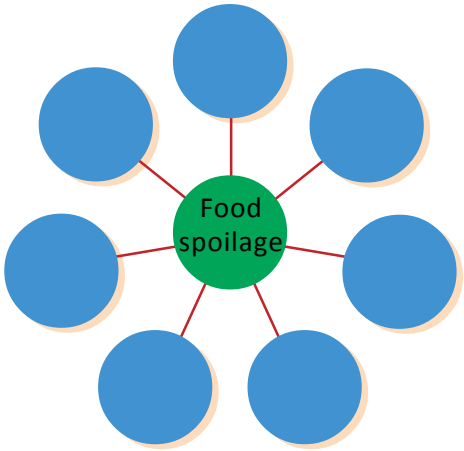
prevented by cooling, by elimination of air, by protection from light and by addition of anti oxidants.

Enzymes react with the oxygen of the atmosphere and result in oxidation of various nutrients like thiamine, ascorbic acid (Vitamin C) and carotene. This lowers the nutritive value of the food.

G. **Spoilage by insects, parasites and rodents:** Insects cause destruction to cereal grains, fruits and vegetables. Apart from the loss of food due to consumption by insects, greater damage due to cuts and bruises on food are also affected on food. Rodents consume large quantities of food, besides contaminating the food with their excreta.

Infestations (invasions) by insects, pests and rodents also account for huge loss of food due to spoilage. These invaders leave behind faeces, saliva, body parts like hair, nails etc. which are infested with microbes or parasites. These, in turn, infect humans and cause illness. Unhygienic practices during food growth, harvesting, distribution, processing, marketing and food handling can result in the unwanted entry of these agents.

Complete the illustration of different types of food spoilage.



Collect more information on the causes of spoilage of food using internet and other resources.

Know your progress

1. Define food spoilage.
2. What are the causes of food spoilage?
3. Write short notes on spoilage by enzymes.

Collect a list of food items that are easily affected by micro organisms.

5.3 Food Preservation

What do we do to avoid food spoilage ?

- .....

It is essential that food subtances be stored in ideal conditions of storage to prevent undesirable changes and to preserve its quality. Today food is preserved for the following reasons:

- to add variety to the diet
- to make use of food when it is cheap and plentiful and to store it for later use
- to make the food available throughout the year.

In addition to prevention of decay, preservation aims to retain as many of the qualities of the fresh food as possible such as flavour, texture, colour, appearance and nutritional value. It also aims to prevent micro organisms from contaminating the food once it is preserved, by sealing it from the outside air. However, it must be remembered that no method of preservation will improve the original quality of the product.

Thus food preservation can be defined as the process of treating and handling food to stop or slow down food spoilage, loss of quality, edibility or nutritional value and thus allow for longer food storage.

Some principles need to be followed for a successful food preservation. They are:

A. Principles of food preservation

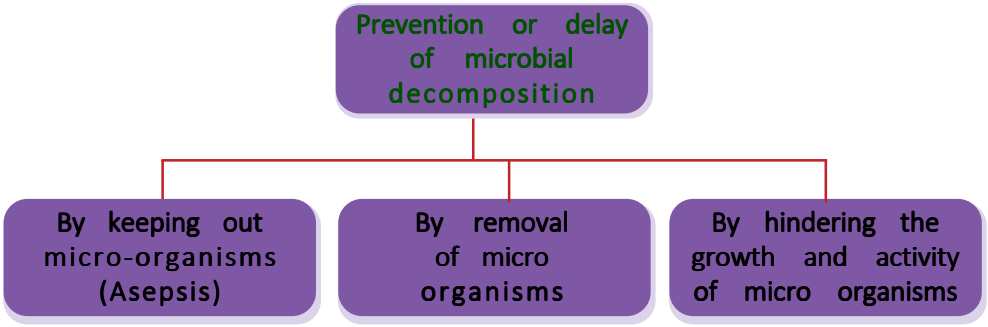
The principles on which food preservation is based can be classified as follows:

a. Prevention or delay of microbial decomposition.
b. By killing microorganisms, eg. by heat or radiations.
c. Prevention or delay of self decomposition of the food.
d. Prevention of damage by insects, animals, mechanical cause etc.

Let us learn each one of these principles with examples.

a. Prevention or delay of microbial decomposition

It consists of three types.



i. By keeping out microorganisms (Asepsis)

Shell of nuts such as almonds and walnuts, skins of fruits such as bananas, oranges, shells of eggs and the skin or fat on meat and fish are typical examples of asepsis. Packaging prevents entry of microorganisms into food. A can of peas stays without spoiling because microorganisms cannot enter the sealed can. Use of clean vessels and hygeinic conditions helps to prevent spoilage of milk during collection and processing by keeping out microorganisms.

ii. By removal of microorganisms

This method is limited to preservation of clear liquids (eg. filtration). The liquid is filtered through a "bacteria proof" filter made of asbestos pads, unglazed porcelain or similar materials and is allowed to percolate through with or without pressure. This method can be used successfully with water, fruit juices, soft drinks etc.

iii. By hindering the growth and activity of microorganisms

Food can be preserved by low temperature, drying, creating anaerobic conditions and by using chemicals. Use of low temperature increases the lag phase of many micro organisms and thus prevents their growth in foods. A good example of this can be seen in the preservation of milk at refrigeration temperatures.

Drying removes moisture from food. Micro organisms even if present in the food cannot grow due to lack of minimum moisture. eg. noodles, papads, raisins etc.

Maintainance of anaerobic conditions in the food hinders the growth of many bacteria which need oxygen. eg. canned peas and packed fruit juices.

b. By killing microorganisms

i. **Heat:** Exposing food to high temperature kills most of the micro organisms present and helps to preserve food.

ii. **Irradiation:** Irradiation of food is the process of exposing food to either electromagnetic or ionising radiations to destroy the microorganisms present. This has to be done with caution as it may render the food radioactive. An example of irradiation is the use of ultraviolet lamps in sterilising slicing knives in bakeries. Ionising radiations like **α, β** and **γ** rays have been used successfully for the preservation of vegetables, fruits and sea food.

c. Prevention or delay of self decomposition of the food

i. **Destruction of enzymes:** A good example of the destruction of enzymes to prevent self decomposition of food is the mild heat treatment given to vegetables before either canning or freezing called blanching. This can be carried out either by dipping vegetables in hot water or exposing them to steam for a few minutes.

ii. **Prevention of oxidation:** Fats and oils can turn rancid and become unfit to use because of oxidation. This can be prevented by the addition of small quantities of chemicals which prevent oxidation of fats. These chemicals are called anti oxidants.

d. Prevention of damage by insects, animals, mechanical causes etc.

Hygienic handling of food at all stages from the field to the time it reaches the dining table, can ensure minimal spoilage by outside agents like rodents, insects etc. Care should be taken in the construction of storage spaces so that it is impervious to the entry of such agents.

B. Methods of food preservation

Food preservation methods can broadly be classified into two categories.

a. **Bacteriostatic methods** in which microorganisms are unable to grow in the food. eg: dehydration, pickling, salting, smoking, freezing etc.

b. **Bactericidal methods** in which most of the microorganisms present in the food are killed, as in canning, cooking, irradiation etc.

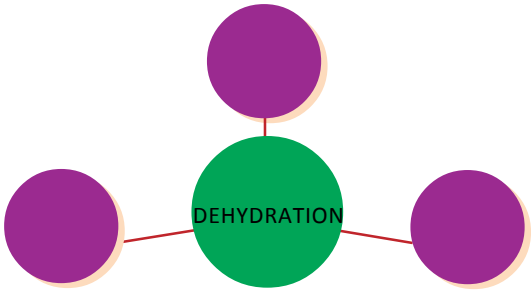
a. Bacteriostatic methods

Altering environmental conditions so as to prevent growth of micro organisms can help to preserve food. Such conditions are called bacteriostatic and can be created by removal of water, use of acid, use of oil and spices, use of chemical preservatives and use of low temperature. They are:

i. **Dehydration (removal of water):** Micro organisms need moisture to grow. When the moisture in the food is removed and the concentration of water is brought below a certain level, they are unable to grow and spoil the food. Moisture can be removed by the application of heat as in sundrying and in mechanical heating or by binding the moisture with the addition of sugar or salt and making it unavailable to the micro organisms.

- **Sundrying:** Direct rays of the sun are used for drying a variety of food. Fruits, vegetables, cereals, pulses etc. are dried and stored in this method. As foods are dried this way, they are exposed to dirt, insects and to air, there is always a risk of contamination and spoilage.
- **Smoking:** Food can also be dried by exposing them to smoke by burning some special kind of wood. In this method, while the heat from the smoke helps in the removal of moisture and exposure to smoke imparts a characteristic flavour to the food, eg. meat and fish.
- **Addition of salt and sugar:** Tying up moisture by addition of solutes such as salt or sugar also prevents growth of microorganisms and helps to preserve foods. The high concentration of sugar and other salts binds the moisture making it unavailable for micro-organisms to grow. These factors contribute to an increased shelf life of the product.

Using the above information complete the illustration given below :



ii. **Use of oils and spices:** A layer of oil on the top of any food prevents the growth of micro organisms like moulds and yeasts. Thus certain pickles in which enough oil is added to form a layer at the top can be preserved for long periods. Spices like turmeric, pepper and asafoetida have little bacteriostatic effect. Their primary function is to impart their characteristic flavour to food.

iii. **Use of acids:** Acidic conditions inhibit the growth of microorganisms. Organic acids are added or allowed in the food to preserve them. Acetic acid (vinegar), citric acid (lemon) and lactic acids are the commonly used preservatives.

iv. **Use of chemical preservatives:** Certain chemicals when added in small quantities can hinder undesirable chemical reaction in food by:

- Interfering with the cell membrane of the microorganisms, their enzyme activity or their genetic mechanism.
- Acting as anti oxidants.

Do you know!

PFA 1954 classifies preservatives into two types- Class I and Class II preservatives. Class I includes salt, sugars, oils, spices and condiments, vinegar and honey. Class II preservatives include sulphur dioxide, sodium and potassium metabisulphites, salicylic acid, benzoic acid, sorbic acid etc

Benzoic acid in the form of its sodium salt is an effective inhibitor of moulds and is extensively used in the preservation of jam and jellies. Potassium metabisulphate, sorbic acid, calcium propionate and sodium benzoate are other commonly used chemical preservatives.

Thus chemical preservatives when used correctly in the safe limits can help to preserve foods for a long time.

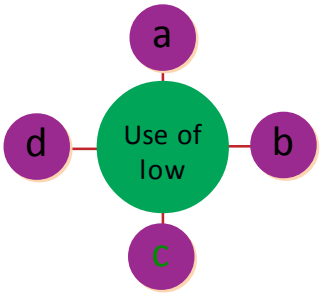
v. **Use of low temperature:** Microbial growth and enzyme reaction are retarded in food at low temperatures. The lower the temperature, the greater the retardation; low temperatures can be employed as follows:

- **Cellar storage (about 15°C):** Temperatures in cellars (underground rooms)where surplus food is stored in many villages are usually not much below that of the outside air and is seldom lower than 15°C. The temperature is not low enough to prevent the action of many spoilage organisms or of the plant enzymes. Decomposition is however slowed down considerably. Eg. root crops, potatoes, onions etc. are stored for a limited period during the winter months.
- **Refrigeration or chilling temperatures (0°C to 5°C):** Chilling temperatures are obtained and maintained by means of ice or mechanical refrigeration. Fruits and vegetables, meats, poultry, fresh milk and milk products etc. can be preserved from two days to a week

when held at this temperature. In addition to the foods mentioned above, foods prepared for serving and left-over's may also be stored in this temperature.

- **Use of freezing temperature or cold storage temperatures:** At temperature below freezing point of water (-18°C to -40°C) growth of micro organisms and enzyme activity is reduced to the minimum eg. poultry, fish, peas etc.
- **Freeze drying:** In this method, the food is frozen and the water from the food is removed under vacuum. Here the water sublimes. ie, it is converted into water vapour without passing through the liquid stage. The food is preserved in its natural state without any loss of texture or flavour. The food is packed in plastic or aluminium foil packets in an atmosphere of nitrogen. Food preserved using this method can be stored at room temperature. eg. Instant coffee, prawns, green peas etc.

Using the above information complete the illustration given below:



Collect details about food preservation methods that is being used in your house and make a note on it.

collect information regarding natural as well as artificial ingredients used in processed foods available in the marcket.

b. Bactericidal methods

Bactericidal means destruction of bacteria. Here heat can be used as an agent to destroy bacteria, moulds, yeasts and enzymes present in food. The specific heat treatment varies with the organism that has to be killed, the nature of the food to be preserved and other means of preservation that may be used in addition to high temperature. High temperatures used for preservation are usually classified for convenience as follows:

i) Temperature below 100°C (Pasteurization)
ii) Temperature of boiling water 100°C
iii) Temperature above 100°C (Canning)

i. Temperature below 100°C (Pasteurization)

Can you say how 'milma' milk is kept bacteria free for a longer period?

- .....

Pasteurization is the name given to the method employing temperatures below 100°C for the preservation of food. Pasteurization is used widely in the treatment of market milk and other dairy products. Here the milk is heated to 72°C or higher and kept at that temperature for at least 15 seconds. After pasteurisation, the milk is rapidly cooled to 10°C or lower and held at that temperature. This temperature inhibits the growth of micro organisms that may have survived. Fruit juices, aerated drinks are also preserved by this method.

ii. Temperature of boiling water 100°C

Cooking of rice, vegetables, meat etc. at home is usually done by boiling the food with water and involves a temperature around 100°C Boiling the food at 100°C kills all the vegetative cells and spores of yeasts and moulds. Many foods can be preserved by boiling at home eg. milk. Usually cooked food can be preserved from 12 to 24 hours at room temperature.

iii. Temperature above 100° C (canning)

Have you ever used skimmed milk for making 'Payasam' or other deserts? How is it preserved?

- .....

Canning is the method of applying high temperatures to food and sealing in air tight cans followed by rapid cooling. This kills all the microorganisms and sterilises the food. This process also prevents re-contamination of the food. The duration of heating and the temperature required depends on the type of foods being canned and the microorganisms that are likely to grow in it. The earlier cans have been replaced by tins and glass containers now, and this new technology prevents rusting of the containers, keeping the food safe to eat. These new methods of canning retain maximum nutrients with minimal changes in appearance, taste and flavour. Fruits, vegetables, meat and meat products, fish and sausages are some of the commonly canned foods. Canned food ensures that the food substances are available throughout the year; however they are more expensive than fresh food.

Conduct a seminar on 'Different methods of food preservation'.

Know your progress

1. Define food preservation.
2. State the importance of food preservation.
3. What are the methods of food preservation?

Let us conclude

Food spoilage refers to deterioration of the physical and chemical properties of food due to the influence of air, heat, light, moisture etc. which foster the growth of micro organisms, making it unfit for consumption. Improper handling, improper storage, inadequate preparation and cooking, careless packaging and invasion of harmful micro organisms can cause food spoilage. There are certain principles in food preservation .They are the prevention or delay of microbial decomposition, by killing the micro organisms, prevention or delay of self decomposition of the food and prevention of damage by insects, animals, mechanical cause etc. Food preservation methods can broadly be classified into two categories like bacteriostatic methods and bactericidal methods. Bacteriostatic methods include dehydration, use of oils and spices, use of acids, use of chemical preservatives and use of low temperature. Bactericidal methods include temperature below 100°C, temperature of boiling water and temperature above 100°C.

Let us assess

1. Describe the causes of food spoilage.
2. Name some microorganisms which can spoil food.
3. We notice the colour change on a piece of cut apple after a short period of time.Give reason.
4. State the main reasons why food is preserved.
5. Prepare a flow chart on the principles of food preservation.
6. Differentiate between two methods of food preservation.
7. Match the following.

A	B	C
Dehydration	Freeze drying	Jams
Chemical Preservative	Smoking	Green peas
Low temperature	Potassium metabisulphate	Fish

6 Introduction to Fibre Science

Key Concepts

Significant Learning Outcomes

After the completion of this chapter, the learner:

- defines fibre and classifies fibres
- identifies, differentiates and illustrates different types of fibres
- explains properties of fibres
- compares properties of different fibres
- appreciates the traditional methods of textile production

The notion of 'Clothing' came into existence at a very early age. Primitive people made their clothing from skins of animals and barks of trees. With the development of science, textile industries developed and different fibres came into use. A study of textile science therefore would mean the study of the process by which cloth is produced. In modern times however it includes not only the processes by which a basic raw material is converted into a fabric but also the processes the fabric undergoes to take the final finish. The use of fibre for

textile purpose is one of mankind's oldest art. So study of textile science has become a very interesting and challenging science. In this unit we shall study about fibres.

6.1 Fibres -Definition, Classification

A. Definition

You might be familiar with the term fibre. Do you know the significance of fibre in textiles?

- .....

Fibres are the fundamental visible units used in the fabrication of textile fabrics. The fibre is a very fine, hair-like material that is very small in diameter in relation to its length. It is the beginning of all clothes. Some fibres are short, others are very long, some are kinky, scaly and rough, and others are straight and smooth. They may have high or low tensile strength. They may be transparent or opaque, coloured or colourless and even or uneven in diameter.

Fibres are either man-made or obtained from natural sources. Cloth is manufactured by spinning fibres to give strength. We get most of our clothing from natural fibres. With the advancement of science, more synthetic fibres were developed and are now in routine use.

Only a few varieties of natural fibres differ in quality. Let us examine the classification of fibres.

B. Classification of fibres

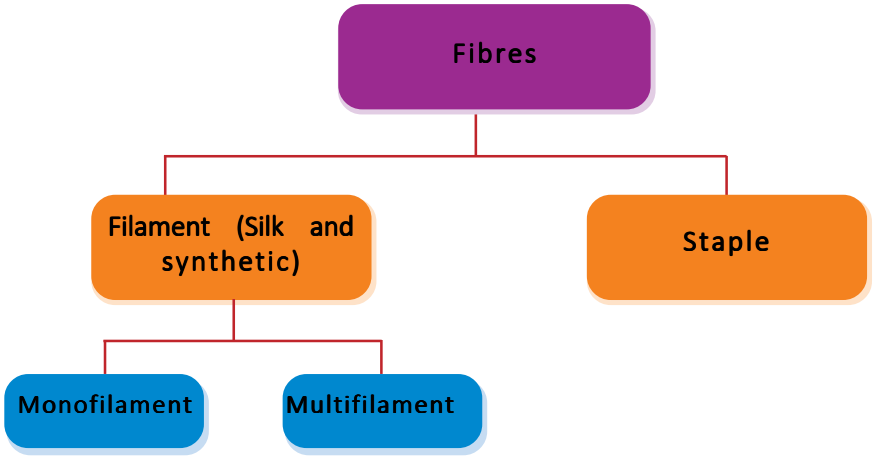
Different types of fabric may be manufactured with different types of fibre. What are they?

- .....

The 20th century has seen the discovery and use of more and more fibres. There was a time when all the raw materials for making fabric came from nature. But today with the development of science there are many varieties of fibres used in the textile industry. Generally fibres are classified on the basis of their length and source. They are detailed below:

a. Classification according to their length

Fibres are divided into two classes according to their length. They are:



i. **Filament fibres:** These are natural or man-made fibres of continuous length, measurable in yards or meters. Silk and other man-made fibres are filaments. A filament is a very long fibre. The length of filaments may range from a few hundred meters as in the case of naturally occurring fibre -silk, to several kilometres in the case of man-made fibres.

These filament fibres are of two types:

- **Monofilament fibres**: These are made up of single, smooth, solid strands. These are very strong and soft, so these are used in hosiery goods.
- **Multifilament fibres**: These are composed of a number of tiny filaments twisted together. The size and number of filaments vary widely. These are used for manufacturing lustrous and soft clothes.

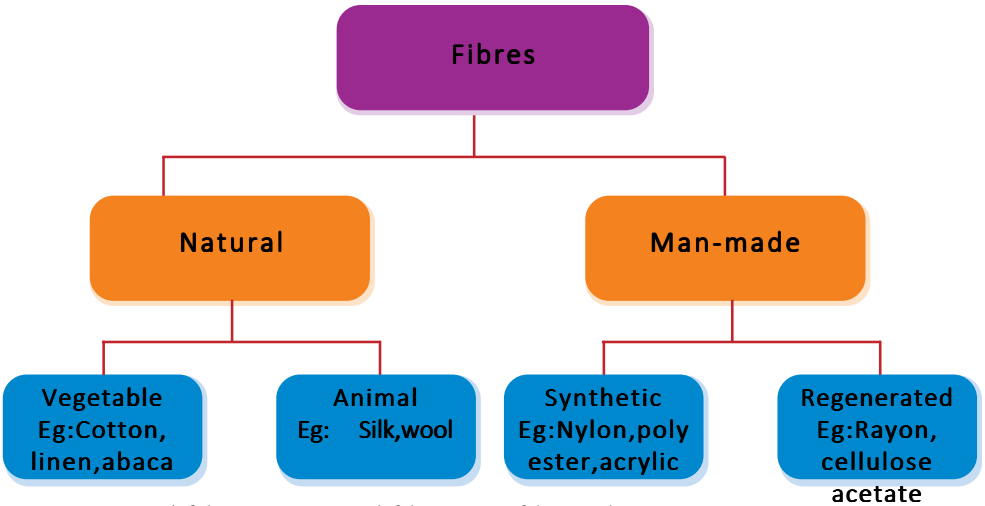
ii. **Staple fibres**: Staple fibres are short and measurable in inches and range from three quarters of an inch to eighteen inches in length. All natural fibres except silk are examples of staple fibres; however man-made fibres are cut into short lengths. They are also known as staple fibres.

From the early days of textile industry, cotton, silk, wool, and linen fibres have been used for making fabrics and household articles. In addition to these, the textile industry is continually using many other fibres, natural, synthetic and man-made.

b. Classification based on source

Fibres are classified into two on the basis of the sources from which they are obtained.

Observe the illustration given below and prepare a note on the classification of fibres.



i. **Natural fibres:** Natural fibres are fibres that occur in nature. Can you list some natural fibres?

- .....

Natural fibre can be of three types namely:

- **Vegetable fibres:** Vegetable fibres are obtained from plants. The basic material of all plant life is cellulose. Cellulose is formed of linear chains of glucose units bound to each other like beads in a necklace. All cellulose fibres have similar basic properties. Cellulose fibres are good absorbents and good conductors of heat and electricity. It is comfortable to wear clothes made of cellulose fibres, especially during summer because of their greater absorbency. The fabrics made of cellulose fibres can be boiled to sterilization and there is no special precaution to be taken while

Do you know!

The sisal fibre is a "hard" fibre extracted from fresh leaves of the sisal plant, Agave sisalana. It is usually obtained by a decortication process, in which the leaf is crushed between rollers and then mechanically scraped.

ironing. They burn freely and quickly. Moth and mildew harm cellulose fabrics. Example: - Cotton and kapok which are actually seed hairs.

- Linen, jute and hemp are obtained from stems of plants.
- Abaca and sisal are obtained from leaves of plants

- **Animal fibres**: Animal fibres are obtained from animals. They are made up of proteins as their chief constituents. Animal fibres are strong but become weak when wet. These are bad conductors of heat and have high resiliency. Example:

Wool -Hair of sheep, goat, rabbit or camel.

Silk- Secretion of an insect (silk worm).

- **Mineral fibres:** are obtained from minerals. These are inorganic materials shaped into fibres and are mainly used in fire proof fabrics. One example of which is asbestos. This is used more for industrial purposes than for clothing or household fabrics.

ii. Man-made fibres: Haven't you heard about rayon shirting and polyester clothes? What is meant by Rayon and Polyester?

- .....

These are manmade fibres. They do not occur in fibre form, but are turned into fibre by man. These are manufactured from materials that are non-fibrous but are made into fibres, by breaking them down from their original form and reassembled into different sorts of structures. All man-made fibres are first made into filaments from which the fabric is woven. These are of two types. They are as follows:

- **Synthetic fibres**: These fibres are

obtained by a series of chemical reactions. The materials used are salts and solvents of various kinds. Natural materials are not used for these fibres. These fibres are strong, bad conductor of heat and thermoplastic in nature. They do not need much care and have great strength. Examples are Nylon, Polyester, and Acrylic etc.

- **Regenerated fibres**: The raw materials are from natural sources i.e. cellulose or protein. The properties of fibre depend on the method of its manufacture and the source of the regenerated fibres. Examples are Rayon and cellulose acetate.

Know your progress

1. What do you mean by fibres?
2. Classify fibres.
3. Write examples of vegetable fibres.

6.2 Fibre Identification

If you are asked to select a silk cloth and polyester cloth, how will you identify them from the textile shop? How do you identify different types of fibres?

- .....

Fibre identification is one of the most important as well as most interesting topics in fibre science. The various types of fibres, which modern science has discovered or invented, coupled with the various elaborate present day methods and processes adopted in the manufacture and finishing of fabrics, have made their identification more complicated. Besides, the consumer is interested in knowing the fibre content, which is ultimately going to affect the durability, appearance, comfort and suitability for laundering and usage. However, knowledge of the characteristics of each kind of fibre helps a good deal, because every fibre has certain inherent qualities, which cannot be wholly reproduced in any imitation fibre. For instance, wool has its own specific characteristics. Fabrics made with newer blends of synthetic fibres are also difficult to judge merely by the appearance or touch. To identify such fabrics, the help of other tests, even of chemical test is needed. Now let us discuss some simple tests for the identification of fibres.

A. Tests for the identification of fibres

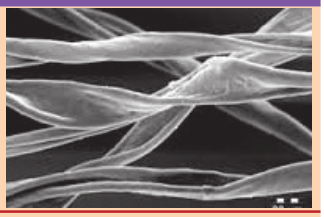
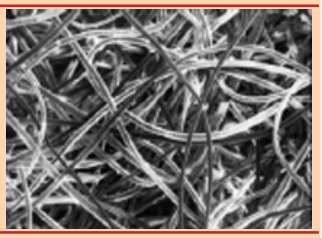
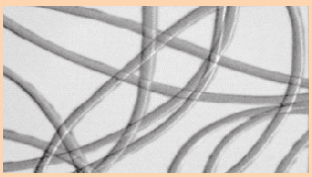
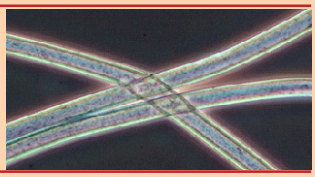
The following test can be carried out by a student of textiles or by a layman without the help of a laboratory or expensive chemicals.

a. Visual inspection: The first step in identification of a fibre is always inspection of a fabric for its appearance and feel of the hand. Man-made fibres can be made into fabrics that resemble natural fibre and natural fibres can be changed by finishes. So the ability to identify the fibre by mere touch needs long experience and keen perception. It covers visual as well as tactile senses. Look for the following things when inspecting a fabric:

i. Length of fibre (untwist a yarn for this). Any fibre can be made into staple length but not all can be filament length.
ii. Lustre or lack of lustre.
iii. Body, texture, hard, soft to hard, rough to smooth, warm to cool or stiff to flexible.

For visual inspection, grasp the edge of a cloth between the thumb and the index finger with the thumb on the top. Rub the thumb and the forefinger across the cloth, lengthwise and then in a circle. The pliability, elasticity, warmth, softness and smoothness can be felt. The vegetable fibres are usually cooler to touch than animal fibres or synthetic fibres. A hundred percent cotton fibre without a finish is lifeless. Linen is cool and pliable. Silk is very soft, lustrous, smooth and slippery and wool is warm and resilient. However, it is very difficult to identify each fibre especially the synthetics by mere touch because the type of yarn used, the finish and the construction can often change the "feel" of the fabric.

b. Microscopic test: Knowledge of the fibre structure obtained by seeing the fibres under the microscope and observing some of the differences among fibres in each group, is of help in understanding fibre and fabric behaviour. Microscopic study of fibres is almost indispensable because this is one of the most reliable ways of arriving at the correct identification of fibres. In cases of fabrics woven out of a mixture of fibres, it is very difficult to get definite or clear results. The same difficulty arises in the case of cotton and linen, especially when these fabrics are heavily sized or when cotton is mercerized. But a microscopic examination will not fail to give a correct identification of the fibre or fibres used in a fabric. Table 6.1 shows the longitudinal view of different textile fibres.

Name of the textile fibres	Characteristic features	Microscopic view
Cotton	1. Flat fibre 2. Ribbon like twist 3. No crimp 4. Central lumen 5. No lustre	
Linen	1.Shiny surface 2.Flat and transluscent	
Silk	1. Rod like structure 2. Circular 3. High lustre 4. Gum present on surface 5. No crimp	
Wool	1. Rough surface 2. Crimp very evident 3. Scales present 4. More or less circular 5. Lack of lustre	
Nylon	1. Round rod like structure 2. Smooth surface 3. Translucent 4. High lustre 5. No crimp	
Polyester	1. Smooth and transparent 2. Rodshaped	
Acrylic	The microscopic test cannot be used to identify acrylic fibres.	

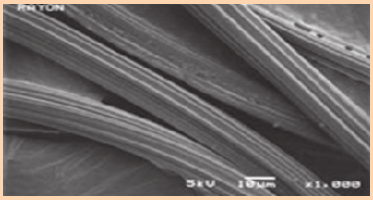
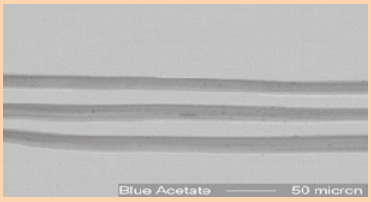
Rayon	1.Straight and even surface 2.No crimp 3.Lines or striations present 4.Lustre not very good 5. Resembles nylon	
Cellulose Acetate	1. Rod like structure 2. Fibre lumen present 3. No crimp 4. Poor lustre 5. Smooth surface	

Table 6.1 Longitudinal view of different textile fibres

c. Burning test

Have you ever noticed testing a fabric by burning it? How is a burning test for fabrics conducted?

Burning test is a very simple and reliable one. It helps to identify the group in which the fibre belongs to - cellulose, protein, mineral etc. Certain general directions for the burning test are given below.

i. Ravel out and test several yarns from each side of the fabric to see if they have the same fibre content.

ii. Hold the yarn horizontally with a pair of tweezers or tongs. Feed the fibres slowly into the edge of the flame and observe what happens.

Table 6.2 shows the result of burning test for the identification of different textile fibres.

Fibre	Approaching	In flame	Removed from flame	Odour	Ash or residue
Cotton	Rushes towards the flame	Catches fire and burns	Burns rapidly till the end	Burning paper	Greyish ash retains shape, very soft to touch
Linen	Does not shrink	Burns quickly	Continues burning, shows an afterglow	Like burning paper	Light,feathery gray in colour
Silk	No reaction	Catches fire	Self extinguishing	Same as wool	Same as wool very small amount
Wool	Shrinks away from flame	Catches fire and burns slowly	Self-extinguis hing. i.e. stops burning	Burning hair or feathers	Black curled up ash, crinkly to touch.
Nylon	Shrinks from flame	May catch fire melt and drop	Stops burning and melting	Burning celery	Molten solidified hard residue, light grey or fawn in colour.
Polyester	Shrinks from flame	Melts, catches fire and burns with a sooty flame	Stops burning and melting	Plastic burning	Molten solidified hard residue, black in colour
Acrylic	Shrinks from flame	Catches fire and burns rapidly	Continues burn- ing with a flame sputtering and melted fibre dripping	Like fire crackers	Molten solidified residue but not as hard as nylon, greyish black in colour
Rayon	No reaction	Catches fire and burns fast	Burns rapidly till the end	Burning paper	Black ash, soft to touch, very small amount
Cellulose Acetate	Burns freely	Melts and decom pose into a black ash	Continues to burn and melt.	Has an acid harsh, sharp odour similar to hot vinegar	Residue is a hard dark, solid bead.

Table 6.2 Burning test for the identification of different textile fibres

Collect samples of different textile fibres and paste it in your activity log and label them. Identify them using visual test and burning test.

Know your progress

1. Write some simple tests for the identification of fibres.
2. Draw the microscopic view of natural fibres
3. Explain the microscopic appearance of different fibres

6.3 Properties of Fibres

The availability of a fibre for textile purpose must be considered with regard to its adaptation to the various operations and processes through which it is required to pass in the formation of a woven fabric. For a fibre whether it is natural or man-made certain properties are necessary and certain others are desirable. Let us discuss in detail.

A. Cotton

Where do you get cotton from?

- .....

Cotton is the most widely used textile fibre all over the world. India is the acknowledged birth place of cotton and one of the largest cotton growing countries of the world. When raw, the fibre has a tube like structure containing sap. When the fibre ripens, the sap dries up, the tube collapses and the fibre becomes like a flat, twisted ribbon. Cotton production consists of a series of processes which are detailed below:

a. Physical properties

i. **Composition:** The cotton fibre is composed chiefly of 88-90% cellulose, 5-8% of water and the remaining consists of natural impurities.

ii. **Structure:** When seen under microscope it appears as a narrow, flattened structure with spiral twists.

iii. **Length:** Cotton is a staple fibre with varying length from ½”-2.5". Cotton with short length is known as short staple and with long length is known as long staple. Long staple is used for manufacturing fine quality cloth; short staple is used for manufacturing rough clothes. The width is measured in microns and it is 16 -20 microns.

iv. **Strength:** Cotton fibres are very strong compared to other natural fibres. The strength increases on wetting up to 25% than when it is dry. This property has its significance as less care is required during washing of the fabric.

v. **Moisture and absorption:**

Why cotton is considered most suitable for the hot climate?

•

.....

Mostly cotton fibres have 8.5% of moisture but they have the ability to absorb 15-20% of moisture. Due to this property they take time for drying. This is a positive property for cotton fabrics because they can absorb perspiration easily and give the feeling of coolness. That is why cotton is good for summers.

Do you know!

Resiliency denotes that the fibre can be compressed or crushed and, on release of pressure, tends to return to its original shape. This quality causes the fabric to be wrinkle resistant.

vi. **Shrinkage:** Cotton fabrics shrinks, when it is washed, for the first time, even though the fibre does not have the shrinking property. This is because, cotton fabrics get stretched during the processing and weaving time and they bounce back at the first wash.

vii. **Resiliency:** Cotton fabrics have low resiliency and wrinkle easily unless they are given the finishing.

viii. **Effect of friction:** It is not affected by friction. Due to this reason we can rub the dirty portion with the brush and even beat the article because friction has very less effect on the fabric.

ix. **Effect of heat:** We can iron the fabric at very high temperature but very high temperature gives scorch marks on the fabrics. Burns readily and ignites easily leaving an ash-like burned paper.

x. **Effect of sunlight:** Sunlight bleaches white fabrics. Coloured fabrics fade away if kept for longer duration.

xi. **Heat conductivity:** Cotton is a good conductor of heat because it allows the body's heat to radiate out and keep body temperature stable i.e. normal temperature. Due to this reason in summer cotton is better when compared to the other fabrics. It is also not allergic to body.

b. Chemical properties

i. **Action of acids:** Strong acids destroy the fibres but dilute acids have little or no effect. The fibre dissolves in strong acids.

ii. **Action of alkalis:** Alkaline substances like borax, ammonia and caustic soda are not harmful for cotton. That is why white cotton can easily be boiled in washing soda to remove yellowness from the fabric. Strong alkalies change the nature of the fibre.

iii. **Action of bleaches:** All bleaching agents can be safely used on white cottons but should be avoided for coloured cottons.

iv. **Affinity for dyes:** Cotton can easily be dyed with basic dyes. Salt is used to fix the dye on the fabric.

v. **Effect of moth and mildew:** Cotton is resistant to moth; so storage is easily done. Mildew and silverfish destroy the fabric if it is kept in a damp condition. Fungal growth will occur during rainy season if the fabric catches dampness from the storage space.

Complete the following table based on the properties mentioned above.

Physical Properties	Chemical Properties

B. Linen

Have you heard the term linen?

- .....

Linen is a vegetable fibre composed chiefly of cellulose. Linen is obtained from the stem of the flax plant.

Flax is grown in many countries like Russia Germany, France, Holland, United States etc. Linen is the term applied

to the yarn spun from the flax fibres, and to the cloth or fabric woven from this yarn.

a. Physical properties

i. **Composition:** Flax fibre is composed of 66-70% cellulose and natural impurities which amounts to 25-30% of the total weight.

ii. **Structure:** Under the microscope the longitudinal section of the fibre is shiny, flat and translucent. It does not have uniform thickness and nodes are present on the fibre just like bamboo.

iii. **Length:** Length of the fibre is determined by its production process. The length varies from 12 inches to 36 inches. But on an average it is 18 inches to 22 inches.

iv. **Strength:** Linen is a very strong fibre. It is stronger than cotton. That is why it needs less care while washing.

v. **Moisture absorption:** Linen can absorb more moisture than cotton, because of this property it takes more time to dry. Linen is suitable for summer because it can absorb perspiration. Cooling occurs when sweat evaporates and it is comfortable in summer.

vi. **Shrinkage:** Linen fibre does not shrink like cotton but it may undergo relaxation.

vii. **Resiliency:** The fibre wrinkles very soon just like cotton. That is why ironing is required at normal temperature like cotton.

viii. **Heat conductivity:** The fabric is a good conductor of heat and suitable for summers. Linen fabrics allow the body heat to go out and are comfortable during summers.

ix. **Effect of friction:** Linen can easily be washed without any precautions because it is not affected by friction. Rubbing of dirty parts can be done with hand brush.

x. **Effect of sunlight:** Sunlight does not have any harmful effect on white fabrics. On the other hand, coloured fabrics need extra care. These should be put in sun shade so that the colours do not fade away.

xi. **Effect of heat:** The fibre is not affected by heat. It can be ironed at the temperature of 150°C or little more.

b. Chemical properties

i. **Action of acids:** Acids have harmful effect on fibre. Concentrated acids dissolve the fibre if kept for longer duration. Dilute acids do not have any harmful effect.

ii. **Action of alkalis:** Linen is not affected by alkalis. Due to this reason it can be mercerized to give extra strength and lustre. Washing soda can be used safely.

iii. **Action of bleach:** Bleaching is an important process before dyeing. So different types of bleaches can be used on the fabric.

iv. **Affinity for dyes:** The affinity of the fibres for dyes is less than that of cotton. Hence it is difficult to dye.

v. **Effect of Moth and Mildew:** Fabrics made from Linen are not susceptible to moth but it has a tendency to develop mildew during rainy season.

C. Silk

Which fibre is more appealing to the eye and mostly used to make wedding dresses? Why?

•

.....

Do you know!

The origin of silk is shrouded in mystery. It is believed that it was discovered accidently, when the cocoon of an insect fell in the cup of tea of a Chinese princess. She pulled it out and discovered that the cocoon unwound itself into one long continuous filament. This is the story behind the discovery of silk.

Silk is considered as the 'queen of fibres' due to its softness and lustre. Silk is a continuous filament protein fibre produced from silk worms. This fibre is the longest of all natural fibres. Its cultivation was started in China about 2700 B. C. Silk is cultivated in China, Japan, France, India etc. In India, Jammu and Kashmir, West Bengal, Assam, Karnataka and Tamil Nadu are the main producers of silk.

a. Physical properties

i. **Composition:** This fibre is made up of elements like carbon, hydrogen, oxygen and nitrogen. Beside these elements the fibre has

a gum known as sericin. The percentage of fibrion is 80-85% and of gum or sericin is 10-15%.

ii. **Structure:** The longitudinal section of silk under the microscope appears to be flat, uneven and ribbon like. If the fabric has not been degummed then a layer of gum can be seen in the form of small circles or dots.

iii. **Length:** Among the natural fibres silk is the only fibre available in filament form. The length of the filaments varies between 800-1300 yards.

iv. **Strength:** Silk is a strong fibre.

v. **Moisture absorption:** Silk absorbs 10-30% of the moisture. The advantage of this property is that the fabric can be dyed very easily.

vi. **Shrinkage:** Silk fabrics do not shrink after washing like cotton.

vii. **Resiliency:** Silk is a resilient fibre. Hence the wrinkles can be easily removed as compared to cotton.

viii. **Heat conductivity:** This fibre is a bad conductor of heat. The fabrics do not allow the body's heat to go out and are not suitable for summers.

ix. **Effect of friction:** Silk is a delicate fibre which is affected by friction. Friction spoils the lustre and the texture of the fibre. So rubbing should be avoided while washing the fabrics.

x. **Washability:** Kneading and squeezing are the methods for washing silk.

xi. **Effect of Heat:** Intense heat weakens the strength of the fibre. Ironing is done when it is slightly damp.

b. Chemical properties

i. **Action of Acids:** Silks are damaged by concentrated acids but organic acids can be used safely on silks. Acetic acid is used in the last rinse to restore Lustre of the silk.

ii. **Action of Alkalis:** Silk fabrics are damaged with alkalis. Strong alkalis weaken the fabric but weak alkalis like Borox and Ammonia can be safely used.

iii. **Action of Bleaching Agents:** Sunlight and Chlorine damage the

fabric. The fabric which is white in colour turns yellow if exposed to sunlight for longer duration. The safe bleaches are Hypochlolrites and Javelle water. However mild oxidizing agents like hydrogen peroxide and potassium permanganate can be used.

iv. **Affinity for Dyes:** Silk has strong affinity to dyes. It can be easily dyed with acid, basic and direct dyes. The fibre takes up dyes very quickly. Colours are bright and do not bleach during washing.

v. Effect of Moth and Mildew: Silk is not harmed by moth and mildew like wool.

D. Wool

Which fibre is the most suitable for winter season? Why?

- .....

Wool was the first fibre that was used by primitive people. Primitive people used to hunt sheep and goats for their food. He used to wrap his body with the skin of different animals to provide protection against cold. He used to cover his body in different climates. Later man discovered the use of hair after interlocking and twisting them. Thus the hair of sheep was used for making woollen clothes.

Wool is obtained from sheep, goat, rabbits etc. The grading of wool is done according to the type of the animal used for obtaining wool and the part of the animal used for shearing wool. The Kashmir and Kabul "Pashmina" is known for its softness and fine texture. The best wool is obtained from the Australian Merino.

a. Physical properties

i. **Composition:** The important constituent of wool fibre is a protein known as "Keratin". This is the only natural protein fibre, containing Sulphur. The composition of wool is carbon, oxygen, nitrogen, hydrogen and sulphur

ii. **Structure:** When woollen fibre is observed under the microscope the surface of the fibre consist of cells, irregular in shape and slightly overlapping like scales of the fish. These are termed as Serrations.

iii. **Length:** Depending upon the type and quality of the fibre the length of wool may vary from 2"-15".

iv. **Strength:** It is stronger than silk. When wet, wool loses about 25% of the strength. The longer the fibre the greater will be the strength of the yarn.

v. **Moisture Absorption:** Wool gets wet very slowly but once it is wet it has very high moisture absorption. It can absorb 30% moisture and retains its moisture for longer period. Thus woollen fabrics need more time for drying.

vi. **Shrinkage:** Woollen fibre has the ability to shrink when it absorbs moisture. This property of wool has been used for making felts. In this moisture, heat and pressure is given to wool fibres. Due to this felt is made and used for various purposes. Precautions are taken during washing of woollens. Hot water is avoided because woollens shrink after washing. Rubbing should be avoided because the fibre overlaps during rubbing.

vii. **Effect of Friction:** Friction is harmful for wool due to its structure. Wool fibre is heavy scaled. If friction is applied on wool, scales of the fibre get entangled into each other, due to this pilling is formed on wool. So friction should be avoided for woollen fibres.

viii. **Heat Conductivity:** Wool is a bad conductor of heat. The scales on the surface of the wool and crimp in the fibre create little pockets of air that serve as insulative barriers (bad conductor) and give warmth (Body heat is not radiating out and that is why it keeps the body warm).

ix. **Effect of sunlight:** Sunlight is not good for woollens but it can be kept in sunlight for shorter duration. Strong heat weakens the fabric and destroys the colour.

x. **Effect of Heat:** The structure of wool is changed by direct and prolonged heating. Woollens are pressed by using thin, damp cloth. In this way direct heat can be avoided.

xi. **Resiliency:** Wool is highly resilient and comes to its original shape when used for different dresses. It does not wrinkle very fast like cotton and silk. Pressing is required if it is not dried properly.

b. Chemical properties

i. **Effect of Acids:** Cold and Dilute acids do not harm the fabric. However, concentrated acids can destroy the fibre.

ii. **Action of alkalis:** Concentrated alkalis destroy the fibre immediately. Dilute alkalis and alkaline soaps also weaken the fibre. However, Borax and Ammonia are not harmful for woollens.

iii. **Action of Bleaching Agents:** Strong Bleaching agents like Chlorine bleaches and Sodium hypochloride are harmful to woollens. Other Oxidising and reducing agents like Hydrogen peroxide; Potassium permanganate can be used safely for bleaching and for stain removal.

iv. **Affinity for Dyes:** Wool has high affinity for most of the dyes especially Acid and Basic Dyes.

v. **Effect of moth and mildew:** Wool is easily damaged by moths for this reason woollens are kept with special care. However, mildew does not easily attack except when stored in a damp place.

Complete the following table based on the properties mentioned above

Physical Properties	Chemical Properties

E. Nylon

Haven't you seen the fishing net used by fishermen? What is it made of?

- .....

Nylon is the first man-made fibre which is synthesized by organic laboratory chemicals. It is a polyamide fibre. Nylon is made from coal, air and water.

It is a mixture of two different coal tar products i. e. Adipic acid and HexamethyleneDiamine.

Do you know!

The notation 6, 6 denotes that there are two monomers, each containing six carbon atoms, which are required to form the polymer of this type of nylon.

This product is heated to give a condensed product known as Nylon polymer, which is stretched into fibres. It is the nylon filament produced by the Melt spinning process. The most important polyamide fibre in terms of amount produced is nylon 6, 6.

a. Physical properties

i. **Microscopic Appearance:** Under microscope, nylon appears to be smooth, shiny and transparent. Nylon may be tubular or round in cross section.

ii. **Composition:** Nylon is made from organic chemicals. It has carbon along with other elements of oxygen, hydrogen and nitrogen. Sometimes inorganic salts such as titanium dioxide, a delustering agent, are used to reduce lustre of the fibre.

iii. **Length:** It is a long filament which may be cut into staple length as required.

iv. **Strength:** Nylon is a strong and durable fibre. This is the strongest among all the fibres used for making garments. This fibre does not lose its strength and durability after a long duration.

v. **Moisture Absorption:** It is a hydrophobic fibre which does not absorb moisture. Because of this property fabrics become wet due to perspiration and stick to the body during summers. Hence it is not comfortable to wear nylon in summers. These fabrics dry quickly because of less moisture absorption.

vi. **Shrinkage:** Nylon does not shrink.

vii. **Resiliency:** Resiliency is good. Thus nylon fabric does not crease easily and require less ironing.

viii. **Heat Conductivity:** Nylon is a bad conductor of heat. Due to this reason it is not suitable for summer as body's heat does not radiate out through the nylon.

ix. **Effect of Friction:** It is a strong fibre and does not need precaution while washing. So friction can be used very easily on nylon fibre.

x. **Effect of Sunlight:** Nylon does not have any effect of sunlight.

xi. **Effect of Heat:** Ironing should be done with care because it is a thermoplastic fibre. It melts at high temp and sticks to the iron. So,

Nylon fabrics require light ironing.

xii. **Electrostatic Property:** Due to this property garments cling to the wearer which causes discomfort to the wearer.

xiii. **Washability:** Due to the soft composition and the non-ionic nature, dust particles are unable to stick on the fibre. This makes washing easier and is lesser prone to stains.

b. Chemical properties

i. **Action of Acids:** Nylon dissolves in hot solution of dilute acids as well as concentrated acid.

ii. **Action of alkalis:** These do not have any harmful effect on nylon and can be washed with any soap or detergent.

iii. **Effect of Bleaches:** Any bleach can be used on this fibre.

iv. **Affinity for dyes:** Affinity for dyes is high, so it can be easily dyed in fast colours.

v. **Attack of Moth & Mildew:** Moth and mildew have no effect on nylon.

Using a piece of this type of fabric try to conduct simple experiments to identify the physical and chemical properties of this fabric and prepare a note on this

Complete the following table based on the properties mentioned above.

Physical Properties	Chemical Properties

F. Polyester or dacron or terylene

Name the most preferred fibre for uniform fabrics.

- .....

Dacron or polyester is not chemically related to any other fibre. Polyester

is the name of a polymer that is present in the fibre. The fibre was first synthesized during the Second World War and its commercial production started in 1951. The basic elements for polyester fibres derived from petroleum, coal, air and water. The method of production is similar to that of other synthetic fibres. The chemicals are processed till the required combination is obtained. The material formed is in the form of chips or flakes. The chips are heated and the filament is produced by melt spinning. Polyesters produced in India are known as 'terene' or 'terelyne'. The Terylene fibre is produced from ethylene glycol and dimethyl tetraphthalic.

a. Physical properties

i. **Microscopic Appearance:** Under the microscope it appears as a smooth and transparent fibre.

ii. **Fibre Structure or Composition:** This is an organic substance and its chemical composition varies according to the chemicals for synthesizing.

iii. **Length:** The length of fibre is long so it is a filament. But it may be cut into staple length.

iv. **Strength:** Strength of the fibre is very good but we cannot compare it with nylon. Polyester is a strong and durable fibre. It doesn't lose its strength and durability after long duration.

v. **Moisture Absorption:** It doesn't absorb moisture and is easy to dry but it gives discomfort in summer. It sticks to the body.

vi. **Resiliency:** Resiliency is good. Thus polyester fabric does not crease easily and require less ironing.

vii. **Heat Conductivity:** Polyester is a bad conductor of heat. Due to this it is not suitable for summer. Body's heat doesn't radiate out.

viii. **Effect of Friction:** It is a strong fibre and doesn't require any precaution while washing.

ix. **Effect of Sunlight:** Polyester doesn't have any effect of sunlight.

b. Chemical properties

i. **Action of Acids:** Strong acids are harmful for the fibres but organic acids can be used.

ii. **Action of alkalis:** Not affected by alkalis.

iii. **Effect of Bleaches:** Not affected by bleaches. It doesn't need bleaching.

iv. **Affinity for Dyes:** It is difficult to dye polyester due to hydrophobic nature.

v. **Moth & Mildew:** It does not get affected by moth and mildew and so it can be stored very easily.

G. Acrylic

Acrylic fibres are produced from a chemical compound called acrylonitrile. This is formed by combining natural gases, air and water.

The basic raw materials from which these are obtained are coal, air, water, petroleum, limestone and natural gases. All these materials on processing form a plastic like substance. It is to be dissolved in a suitable solvent to form the spinning solution. The spinning solution is then passed through the spinnerets into a chamber where hot air is blown. The solvent evaporates because of the hot air; thus the acrylonitrile solidifies as filament. This is dry spinning. Acrylic fibre is commonly known as orlon or cashmilon in India.

Do you know!

The term acrylic is derived from the Latin word acryl, which means bitter, irritating or pungent, and is descriptive of the compound, acrylic acid.

a. Physical properties

i. **Microscopic appearance:** The longitudinal appearance of the acrylic fibre is regular in width, usually showing only one heavy striation but sometimes several fine striations are also seen. The microscopic appearance cannot be used to identify the acrylic fibre.

ii. **Composition:** The acrylic fibres are composed of acrylonitrile units.

iii. **Length:** The acrylic fibres appear as slightly wavy filaments or staple fibres.

iv. **Strength:** Acrylic is not strong as nylon, but is stronger than wool and other natural fibres.

v. **Moisture Absorption:** Acrylic fibres are hydrophobic because the polymer system is highly crystalline. So only a few water molecules are absorbed.

vi. **Effect of Sunlight:** Acrylic textiles, when exposed to sunlight, will initially suffer a small loss in tenacity. After this initial loss there is a 'levelling off' in any further reduction in tenacity. From then onwards acrylics have excellent sunlight and weather resistance.

vii. **Heat Conductivity:** It has a better resistance to heat as compared to nylon but high temperature or exposure to heat for a long time will damage acrylic.

b. Chemical properties

i. **Action of acids:** Acrylic has good resistance to acids.

ii. Action of alkalis: These fibres can withstand alkalis but sometimes undergo saponification on the surface. This leads to yellowing of the fabric.

iii. Action of organic solvents: The common organic solvents used in dry cleaning do not harm acrylic fibres.

iv. Moth & mildew: Has excellent resistance to clothe moths, carpet beetles, mildew, bacteria and fungi. This is one reason why it is acting as a substitute for wool in winter apparel.

H. Rayon

Have you seen the fibre which resembles silk?

- .....

Rayon is an artificial synthetic fibre made from cellulose. The rayon fabrics were first called "Artificial Silk" because this fibre has lustre like silk. Rayon is a regenerated manmade fibre. Its commercial production started in Germany at the beginning of the last century. The substance from which rayon fibres are made is cellulose-a vegetable matter. It is obtained from cotton linters (cotton fibres less than 1cm long) or from wood pulp. Cellulose in this form cannot be used as fibres. The basic process consists of digesting or dissolving it in certain chemicals. This

solution is forced through the spinnerets in a chemical bath where hardening of the filaments takes place.

a. Physical properties

i. **Microscopic structure:** The microscopic structure of rayon is smooth, shiny and flat in appearance.

ii. **Composition:** Rayon contains cellulose as the main content which has elements of carbon, hydrogen and nitrogen.

iii. **Length:** Rayon is a filament that is why it is lengthy.

iv. **Strength:** As compared to cotton, rayon is a weak fibre. In wet state the strength decreases. So rayon fabrics have to be washed carefully.

v. **Moisture absorption:** It absorbs water and is good for summer.

vi. **Shrinkage:** Rayon shrinks after washing and shrinkage is more than cotton.

vii. **Resiliency:** Rayon is more resilient than cotton.

viii. **Heat conductivity:** It is a good conductor of heat.

ix. **Effect of friction:** It cannot withstand friction and rubbing is harmful.

x. **Effect of sunlight:** Does not have any harmful effects.

b. Chemical properties

i. **Action of acids:** It is not affected by acids.

ii. **Action of alkalis:** Alkalis destroy rayon. Hence neutral soaps and detergents can be used.

iii. **Action of bleaches:** Strong oxidizing bleaches are harmful but mild bleaches such as hydrogen peroxide, sodium perborate can be used.

iv. **Affinity for dyes:** It has good affinity for dyes. They dye very quickly and evenly.

v. **Attack of moth and mildew:** Mildew and silverfish attack rayon very easily.

Complete the following table based on the properties mentioned above.

Physical Properties	Chemical Properties

I. Cellulose Acetate

There is slight difference between the chemical composition of rayon and cellulose acetate.

Rayon is composed of cellulose whereas cellulose acetate has acetate groups along with cellulose.

Cellulose acetate flakes are obtained by adding water to the spinning solution. After drying, these flakes are dissolved in acetone to make spinning solution. For spinning, the solution is passed through the spinnerets into hot air chamber. Thus acetone evaporates leaving cellulose acetate filaments.

a. Physical properties

i. **Composition:** This fibre is composed of cellulose and acetate groups.

ii. **Structure:** Acetate fibre is shiny, smooth and flat having uniform thickness.

iii. **Length:** Cellulose acetate, a man-made fibre, is available in filaments. If staple length is required, the filaments are cut according to requirement.

iv. **Moisture absorption:** This fibre does not absorb moisture easily. That is why it is not suitable for summers. Due to this reason it is difficult to dye.

v. **Strength:** This is one of the weakest fibres and its strength is reduced when it is wet.

vi. **Shrinkage:** The fibre has very less shrinkage.

vii. **Resiliency:** It is more resilient than rayon.

viii. **Heat conductivity:** It is a bad conductor of heat.

ix. **Effect of friction:** Being a weak fibre, fabrics cannot withstand rubbing.

x. **Effect of heat:** Melts at high temperature. So ironing should be done carefully.

b. Chemical properties

i. **Effect of acids:** Dilute and cold acids do not have any bad effect on the fibre. The fibre dissolves in concentrated acids.

ii. **Action of alkalis:** Alkalis do not have any bad effect on the fibre. So washing can be done very easily with any detergent.

iii. **Action of bleach:** It does not turn yellow and does not require bleaching.

iv. **Affinity for dyes:** It does not have good affinity for dyes because it absorbs water in fewer amounts. So the dyeing process is very slow.

v. **Attack of moth and mildew:** This fibre is not attacked by moth and mildew.

Know your progress

1. List any five chemical properties of wool.
2. State any five physical properties of cotton.
3. How does moth and mildew affect cotton?
4. Name the fibre which is known as "Artificial Silk".
5. State any five Chemical properties of Cellulose acetate.
6. Name the first man-made fibre.
7. Write short notes on acrylic fibres.

Let us conclude

Clothing came into existence at a very early stage. With the development of science, textile industries developed and different fibres came into use. Fibres are the fundamental visible units used in the fabrication of textile fabrics. Fibres are obtained from natural sources or man-made sources. Cloth is manufactured by spinning fibres which gives strength. We get

most of our clothing from the natural fibres. Natural and man-made fibres are the main classifications. Fibres are also classified on the basis of length and source. Cotton, linen, silk and wool are natural fibres where as synthetic and regenerated fibres are man-made fibres. Fibre identification is one of the most important as well as most interesting topics in fibre science. Visual inspection, microscopic test and burning tests are commonly used by us for the identification of different textile fibres. There are various operations held in the production and processing of fibre to fabric. The knowledge about the property of each fibre helps to improve our understanding about fibres.

Lab Activity

Identification of fibres -Cotton, Silk, Wool, Nylon Rayon using visual, microscopic and burning tests

Let us assess

1. Linen is suitable for the summer season. Why?
2. White cotton can easily be boiled in washing soda. Give reasons.
3. Compare the physical properties of Polyester and rayon.
4. Match the following.

Column A	Column B
Cotton	Flax plant
Silk	Keratin
Linen	Cellulose
Wool	Fibrion

5. Classify the following into natural and man-made
(nylon, linen, wool, polyester, silk, acrylic, cotton)

7 Yarn - Production and Properties

Key Concepts

7.1 Yarns-definition, types

7.2 Yarn production -spun and filament

7.3 Yarn properties

Significant Learning Outcomes

After the completion of this chapter,the learner:

- defines yarn and categorizes and identifies the different types of yarns
- describes yarn production
- explains yarn properties
- appreciates the traditional methods of yarn production

To convert textile fibres into fabrics various methods of fibre arrangement are employed. Probably the most common method is to convert fibres into yarns, which are then weaved into fabrics. Yarns are essential for knitted, woven or knotted structures and for many braided structures. 'Yarn' is defined by the American Society for Testing and Materials (ASTM) as "A Generic term for a continuous strand of textile fibre, filament, or material suitable for knitting, weaving to form a textile fabric." In the beginning, the yarns were spun by man with bare

hands without the aid of any tools and it must have been many centuries before the spindle was evolved for spinning. The spindle or takli still survives for spinning wool, silk and cotton yarn.

7.1 Yarn - Definition and Types

What are fibres called when they are grouped together?

- .....

A yarn is a long continuous length of interlocked fibres. Strands of fibres are brought closer to each other by twisting. Twists impart strength to the fibre strand which is then termed as a yarn. It is suitable for the production of fabrics, making thread for sewing, crocheting, knitting, embroidery and for rope making. A thread is a highly twisted and smooth strand of fibre. It is used for sewing, embroidery etc. The family of yarn is constituted of:

A. Spun yarns
B. Filament yarn
C. Tape, network or film yarns

A. Spun yarns

These are made by a number of staple fibres twisted together. Natural fibres such as cotton, linen, wool and jute can be made into spun yarns. Even manufactured fibres can be cut into staple lengths and processed to give spun yarns. This requires mechanical spinning which is quite complex.

Spun yarn has a dull, fuzzy look. They soil readily and are prone to pilling. On the positive side they are comfortable to wear and have less static build-up.

B. Filament Yarns

These are made by chemical spinning. All manufactured fibres are produced as filament yarns, by a variety of chemical spinning methods. Monofilaments are made by a single filament which is obtained by spinnerets, with one hole. Generally, such a yarn is stiffer and coarser than a multifilament yarn. Multifilament yarn is made from a number of filaments laid together with or

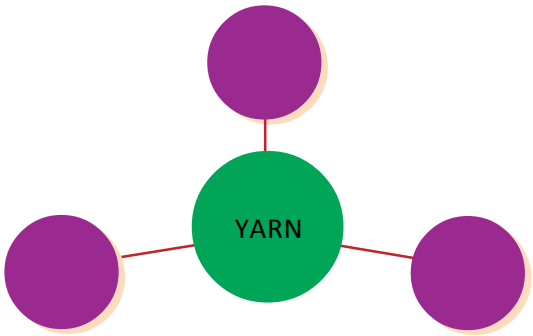
without twist. In this case, the spinnerets have many holes through which the dope is extruded simultaneously. Multifilament yarns are soft and pliable.

C. Tape, Network or film yarns

These are produced by splitting or slitting of sheets of materials or polymers which are extruded and solidified. One or more strips are made by lengthwise division of the polymer sheet.

Such yarns prove to be cost effective and is extensively used in industrial textiles for packaging. Polyethylene is often made by this method.

Based on the descriptions given above try to complete the illustration.



On the basis of the number of constituent parts that go into the making of a yarn, it can be classified into single, ply or cord.

a. **Single yarn**: It is made up of filament or staple fibres. Such yarns are used for a uniform look. Single yarns are rarely employed in textile applications. When the amount of twist is increased, it results in interesting effects eg. Crepe yarns.

b. **Ply yarn**: A ply yarn is made up of two or more singles. Ply yarns are named on the basis of the number of singles that join to make them. For example, 3 ply and 4 ply. These yarns are also known as multiple strand yarns. Ply yarns are less flexible, more coarse and heavier than single yarns.

c. **Cord yarns**: A cord yarn is composed of two or more ply yarns. For naming cord yarns, the number of plies as well as the number of single yarns in those plies is used. For example, 3, 2 ply cord yarn represents the use of 3 plies in yarn construction, each composed of 2 single yarns.

Try to complete the table given below:

Type of Yarn	Feature	Figure
Single yarn	.....	
Ply yarn	.....	
Cord yarn	.....	

On the basis of the visual appearance yarns may be classified into smooth or textured yarns.

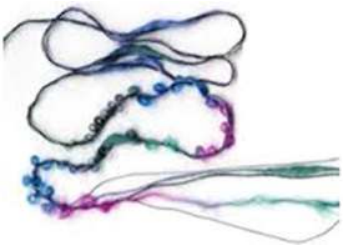
a. **Smooth filament yarns**: These have a regular surface and cross sections. They feel slippery and clammy. Fabrics made from these may lack warmth and comfort since filaments have a poor score in bulk, absorbency, pilling resistance and stretch properties. Aesthetic appeal of such filaments is also poor.

b. **Textured filament yarns**: Texturing can be defined as the permanent introduction of loops, coils, crimps or other distortions in an otherwise straight, smooth filament. This process imparts stretch, bulk, improved handle and greater absorbency to the filaments. Crease and pill resistance also get enhanced.

On the basis of yarn function, it can be classified into simple and complex.

a. **Simple yarns**: As the name suggests, simple yarns have a uniform size, regular surface and relatively smooth appearance. They have an equal number of twists per inch through their length. This uniformity makes them durable and helps prevent snagging and tearing. Such yarns are relatively easy to maintain.

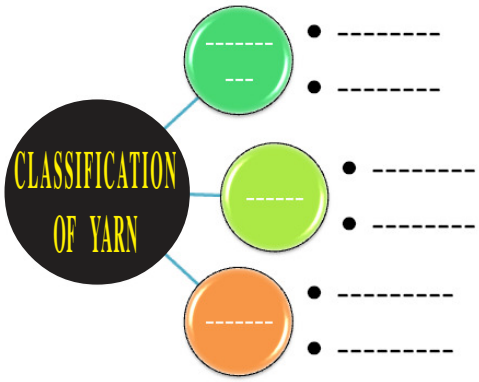
b. **Complex yarns**: Fancy yarns bring an unusual look, variation and interesting effects into the fabric. Such yarns do not have a uniform thickness throughout their length. This in turn implies that



they may show uneven performance in strength and wear. Complex yarns may be single or ply, though occasionally they may even have a cord structure.

In order to distinguishdifferent yarns on the basis of the number of constituent parts that go into the making of a yarn we can collect samples and paste it in the activity log and label it.

Complete the following Illustration about the classification of yarn and prepare a note.



Know your progress

1. Define fibres
2. What are the different types of fibres?
3. Classify fibres on the basis of yarn fibres

7.2 Yarn Production -Spun and Filament

Can you identify the object in the given figure? What is it? What is its use?

- .....

A. Spun Yarn Production

Spun yarn can be produced by any of the three techniques, namely:

a. Conventional /Mechanical spinning

b. Non-conventional spinning and

c. From manufactured filaments.

a. Conventional/Mechanical Spinning

This has been a commonly practised method of yarn production. The phrase 'mechanical' implies that the fibres are made to pass through a series of machines that eventually convert them into yarn. The kind of machinery and at times, the number of runs through it is decided by the fibre length.

b. Non Conventional Spinning

Apart from the conventional ring spinning process, there are some non-conventional processes as well. These include,

i. Rotor spinning (Open end Spinning)

Here the sliver is fed into a rotary beater. This device ensures that the fibres are beaten into a thin supply which enters a duct and gets deposited on the sides of the disc (rotor). Turning of the rotor introduces twist in the fibre strand through air currents.

ii. Friction Spinning

It consists of two perforated drums of the same diameter, moving in the same direction. Carded fibres are transported by air current to the rip of the rollers. They become compressed and twisted due to friction between rollers and strong air suction through the perforations. Amount of twist inserted is related to the rotation of the drums (up to 100 twists per rotation is possible). The final yarn is pulled out from below the roller and wound on a package placed at the top of the drums.

iii. Integrated Composite Spinning

This is also referred to as triflers spinning. In this method, a strong and uniform core of monofilament is coated with a bonding agent. It is then covered with staple fibre slivers which give it the desired appearance.

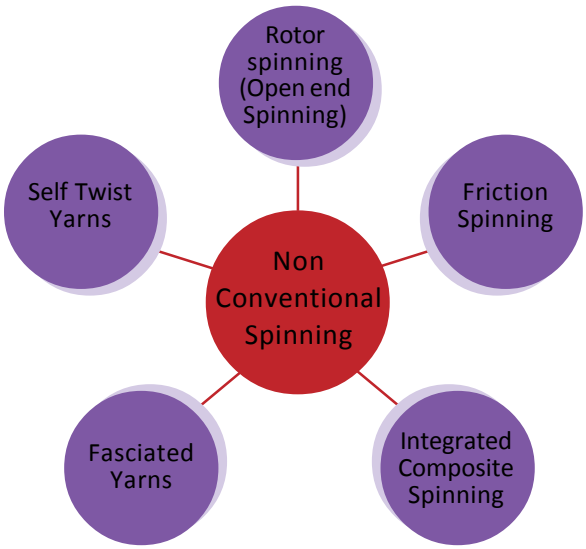
iv. Fasciated Yarns

There are a bundle of parallel fibres which are wrapped by other relatively long fibres. Fasciated yarns have poor abrasion resistance since surface fibres are not well anchored. This is not very popular today.

v. Self Twist Yarns

A pair of roving is passed through two rollers which are oscillating as well as rotating in opposite directions. Each imparts a twist in opposite directions which converts it into a yarn. After leaving the rollers, the two yarns are held together.

Observe the illustration given below. Using the illustration and the description given, prepare a note on Non- conventional spinning.



C. From manufactured filaments

Commercially available textile fibres have always influenced, to a considerable extent, the production technology as well as the sequence of production machinery in textile mills.

Spun yarns can be composed of fibres that are relatively short and are not exceeding eight inches. These yarns can be made from natural and man made fibres that fit the length ranges described. Individual fibre lengths within a given yarn may vary. Spun yarns exhibit a hairy or fuzzy appearance .The following methods is used to spun yarns from manufactured fibres.

i. Tow to top (Convertor System)

The spinneretters are modified to produce a tow or bundle of filaments with

fine diameter. The tow is stretched so that it breaks at the weakest point or cut to produce staple lengths. These are processed through the conventional spinning systems to form spun yarns and this method is called tow to top.

ii. Direct tow to yarns (Direct Spinning)

The extruded tow is fed to a special draw frame. The drafting rollers stretch it to the required thinners to break it into shorter lengths. All steps prior to drafting are omitted. The name direct spinning refers to the fact that conversion of tow to yarn takes place in a single process.

iii. Filament yarn production (Chemical Spinning)

The process of chemical spinning could be broken down into three components namely pre spinning steps, actual spinning and post spinning steps. Table 7.1 shows the steps in chemical spinning.

Chemical Spinning		
Pre-Spinning Operations	Actual Spinning	Post-Spinning Operation
Addition of · Delustrant · Bleach · Optical Brightening Agent · Dye pigment	· Melt · Dry · Wet · Emulsion · Gel	· Drawing · Washing · Spin finishing · Heat setting

Table 7.1 Steps in Chemical Spinning

a. Pre- Spinning Operations

These include addition of delustrants (for reducing the bright lustre of manufactured fibres) to manufactured fibres.

b. Actual Spinning

For any kind of chemical spinning there are three common steps. They are.

- Conversion of a polymer into a liquid or spinning solution, also called a dope
- Extruding the solution through spinnerets ie, pumping the dope.
- Solidification of the liquid into filaments (solids).

The various types of chemical spinnings are:

i. Melt Spinning

Here the polymer is heated and melts to form a liquid spinning solution. eg.: Nylon, polymer etc.

ii. Dry Spinning

Here, a volatile solvent (acetone) is used to dissolve raw materials and form a solution. eg.: Acetate.

iii. Wet Spinning

This is the oldest, most complex and also the most expensive method of manmade yarn manufacture. A non-volatile solvent is used to convert the raw material into a solution. eg : Viscose.

iv. Gel-Spinning

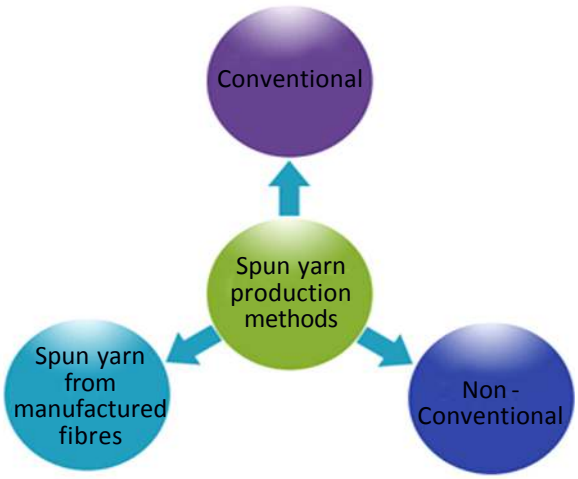
Polymer is mixed with a solvent to form a gel. This is passed through the same equipment as for melt spinning. The solvent is then extracted and the fibres are drawn.

v. Emulsion Spinning

In this the polymer is made into an emulsion, forced through a narrow tube to align it, and then fused without melting by application of heat. This is followed by extrusion into a coagulating bath through a spinnerette and subsequently stretched to impart orientation.

C. Post-spinning operations

These are common to all methods of chemical spinning and include washing, drawing (i.e., stretching) to improve orientation and heat setting.



Now let us present different spinning methods diagrammatically.

Know your progress.

1. Explain the steps in chemical spinning
2. Describe the methods of spun yarn production

7.3 Yarn Properties

How do we get long yarns from staple fibres?

A. Yarn twist

Fibres are given a twist to hold them together and impart strength to a yarn. One end of the fibre strand is held stationery while the other end is revolved. The fibre then assumes a spiral position around the yarn axis. There are three important aspects of yarn twist, namely amount, direction and balance of twist.

a) Amount of twist

The unit of twist is twist per inch (**tpi**) of yarn length. Generally filaments need a twist of 3-6 tpi while staples require a higher tpi of 10-20. More twist is required for staple, fine yarns and warp yarns. Twist is also qualitatively termed as low, medium and high.

Low twist yarns are soft, fluffy, warmer, have more surface texture but show less resistance to abrasion and wearing due to lower strength. A good amount of twist produces yarns which are uniform, smooth and have a subdued structure.

b) Direction of twist

The twist in the yarns may be put either to the right (S) or left (Z). Regular weaving yarns are usually in these 2 twists.

S-Right hand and Clockwise

Z-Left hand and Counter Clockwise

a) Degree of balance

The balance of fibre is determined by the proportion of warp and weft

yarns. If the numbers of warp and weft yarns are the same in a square inch the fibre has a good balance. A fibre with poor balance when held in the light will show yarns running in one way ie, lengthwise only. Such a fibre is not good.

B. Yarn number

This is an indicator of yarn thickness. There exists a mathematical relation between the length of a yarn and its fineness. This is quantitatively expressed as a number, hence the term yarn number. There are two systems which can be employed to denote yarn fineness. These are the direct and indirect systems. Direct yarn number system used for filaments, expresses fineness as mass per unit length of yarn. Indirect yarn number system uses length per unit mass of yarns as an indicator of fineness.

Know your progress

1. Define yarn twist
2. What do you mean by yarn number?
3. Name the three important aspects of yarn twist

Let us conclude

A yarn is a long continuous length of interlocked fibres. Strands of fibres are brought closer to each other by twisting. The family of yarn is constituted of spun yarns, filament yarns and tape, network or film yarns. Spun yarns are made by a number of staple fibres twisted together. Filament yarns are made by chemical spinning. Film yarns are produced by splitting or slitting of sheets of materials or polymers which are extruded and solidified. On the basis of the number of constituent parts that go into the making of a yarn, it can be classified into single, ply or cord. On the basis of visual appearance, yarns may be classified as smooth or textured. On the basis of yarn function, it can be classified into simple and complex. Spun yarn can be produced by either of the three techniques namely conventional spinning, non-conventional spinning and from manufactured filaments that have been converted into staple fibres. The process of chemical spinning could be broken down into three components namely pre spinning steps, actual spinning and post spinning steps. Fibres are given a twist to hold them together and impart strength

to a yarn. One end of the fibre strand is held stationery while the other end is revolved. The fibres then assume a spiral position around the yarn axis. There are three important aspects of yarn twist, namely amount, direction and balance of twist.

Let us assess

1. Differentiate between spun yarns, filament yarns and film yarns.
2. Chemical spinning consists of three common steps. Explain.
3. Match the following.

A	B
Melt Spinning	Viscose
Dry Spinning	Nylon and polymer
Emulsion Spinning	Acetate.

4. Choose the right answer from the following.
   a) Single yarn is made up of two or more singles
   b) A ply yarn is made up of filament or staple fibres
   c) A cord yarn is composed of two or more ply yarns.
5. Find the odd one out and give the reason.
   Rotor spinning, Mechanical Spinning, Friction Spinning, Fasciated Yarns
6. Draw a tree diagram on the classification of yarns.
7. What do you mean by low, medium and high twists?
8. When do you know that the fibre has a good balance?

8 Fabric Construction

Key Concepts

8.1 Weaving: Characteristics and Classification, Types of looms, Characteristics of woven fabrics

8.2 Knitting: Concepts, Classification

8.3 Non woven: Classification

8.4 Other methods of fabric construction

Significant Learning Outcomes

After the completion of this chapter, the learner:

- describes parts of looms and classifies types of loom
- explains characteristics of woven fabrics
- distinguishes different weaves
- defines knitting and explains concepts of knitting
- differentiates warp and weft knit structures
- compares knitting and weaving
- classifies non woven fabrics
- discriminates other methods of fabric construction
- develops a positive attitude towards traditional weaving methods (Handloom dresses)

In the last two chapters we saw that the fibres and yarns affect the properties, appearance, and wearability of the fabric. Similarly, fabric construction methods influence the appearance, properties and performance. In everyday life we may use different kinds of fabrics. These fabrics vary in their form, texture and performance. We know that an apparel textile is different from an upholstery fabric. Within the apparel textiles, the inner wears are very different from the outer clothes. These differences stem from the fabric

construction method employed in each case. Let us examine the methods of fabric construction in detail.

Broadly speaking, fabrics can be made from yarns or even from fibres directly. Fabric construction is done by weaving, knitting, non-woven and other methods.

The following section deals with the above said methods of fabric construction in detail.

8.1 Weaving: Characteristics and Classification

Observe the picture.

Can you identify the picture? What is it? Can you name the process of making fabrics shown here?

- .....

Weaving is the oldest method of fabric construction. It is the process in which two sets of yarns interlace at right angles to each other in patterns which are basic or fancy. In weaving the warp and filling yarn may be interlaced in many different ways. The particular method that is used to interlace the warp and filling is called the weave.

The device used in weaving is the loom. The loom has undergone significant modifications but the basic principles and operations remain the same. Warp yarns are held taut within the loom and the filling yarns are inserted and pushed into place to make the fabric.

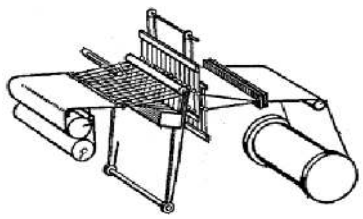


Fig 8.1 diagrammatic representation of a basic handloom

Figure 8.1 shows the picture of a basic handloom. At its back is placed the ***warp beam*** or a roller with the warp yearns wound on it. These pass through the eye or hole in a metal wire or thin strip, called a ***heald***. A number of healds are set in a rectangular wooden frame called a ***harness*** or ***shaft***. In the simplest loom, there are two harnesses and alternate warps pass through them. Thus all odd warps pass through the healds of the first harness, while all even

warps pass through the healds of the second harness. If the first harness is lifted, all odd numbered warp yarns would be raised to create a space called a ***shed***. This motion is called ***shedding*** and is a primary motion of the loom.

The weft yarns or pick is wound in small bobbins (pins) and placed inside a shuttle. This shuttle has a boat-like shape, with pointed ends. After shedding is done, the pick is laid in the second operation called **picking** (another primary motion). For this, the shuttle travels through the shed and waits at the other side.

It is important to weave a fabric which is compact and firm. This is achieved by using a ***reed***, which is a comb-like device placed towards the front of the loom. It has fine metallic wires with spaces called ***dents***, through which the warp yarns have been passed prior to weaving. The reed is pressed against the weft in the third primary motion called ***beating***.

At places where the warp yarn is lifted, it will be visible. At other points, it is the weft yarn that will be seen in an interlacement. After the first pick is laid, the odd numbered warp yarns will be seen on the top, while the even numbered warp yarns will be covered with the weft. For the next pick, the first harness is lowered and the second harness is lifted up.

As the weaving proceeds, the warp yarns keep getting converted into a woven cloth after interlacement by the weft yarns. It is then time for the secondary motions of weaving. These are actually a pair of motions: ***take up*** and ***let off***. The woven cloth is taken up or wound on the cloth beam placed in front of the loom. This pulls the warp yarns from the warp beam at the back of the loom. In other words, the warp beam lets off yarns and makes them available for weaving. The following table sums up the motions of a loom, along with the parts that help carry them out.

Category of motion	Name of motion	Parts employed
Primary	Shedding	Harness frame
	Picking	Shuttle
	Beating	Reed
Secondary	Take up	Cloth beam
	Let off	Warp beam

Table 8.*1 Motions of weaving (Sekhri. S, 2011)*

A. Types of looms

Classification of looms can be done based on the source of power and the mechanism of laying the weft yarn.

a) **Source of power:** Based on the source of power, looms can be classified as handlooms and power-looms.

Looms that are manually operated are referred to as handlooms. These are cheaper but have comparatively slower rate of production. The power loom is run by mechanical energy. It is faster than a handloom and is employed by the mill sector. (Fig 8.2).

Fig. 8.2. power loom

b) **Mechanism of laying the weft yarn:** Based on the mechanism of laying the weft yarn the looms can be classified as shuttle and shuttle-less looms.

The loom that uses a shuttle (Fig 8.3) for laying the pick is referred to as a shuttle loom.

In shuttleless looms the pick is laid across the shed using a variety of mechanisms.

Fig. 8.3 *Shuttle*

B. Characteristics of woven fabrics

The following are the characteristics of woven fabrics.

a) **Warp** or **end**: it refers to the yarns laid lengthwise on the loom. Cross wise yarns are called **weft, pick or filling yarns**. (See Fig 8.4) Warp yarns are generally stronger than weft yarns.

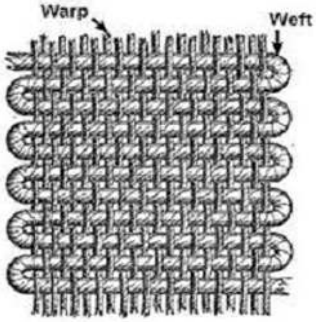
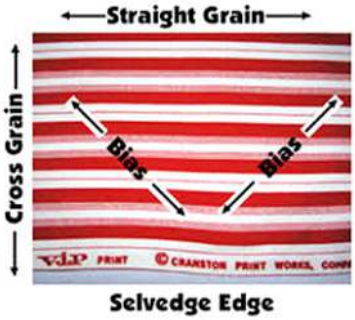


Fig 8.4 *warp and weft*



b) **Bias:** It refers to a direction which is at 45^0 angles to the warp and weft See Fig 8.5). There is maximum stretch along the bias of a fabric.

Fig 8.5 *Bias*

c) **Fabric count (thread count)**: It is an indicator of the compactness of a weave. It is defined as the number of warp and weft yarns per square inch of a woven fabric. A fabric with 50 warps and 40 wefts in one inch will have a fabric count of 50x40 or 90.

d) **Balance:** It is the ratio of the warps to wefts in one square inch. A balanced fabric is one in which this ratio is 1:1.

e) **Selvedge or selvage** is the 'self edge' of a woven fabric. They are the two longer sides of the fabric, which have edges and that do not need any kind of finishing.

f) **Grain line:** It is a straight line with arrows which is drawn parallel to the selvedge to represent direction of the warp yarns.

Weaves: Classification

The interlacement of the warp and weft yarns produces designs called weaves. Various factors such as number of harnesses, threading pattern of warps through the heads, number of picks laid together and lifting plans of the harnesses can be regulated to obtain a wide variety of weaves. Broadly these can be classified into basic and fancy or decorative weaves as shown below in the following table.

Weaves	
Basic (3 types)	**Fancy (6 types)**
a. Plain weave Variations i Rib weave ii Basket weave	a. Dobby
b. Twill weave i Regular twill ii Irregular twill	b. Jacquard
c. Satin and sateen weave	c. Surface figure weave i Spot ii Swivel iii Lappet
	d. Pile weave i Weft pile ii Warp pile (cut and uncut)
	e Double weave f. Leno weave

Table 8.2: *Classification of Weaves (Sekhri. S, 2011)*

A. Basic weave

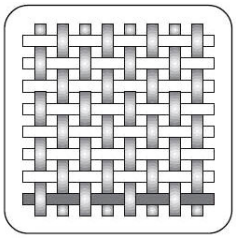
There are three basic weaves from which all woven fabrics are constructed. These are plain weave, twill weave and satin weave. All other special effect woven fabrics use the basic weaves alone or in combination but need complex loom attachments and techniques to achieve the desired appearance. Basic weaves are of three types a. Plain weave b. Twill weave and c. Satin weave.

a. Plain weave

Name the weave commonly used in daily wears and bed sheets?

- .....

The plain weave is the simplest of the three basic weaves. The plain weave is formed by yarns at right angles passing alternately over and under each other. Each warp yarn interlaces with each filling yarn from top form the maximum number of interlacing. Plain weave requires only two- harness looms and the least expensive weave to produce. It is described as a 1/1 weave, read as one harness up and one harness down or as one up and one down which describes the position of the harness when forming the shed. Examples of fabrics with plain weave are organdie, muslin, cambric, poplin, flannel and canvas.

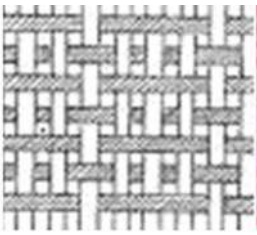


The plain weave has two variations namely rib and basket.

Observe any handkerchief with the help of a hand lens and identify plain weaves and draw the pattern in your activity log.

i. Rib weave

A rib fabric is one where the surface shows raised lines or ridges. In a warp rib the ridge runs across the width of the fabric and is achieved with a high density of warp 'ends', where two or more weft 'picks' are placed in each 'shed'. The warp 'yarn' is often finer than the weft

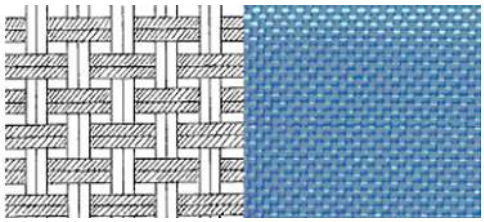


and covers the surface of the fabric. A weft rib is the converse of a warp rib where the rib effect runs along the length of the fabric.

Observe any household linen with the help of a hand lens and identify rib weaves and draw the pattern in your activity log.

ii. Basket weave

Basket weave is a variation of the plain weave. In this, two or more warp yarns cross alternately side by side with two or more weft yarns. This type of weave resembles a plaited basket. In Royal Oxford the warp has two fine yarns paired together. The weft has one heavier, softly spun fill yarn, which gives the fabric a very subtle basket weave look with a silk-like and lustrous finish. The fabric produced is flexible, loosely woven, somewhat wrinkle resistant, suitable for covering and drapery.



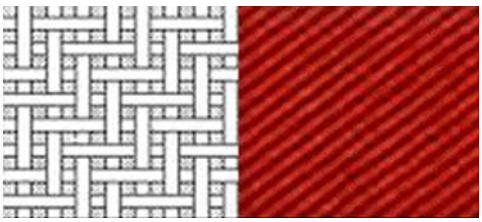
Examples include jute packaging bags, oxford and monks' cloth

Draw the difference between rib weave and basket weave in your note book with a pencil.

b. Twill weave

In twill weave the order of interlacing causes diagonal lines to appear in the fabric. The lines may run to the right, known as the Z direction, or they may run to the left, known as the S direction. On the reverse of the fabric the twill lines run in the opposite direction and are often less distinct. The twill effect can be accentuated by using different coloured warp and weft 'yarns'. Warp-faced twills show a predominance of warp 'yarns' on the face whereas Weft-faced twills (sometimes called twillette) show a predominance of weft 'yarns' on the face.

The fabrics with twill weaves are attractive, durable and strong. Being tightly woven, they do not get as dirty as plain weaves but once soiled, they are difficult to clean.



Twill weaves can be divided into regular twills and irregular twills.

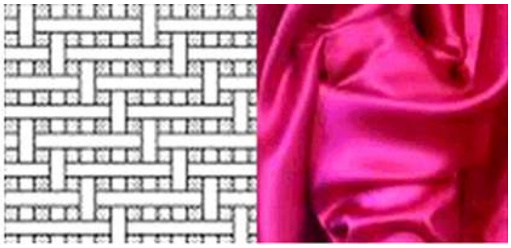
i. Regular twills: are characterised by uninterrupted diagonal lines on the face and back of the fabric.

ii. In **irregular twills** diagonal line changes its path to create interesting effects.

Examples include denim, drill, some tweeds and many suiting fabrics

Observe any clothes jeans/trousers with the help of a hand lens and identify twill weaves and draw the pattern in your activity log.

c) Satin weave



Satin is a weave and not a material. The main feature of satin weave is the uniform distribution of the interlacings, which are never adjacent to one another. A basic satin weave repeats over at least five 'ends' and five 'picks', but the warp 'ends' interlace only once. This type of weave pattern leads to the creation of long 'floats' which because of the scarcity of interlacings (and thread density) in turn produces the smooth, even and lustrous sheen often associated with satin. Floats can snag and get pulled easily; making satin weave fabrics less durable and weaker than plain or twill weave fabrics. Satins find wide use as lining fabric and in sarees.

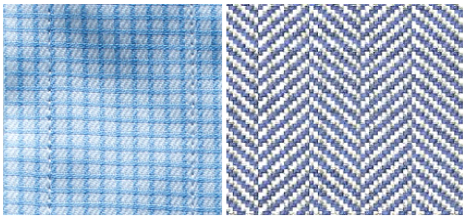
Sateen is a variation of this weave. There is a predominance of the weft yarns in the form of floats with very few warps visible.

Observe any satin cloth with the help of a hand lens and identify satin weaves and draw the pattern in your activity log.

B. Fancy weaves

Fancy weave refers to any weaving method other than plain, twill or satin weaves used to create a fabric with a surface texture or pattern resulting from the interlacing pattern. The cost of the fabric is high and the fabric may have a more specialized application. The techniques used to obtain these fabrics vary in complexity and this influences the fabric cost and serviceability.

a. Dobby weave

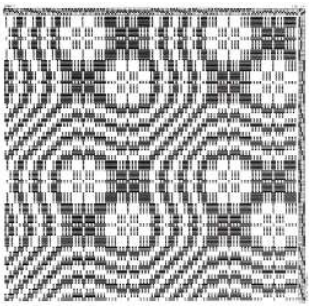


The dobby weave is considered a "fancy" weave because dobby weaves generally have unique geometric patterns in the fabric. This is accomplished using a special loom that rises and lowers the warp threads individually, allowing the weaver to create the dobby weave's distinctive patterns. Dobby fabrics can come in all kinds of patterns, colours, weights and hand feels. Examples include honey comb and birds' eye. It is not possible to remove the design without unravelling the fabric.

Observe any available clothes with the help of a hand lens and identify dobby weaves and draw the pattern in your activity log.

b. Jacquard weave

This is one of the most elaborate weaves, made by evenly combining plain, twill and satin weaves in the same crosswise yarn. It is a fabric woven on a special loom called the jacquard loom. This loom allows individual control on interlacing of up to several hundred warp threads that can give birth to innumerable unique patterns. Jacquard fabrics have floats and lustre. They are more stable and stretchy than the fabrics made through basic weaves. It has elaborate patterns and scenes that make it extremely attractive and also expensive. Jacquard fabrics are mainly used for upholstery and as drapery fabrics.



Examples include brocades and damask.

Do you know!

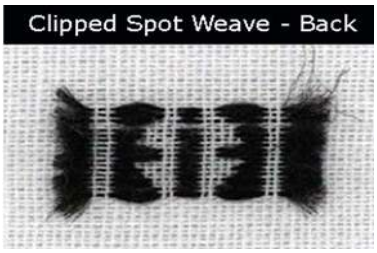
Joseph Marie Charles Jacquard (1757-1834) developed the loom that bears his name. His loom was one of the great inventions of the Industrial Revolution and it revolutionized the weaving of a wide range of fabrics and carpets.

Observe any household linen with the help of a hand lens and identify jacquard weaves and draw the pattern in your activity log.

c. Surface figure weaves

Extra set of warp and /or weft yarns are used to create many interesting designs on fabrics. There are three members in this family.

i **Spot or dot:** These weaves are formed by bringing a certain series of yarn either the warp or the filling to the surface of the cloth at certain points and allowing it to float for a number of ends or picks as the case may be thus producing a spotted effect on the cloth. Spots may be made by floating either the warp or the filling on the face of the cloth: the former are known as warp spots and the latter as filling spots.Generally these differ in colour and/ or weight from the base fabric thus making them prominent. The 'eyelash' patterned fabric (dotted Swiss) is one example of clipped spot.



ii **Swivel weave:** Swivel weaves require an extra filling yarn to form the design. The same filling yarn is used to produce the entire motif. Thus, in swivel weave fabrics, there are no fringes and no floats seen at the back of the fabric. Cotton sarees from Calcutta are a common example of swivel weave. It is also common in women's fabrics for salwar kameez.

iii **Lappet weave:** Extra warp yarn is used to create a pattern which is securely fastened to the ground weave. Fabrics with this weave are durable and expensive. The effect sometimes resembles hand embroidery or machine hakoba embroidery.

Observe any available cloth with the help of a hand lens and identify surface figure weaves and draw the pattern in your activity log.

d. Pile weave

The term is originally from the Latin word *pilus* meaning hair. These weaves have a soft projecting surface of fibres. One set of yarns, called ground warp and weft form the base fabric in plain or twill weave. An extra yarn forms floats which are then cut and brushed to form the pile.

i. **Weft Pile fabric**: Weft pile fabrics are made by using an extra weft yarn. It floats over three or more warp yarns of the ground fabric. Corduroy and velvets are examples of weft cut piles.

ii. **Warp pile fabrics**: Warp pile fabrics are made by using an extra warp yarn. These can be uncut pile and cut pile. Terry pile is an example of uncut pile whereas velvet is an example of cut pile fabrics.

Observe any household linen with the help of a hand lens and identify pile weaves and draw the pattern in your activity log.

e. Double weaves

These are made with 3, 4 or 5 sets of yarns. Double cloth which is made from 3 yarns is also called a double faced or backed fabric. There could be 2 sets of warp yarns, which share one filling yarn. It is also possible to have 2 sets of filling yarns which use one common warp.

Double cloth weave constructions are used in apparel;, upholstery and draperies. Salient uses for double faced or backed fabrics include satin ribbons, interlinings of coats and reversible blankets.

Observe any available cloth with the help of a hand lens and identify double weaves and draw the pattern in your activity log.

f. Leno weave

This is characterised by an open mesh structure which is achieved through a doup attachment on the loom. This controls the warp yarns by moving vertically as well as horizontally. The weave is also sometimes referred to as doup weave. Fabrics produced with such crossed yarn arrangements exhibit superior strength, reduced shrinkage and slippage.

***Draw diagrammatic sketches of the different types of weaves in your* activity log.**

Properties and uses of woven fabrics

The fabric properties are related to thread count, balance, weight, interlacing pattern, fibre content, yarn structure, & finishes. Woven fabrics are usually smooth, unless thicker yarns are used in the construction of the fabric. The edges generally fray quite easily; they don't stretch much on the weft (horizontal) or the warp (vertical) but do stretch a little on the bias (diagonal). The tighter the weave, the stronger it is and the less likely it is to fray.

Woven fabrics are used for a broad spectrum of end uses from the decorative to the functional. Woven fabrics are used in apparel for ladies wear, outer wear suiting, shirting and sportswear. Interiors, curtains, soft furnishings, upholstery, carpets and beddings are made of woven fabrics. Other specialised end uses include geo-textiles, composites, architectural solutions, airbags, transportation and medical textiles.

Know your Progress

1. Explain the parts of a loom.
2. What are the characteristics of woven fabrics?
3. Write short notes on plain weave, twill weave and satin weave.

8.2 Knitting - Concepts and Classification

What is the difference between the weave of your uniform and that of your socks?

- .....

Knitting is defined as an interloping of one or more yarns to make a fabric. Knitted fabrics are made from interlocking loops, formed from one or more yarns. The origins of hand knitting cannot be dated, but is believed to be quite old. Hand knitting uses two needles or pins. One or more yarns may be used in a variety of stitches to produce weft knitted fabrics. The process requires time and skill. In machine knitting loops of yarns are formed with the help of thin, pointed needles. As new loops are formed, they are drawn through the previous ones, thus producing a knitted fabric.

A. Knitting: some concepts

a. **Stitches**: Loop or stitch is the basic structural element of a knit construction. Each loop has one head, two legs and two feet.

b. **Wales:** Vertical column of loops which run parallel to the length of the knitted fabric. It can be compared to the warp in a woven fabric.

c. **Course**: Horizontal row of loops which runs perpendicular to the length of the knitted structure. It can be compared to the weft in a woven structure

d. **Gauge or cut**: It is an indicator of the fineness or coarseness of a knitted fabric which in turn is related to the number of needles used on the machine. The units of gauge are number of needles per inch (npi) on the machine or number of needles per centimetre (npcm).

e. **Technical Face or Technical Back**: These are the terms used for the two sides of a knit structure. The appearance of the technical face and back serves an important function of identifying the type of knit stitch in a fabric.

f. **Needles**: Just as hand knitting employs long, thin needles which come in various diameters, so also machine knitting uses many types of needles.

B. Weft and warp knits

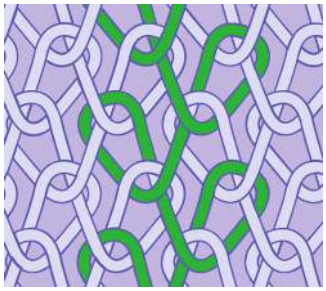
Knitted fabrics can be classified into weft and warp knit structures. Table 8.3 gives the differences in the two constructions.

Weft knitting	Warp knitting
One continuous yarn forms courses across the width	Many yarns form Wales along the length
The yarn is fed crosswise to the length of the fabric	The loop forming yarn is fed in the direction of the length of the fabric
Can be done by hand or machine	Only through machine
Can produce straight fabric to (on flat bed machines) or tubular fabric (in circular machines)	Only flat bed machines are used to produce straight fabric
Can be unravelled: may ladder does	Cannot be unravelled, usually not ladder
Knitting needles can work sequentially (one at a time) or simultaneously (all together)	Knitting needles always work together as a unit
Loops have an open structure	Loops have a closed structure
Yarn specification is not very stringent stringent and hence weft knits are comparatively cheaper	Yarn specification is more and hence cost is comparatively more

Table 8.3 Difference between Weft knitting and Wrap knitting

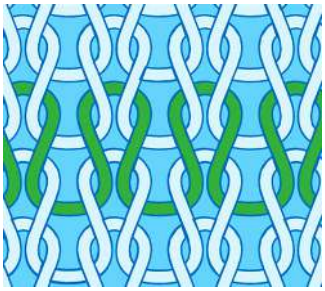
a. Weft knit stitches

There are four weft knit stitches, viz. plain, purl, rib and interlock. Two more variations can also be made (tuck and float) using weft knitting.



b. Warp knit stitches

There are four salient warp knits, viz. tricot, raschel, Milanese and simplex. More than 95% of the warp knitting goods is made by tricot or raschel knitting machines. The rest are made using simplex and Milanese knits.



Observe with a hand lens any cloth with knits and identify the weft and warp stitches.

C. Properties of knits

Knits are known for their excellent drape, fit and comfort. They give warmth due to the insulative air pockets. Other positive features include high absorption, light weight, wrinkle resistance and recovery.

But knits are costly and some fabrics tend to sag and loose shape. Some weft knits also face the problem of ladder formation. If one loop breaks, then a hole is made which starts to 'run' or slip down the wale.

D. Comparison of knitting with weaving

a. Knitting is 'younger' to weaving as a fabric construction process.

b. Yardage as well as garments can be made on knitting machines while looms produce only yardage.

c. Knitting is two to five times faster than weaving.

d. Knitting involves formation of loops, thus a greater length of yarn is used up to form loops across the width and along the length of a knitted fabric.

e. Knits have greater porosity but lesser cover than woven fabric.

f. Fineness of construction is indicated by gauge or cut in knits, as against fabric count or thread count in woven fabric.

g. Wide knitting machines run as fast as the narrow ones; in weaving wider looms have a slower speed of production.

h. Yarn specifications for knitting are more stringent than for weaving. This escalates the cost of raw material. However, no yarn preparation like sizing, washing etc. is needed in knitting.

i. Looping imparts stretch to the knit fabric, while woven fabric does not stretch to any marked degree. Only the bias direction of a woven construction exhibits some stretch.

j. Design can be changed very rapidly, especially in weft knitting. Thus the pulse of prevailing fashions can be reflected more effectively in knitting than in weaving.

Collect some samples of knits and weaves and prepare an album so as to help you to distinguish them.

Know your progress

1. Define knitting.
2. Write some concepts about knitting.
3. What are the properties of knits?

8.3 Non-woven Classification

Is it possible to make fabrics without weaving and knitting?

Non woven fabrics are those fabrics that are changed directly from loose fibres into a fabric, without spinning the fibres into yarn.

Broadly speaking, non-woven includes those fabric structures which are made by some means other than weaving or knitting. This means a partial or complete elimination of conventional textile processes. This in turn leads to large saving of time and cost. Today, non-woven is witnessing a phenomenal spurt in applications and demand.

Non-woven is commonly divided into two groups, viz. felts and bonded fabrics. Felts are perhaps the oldest of fabrics made by man, bonded fabrics are the 'youngest'.

Table 8.4 shows the classification of non-woven fabrics

Non-woven fabrics				
Felts		Bonded fabrics made by		
Wool felts	Needle felts	Thermal treatment Thermoplastic spun bonded	Chemical treatment (adhesive bonded) Dry powder Liquid adhesive	Direct method • Spun bonded • Melt blown

Table 8.4 Classification of non-woven fabrics

A. Felts

Felt is made from wool and similar fibres. The physical structure of these fibres can cause them to interlock tightly under certain conditions. There are two types of felts.

a. Wool felts

These are fabric structures made by the interlocking of scales present on wool fibres. Technically any animal fibre can be used for felt construction. However the most commonly used and practical option is sheep hair or wool. Today, wool fibres are also blended with other non-felting fibres to reduce cost of production but the proportion of wool in such blends is at least 50%.

These are dependent on the raw materials used i.e., type of animal hair and non-felting fibres which may have been added.

Some general features include good insulation properties, easy shaping, good shock and sound absorbance and good resilience. On the other side are poor elastic recovery, low breaking elongation and difficulty in mending holes.

Felts are used in apparels, home furnishings, rugs pads, insulation materials, billiard cloths and in industrial applications.

b. Needle felts

Needle felts are made wholly or mainly from fibres other than wool. Almost any type of fibre can be used, though synthetic fibres are commonly used. Fibre entanglement is achieved by the mechanical action of barbed needles.

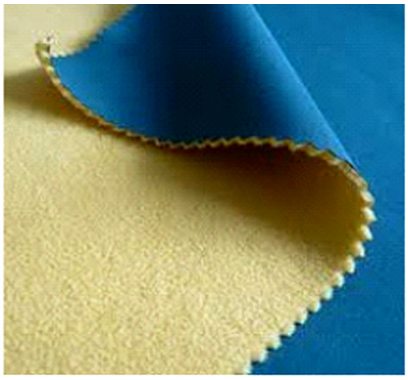
Properties and uses

Needle punched fabrics are light in weight, warm and offer ease of care and maintenance since synthetic fibres are normally used.

Chief uses include pre-moistened wipes, medical/surgical products, decorative fabrics, blankets, interlinings, floor coverings, upholstery materials, mattress covers, packaging materials and industrial filters. Some protective apparels and outer wears are also made using needle felts.

B. Bonded fabrics

Have you ever noticed the material used in tea bags? How does this differ from other fabrics?



- .....

Bonded fabrics are fibre mats held together by adhesives, fusing chemicals or thermal means. Advances in thermoplastic manufactured fibres and adhesives have made such fabric forming techniques more popular than ever. In properties and appearance the bonded fabrics occupy a place between paper and textiles. Most of the bonded fabrics manufactured today are prepared by producing a web of fibres on a card. The web can be held together by applying adhesive. Another method is autogenous bonding where the fibre itself is treated to become tacky to stick together. Some fibres such as rayon can be made tacky by treatment with acid. Bonding is then followed by compressing the web, washing and drying. Other fibres such as acetate can be bonded by simply applying heat and pressure.

Properties and uses

Bonded non-woven fabrics are known for their low cost and for the use of any kind of raw material. Properties like form, stability, crease resistance, air permeability and stability to washing as well as dry cleaning make bonded fabrics ideal for use as interlinings, facings and padding in garments. Cut edges do not fray making the finishing of apparel very simple. Other applications include tissues, diapers, bandages, sanitary towels, disposable napkins, mats, bed pads, lampshades, teabags, cloths for wiping and polishing, industrial textiles, medical textiles, electrical insulations, padding, packaging, roofing, blankets, carpets and carpet underlay, decorative fabrics for crafts and outerwear.

Some of their drawbacks are poor draping qualities, difficulty in mending and the tendency to lose shape or open up on washing.

Know your progress

1. Give the properties and uses of felts.
2. What do you mean by a bonded fabric?
3. What are the different types of non woven fabrics?

8.4 Other Methods of Fabric Construction

How does a shoe lace differ from the above mentioned fabric construction methods?

- .....

The following methods are also used for fabric construction. They are detailed below:

A. Braided fabrics

Braids are primarily a trimming fabric with three or more yarns interlaced diagonally. Braids are very strong in the lengthwise direction. Shoelaces are circular braids. Flat braids are used as trims for interior applications. Occasionally braids are made into interesting fabrics by sewing lengths together. Braided rugs are made by braiding various materials and sewing them together in a circular fashion from the centre to the outside.

In braiding, the yarns are not interlaced at right angles as in weaving, nor are they looped as in knitting. Rather the yarns are connected by twisting or by knotting them together. These can be used for trimmings or joined together to form a fabric. Braided textiles stretch considerably in length. Braiding of a little girl's hair into a pigtail is a simple example of the principle of braiding.

Braided constructions are used in craft items and bags made of jute or coir braids, shoelaces, wicks and electrical wire coverings.

B. Laces

The starting material for lace is generally a thread and not a yarn. If however a yarn is used then it is given enough twist to strengthen it. Lace may be knotted, interlaced, twisted or knit. All laces are characterised by an open mesh structure and decorative design.

Making lace by hand is a traditional home craft using hooks, needles, bobbins or shuttles. Handmade lace is called real lace. Lace fabrics may now be constructed by a weaving technique on a complex piece of equipment called the leaver's machine. With 40, 000 moving parts and hundreds of miles of threads the machine duplicates the most complicated handmade lace. The pattern is controlled by a jacquard attachment.

Lace fabrics can also be made up into dresses, curtains and table cloths.

C. Laminated fabrics

Laminated fabrics is a layered fabric structure in which a face or surface fabric is joined to a backing fabric with an adhesive that does not add significantly to the thickness of the combined fabric.

D. Nets

Nets are open work fabrics made by threads or yarns, on bobbinet machines in which the bobbin yarns are looped around the warp yarns in a spiral formation. This produces large geometric open gaps between yarns with no designs. Applications include veils, curtains, fishing nets, sports equipments and hammocks.

E. Stitch bonded fabrics

An assembly of fibres or yarns are held together (bonded) by stitching along the length direction. Their chief advantage is high production rate with a low capital investment. Applications include filling material for winter clothing, cleaning cloths and low cost furnishings.

F. Tufting

This method of fabric construction aims to simulate pile fabrics, at a fraction of their cost. A woven fabric acts as the base and a set of pile yarns are inserted into it to form tufts or loops on one side. These may be cut and brushed. Fibres generally used for the base include cotton, linen and jute. Tufts are made from a wide variety of natural as well as manmade fibres. A latex coating is then given at the back to enhance the stability of the tufted structure. End uses include warm lining materials, bedspreads, blankets, rugs and carpets.

In order to differentiate non woven and other methods of fabric construction a project work can be done.

Know your progress

1. Write short notes on the following
   a. Braided fabrics
   b. Laminated fabrics
   c. Tufting
   d. Stitch bonded fabrics

Let us conclude

Fabric construction is done by weaving, knitting ,non-wovens and other methods .

Weaving is the process in which two sets of yarns interlace at right angles to each other in patterns which are basic or fancy. Beam, heald, harness or shaft and reed are the parts of the loom. Shedding, picking, beating, take up and let off are the various motions involved in weaving.

Handlooms, powerlooms, shuttle and shuttleless looms are the various types of looms. Warp/end, bias, fabric count (thread count), balance, selvedge or selvage and grainline are the characteristics of woven fabrics.

Plain weave, twill weave and satin and sateen weave are the basic weaves. Dobby weave, jacquard weave, surface figure weaves, pile weave, leno weave and double weave are the fancy weaves.

Knitting is defined as an interloping of one or more yarns to make a fabric. Knitted fabrics can be classified into weft and warp knit structures.

Non woven fabrics are those fabrics that are changed directly from loose fibres into a fabric, without spinning the fibres into yarn. Felts and

bonded fabrics are non-woven fabrics. Felt is made from wool and similar fibres. Bonded fabrics are fibre mats held together by adhesives, fusing chemicals or thermal means.

Braided fabrics, laces, laminated fabrics, nets, stitch bonded fabrics and tufting are the other methods of fabric construction.

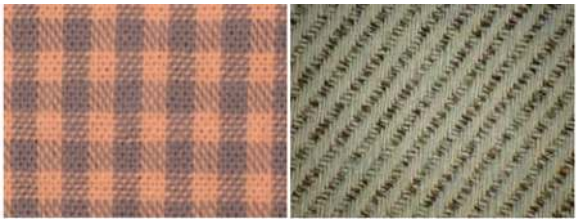
Let us assess

1. Match the following:

A	B	C
A rectangular wooden frame	Reed	picking
Small bobbins	Harness	beating
Comb-like device	Shuttle	shedding

2. Observe the pictures given below and answer the following:

A B



(a) Identify the weaves

(b) Write any two characteristics of weaves.

3. Compare the properties of woven and knitted fabrics.
4. What do you mean by the term technical face or technical back with reference to knitting?
5. Woven fabrics have certain characteristics. Explain.
6. Classify felt fabrics. Describe its characteristics.
7. Differentiate between weft knitting and warp knitting.
8. Name the type of fabric construction method applied in the following items. Describe the method.

   (a) Bandages (b) Shoelaces (c) Rugs and Carpets (d) Veils.
9. Which one of the following is a surface figure weave?

   (a) Dobby weave (b) Swivel weave (c) Double weave (d) Leno weave.

9 Fabric Finishing

Key Concepts

9.1 Finishes: Importance, classification

9.2 Common fabric finishes

Significant Learning Outcomes

After the completion of this chapter, the learner:

- defines textile finishing and identifies importance of finishes
- classifies finishes
- describes and identifies common fabric finishes
- appreciates the techniques used for fabric finishing

In the previous chapter we have seen how fabric is made from yarns. But fabrics may need some kind of treatment before they reach the customer. Here we shall deal with the various processes that make fabrics acceptable to the consumers.

Rema went to a textile shop. She asked for plain cotton cloth. The salesperson showed her a number of clothes with different colours, appearance, feel and cost. She was surprised at the variety of clothes they offered her. Even though all the clothes were cotton, they all were different.

What is the reason for such variations?

- .....

The fabric that comes out after weaving or knitting may not have desired appearance, feel or qualities. Fabrics in its loom state may contain impurities and require further treatment in order to develop its full textile potential. They are called gray goods. Gray goods are fabrics that have not received any finishing operations. In order to impart the required functional properties to the fabric it is customary to subject the material to different types of physical and chemical treatments. These are the final series of operations that produce the finished textile fabrics from gray goods.

Do you know!

The term gray goods do not imply that the fabric is grey in colour. It is another form of the term greige goods. Originally applied only to unfinished silk fabrics, but now used to denote any unfinished fabric as it comes from the loom.

9.1 Finishes

You might have seen that some fabrics when washed at home require some additional treatments like starching, ironing, etc. to improve its appearance. What are they called?

- .....

Finishing refers to the process that converts the fibre, yarn or fabric into suitable material. It is the process performed to yarn or fabric to improve the look, performance or feel of the finished fabric. The term *finishing* includes all the mechanical and chemical processes employed commercially to improve the acceptability of the product.

Apart from making the cloth attractive, finishes are undertaken to remove the various defects of the fabric. These processes are selected on the basis of the nature of the fabric, weave and purpose. Finishes bring variety to fabric and fabric fetches its due value. Finishing may be done in the mill where the fabric has been woven or it may be done at special centres or establishments called converter.

Importance of finishes

Why are finishes done on fabrics?

- .....

Fabric finishes are needed to improve the fabric. The objective of the various finishing processes is to make the fabric from the loom or knitting frame more acceptable to the consumer. The fabric finishes are important due to the following reasons.

a. Improve the appearance - When fabrics like cotton come out of the loom they may be dull or unattractive in appearance. They undergo finishing to improve their colour, pattern or sheen.

b. Change the texture of the fabric – Some fabrics are very rough in their natural form. Such fabrics need some finishes to make them smooth and shiny. The texture of the fabric can be changed by embossing, brushing or smoothing.

c. Improve the feel – Fabrics or fibre can be made softer, crisper, firmer etc., by the application of various finishes.

d. Improve the drape - The hanging quality of the fabric can be improved by applying finishes like weighting.

e. Improve the wearing qualities - Certain finishes like crease resistance, stain resistance, flammability, water proof etc. , make the fabric suitable for the particular purpose for which they are meant.

f. Modify care requirements – Some finishes applied on textiles make them easy to wash; some reduce the drying times, some make them colour fast and prevent shrinkage.

h. Help to bring variety- The finishing process like crape finish, embossing, ageing, printing etc. gives variety to fabrics.

h. Make fabric more durable- Fabrics can be made more durable. Certain finishes like moth proofing, mildew proofing, weighting etc. make the fabric last longer.

i. Produces imitations- The outer appearance of the fabric is changed to give some other appearance. Finishes like fuzzing of cotton fabrics make them look like woollen in appearance and properties. Mercerized cotton looks like silk.

Classification of finishes

There are a number of finishes that are applied to fabrics; these finishes can be classified in several ways. They are based on

a. the life of the finish.
b. the process involved
c. the function

a. Based on the life of the finish

You might have noticed that some fabrics need finishes like stiffening after each wash whereas some may not. Certain finishes last for a long period. Some finishes are durable but some are not. Based on the life of the finish they are classified into

i. Temporary finishes
ii. Semi durable finishes
iii. Durable finishes
iv. Permanent finishes

i. Temporary finishes

These finishes are removed or substantially diminished the first time the article is laundered or dry-cleaned. Many of these finishes are renewable.

e.g. starching, softening and bleaching of white fabrics.

ii. Semi durable finishes

These finishes remain on the fabric for several washes and dry cleaning and it may be removed after several laundering: eg. bleaching.

iii. Durable finishes

These finishes last throughout the life of the fabric but its effectiveness diminishes after each washing and nearly by the end of the normal life of the fabrics, the finish may disappear eg. shrinkage resistance.

iv. Permanent finishes

These finishes involve chemical change in the fibre structure and as a result they do not change throughout the life of the fabric, eg.

Water proofing, fire proofing.

b. Based on the process involved

The application of finishes on the fabrics involves many types of machinery and processes, based on that, finishes are classified into

i. Mechanical finishes.
ii. Chemical finishes.

i. Mechanical finishes

These finishes are also called dry finishes. They involve specific physical treatments like application of moisture, pressure, heat etc. and are given to that fabric surface to cause a change in the fabric appearance. These finishes are either temporary or semi durable and may not last long eg. beating, brushing, calendaring etc.

ii. Chemical finishes

They are also called wet finishes. These finishes are those in which a chemical reaction alters the chemical structure of the fabric. The appearance and the basic properties are changed permanently eg. fire proof, crease resistance.

c. Based on the function

Finishes may be applied to fabrics in order to improve its appearance or performance. They may be classified based on their function as follows

i. Aesthetic finishes /Basic finishes
ii. Functional finishes/Specific finishes

i. Aesthetic finishes / basic finishes

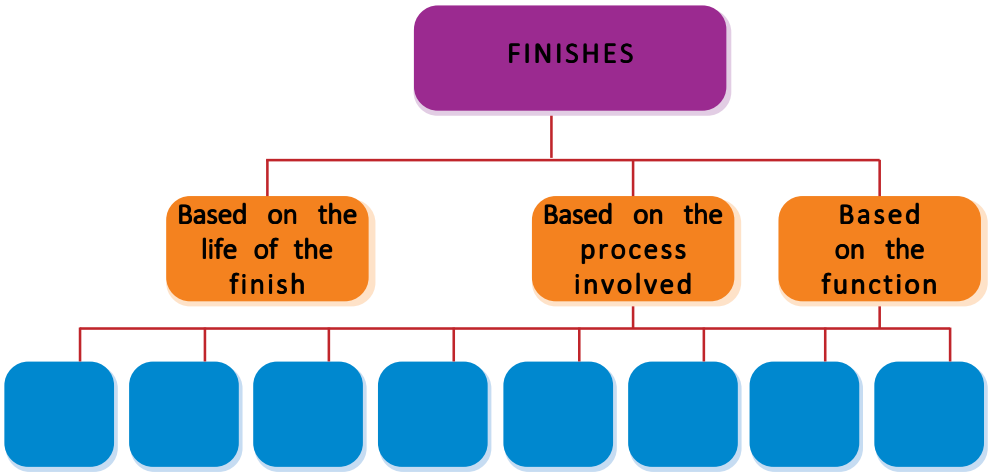
These are basic or common finishes applied to almost all the fabric. Aesthetic finishes improve the appearance and or hang or drape of the fabric eg. mercerization, stiffening, softening, calendaring etc.

ii. Functional finishes/ Specific finishes

Functional finishes or specific finishes change the properties of the fabrics. It also improves its performance for specific purposes eg. fire proofing, water proofing, bullet proofing, anti-microbial finish, crease resistance etc.

Finishes are applied to fabrics based on the physical and chemical properties, type of yarn, kind of weave and use of the fabric. Fabric labels may indicate the finishes that have been applied on fabrics. Care labels show the precaution needed while laundering these fabrics.

Complete the flow chart given below to understand the classification of finishes and record in your activity log.



Know your progress

1. Define finishing.
2. List the importance of finishes.
3. Classify finishes based on the life of finishes.

9.2 Common Fabric Finishes

Can you name some of the finishes that we adopt at home to improve the appearance of clothes?

- .....

Starching is a common temporary stiffening process given to fabrics (especially cotton) to improve its appearance and enhance the durability of the garments. Usually all fabrics undergo some type of finishing treatment to make them acceptable to the consumers. Some of these finishes are beetling, inspection, singeing, desizing, scouring, bleaching, stiffening, weighting, calendaring, tendering, mercerizing, sanforization,

parchmentization, water proofing etc. Not all fabrics undergo each of these processes. The finishes are decided by the producer on the basis of the market requirement.

These are 14 types of finishes. The details of each finishes is given below.

1. Beetling

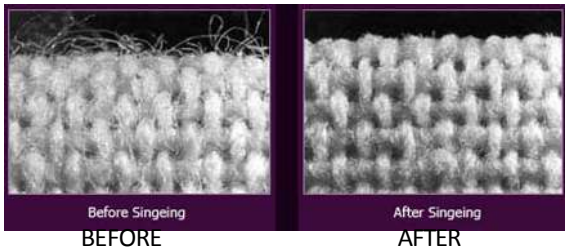
This is the finish applied to linen or cotton. The fabric is beaten with large wooden blocks in order to produce a hard flat surface with sheen. This action closes the interstices of the weave, flattens the yarns and gives greater areas for reflection of light, this increases the fabric lustre. Only table linen is put through the beetling process. When applied to cotton fabrics beetling gives a feel and appearance of linen. This process permanently flattens the yarns of the fabric on which it is applied.

2. Inspection

There is always a possibility for imperfections while fabrics are finished. They have to be identified before the fabric leaves the plant. This involves careful examination of the fabric for any imperfections. Fabric inspection is done in gray form or finished form. The inspection of fabric is a procedure by which the defects of the fabric are identified and fabric is classified according to the degree or intensity of the defects. Some of these can be repaired quite inconspicuously.

A few flaws may require greater repairs. Mending is actually the repairing of imperfections and removal of flaws caused by the fabric construction process. The final step done before the fabric leaves the plant is inspection. Printing flaws, stains, spots and weaving flaws are inspected in the cloth.

3. Singeing



BEFORE AFTER

Singe means to burn the surface lightly. This process increase the lustre and smoothness of the fabric made from staple fibre. The surface fibres are burned. The fabric passes over brushes to raise the fibres, and then passes over heated copper plates or flame at high speed.

This process can be applied to both yarns and fabric to produce an even surface by burning off lint and threads, projecting fibres, yarn ends etc. To prevent any damage after glow or sparks, the fabric immediately enters a water bath. Cotton and rayon fabrics are frequently singed but wool, silk and man made fibres are not, because they would form rough melt balls on the fabric. Singeing is done to yarns when they are used for fine quality cotton goods.

4. De-sizing

The preparatory process for weaving includes sizing or application of stiffening agents. This hampers in application of subsequent finishing and colouring. De-sizing is the removal of this sizing. Depending on the fibre that has been used the cloth may be steeped in a dilute acid and then rinsed or enzymes may be used to break down the size. Silk fibres undergo degumming since sericin gum imparts stiffening to silk fabrics.

5. Scouring / Cleaning

The fabric after weaving may be soiled with many impurities. These have to be cleaned before further processing. Scouring is the chemical washing process done on fabrics to remove natural wax, dirt or other impurities accumulated in the manufacturing process. This makes the fabric more smooth, neat and absorbent.


Scouring of wool fibers

The washing is done according to the nature of the fibre. Cottons are boiled in soap solutions while silks are

boiled for degumming and woollen fibres are boiled to remove grease and oil. Man-made fabrics require only normal washing.

6. Bleaching

Bleaching is a chemical treatment given to fibre, yarn or fabric to improve whiteness by removing the natural colour and remaining trace of impurities. Suitable bleaching agents are used to remove the colour and impurities. Cotton being a vegetable fibre is bleached using oxidizing agents such as dilute sodium hypochlorite, and peroxide is used for protein fibres. Man made fibres do not need bleaching. Synthetic fibres, when they require bleaching, may be treated with either oxidizing or reducing agents depending upon their chemical composition. Sun rays are natural bleaching agents especially for linen. The natural colour of the fibre is bleached for whiteness. The advantages of bleaching are:

Cotton bleaching machine

- Bleaching gives whiteness to the fabric
- It helps in the easy dyeing and printing of the fabric
- Special finishes can easily be given to bleached fabric
- It enhances the quality, absorbency and lustre of the fabric
- The chemicals used in bleaching disinfect the fabric.

7. Stiffening / Sizing

The fabric from the loom is loose which is given such finishing that gives stiffness to the fabric and helps in maintaining its shape. This, finishing is given to the fabric to subdue certain defects like fitting the openings and providing an appearance of freshness to the fabric. Normally starches, dextrin, gelatine, oil and wax are used for sizing. Silk is given gum starch. Sizing makes the fabrics crisp. Sizing can be permanent and temporary in nature. Starch which is soluble in water is

temporary and if starch is mixed with resin and then set in the fabric by heating, then it is permanent sizing. Some permanent sizing increases the textile strength and lustre of the fabrics and others improve the abrasion resistance and reduces shrinkage.

8. Weighting

The weight of certain fabrics like silk is increased by giving this finish. This process improves the feel and draping quality by immersing the fabric in a solution having metallic salts. Low grade wool fabric is also weighted some times by felting short wool fibres into the fabric. After degumming the silk fabrics become soft and light. This loss of weight is compensated by treating silk with suitable organic and inorganic compounds such as salts of tin, aluminium, iron and tannin acid. The salts penetrate the yarns and become a permanent part of the fabric but cannot be detected by handling. Weighted silk acquires a beautiful texture and appearance. Too much of weighting is harmful to the fabric as it lowers the strength and lustre of silk.

9. Calendaring

This is a finish similar to ironing.

- What happens to a cloth when we iron it?
- .....

The fabric is passed through a series of smooth hot rollers to remove wrinkles. It makes the fabric smooth and lustrous, thereby improves its appearance. The calendaring effect on the fabric is usually temporary and disappears after first washing. Semi permanent lustre is sometimes achieved by padding fabric in sparingly soluble polyvinyl acetate before calendaring, where the solution acts as a binding agent. More permanent finish can be obtained by treating fabric with a crease recovery agent followed by drying.

10. Tendering


Tendering machine

The fabric becomes irregular in width after the process of weaving and washing. Tendering finish is given to a fabric to bring the fabric to normal width. Tendering machine is 20-90 ft in length and has hooks on both sides. Selvedges of the fabric are firmly fixed in hooks on both the ends. Now steam is passed on the fabric and when the fabric regains normal width, it is passed through hot air chambers where it dries up. The fabric is straightened by placing the warp and filling at right angles. The fabric also attains regular width. This finish is an important one as improper tendering can lead to 'off grain fabrics' which will affect the appearance and performance.

11. Mercerization

Cotton cloth in gray form has rough, irregular and unattractive surface. To make the fabric more attractive mercerization is done. In this process the fabric is soaked for 15 minutes in 15-20% solution of caustic soda under regulated pressure and temperature. After this the fabric is washed and neutralized in dilute acidic solution. Then it is washed in water and dried. Mercerizing causes the flat twisted ribbon like cotton fibre to swell into a round shape and to contract in length. The fibre becomes more lustrous than the original fibre and its strength increases by 20%.


Mercerizing machine

Cotton fabrics are mercerized for the following qualities

- The fabric becomes strong and durable.

- The fabric becomes more compact.
- Increases the glazeness and lustre of the fabric and gives a silk like appearance.
- Absorbency increases.
- Affinity for dyes increases and makes printing and dyeing easy.
- Dyed in fast colour.

12. Sanforization

Sanforisation machine

Fabrics made of natural fibres shrink because they are stretched during the process of weaving and tend to go back to their original shape on washing. Sanforization is the method of stretching, shrinking and fixing the woven cloth in both length and width to reduce the shrinkage. This is done with the help of machines. The fabric is stretched and pressed against a hot roller which makes the surface of the fabric compact. The fabric becomes smooth and compact and such fabrics neither shrink nor lose their shape. This process is also called pre-shrinkage.

13. Parchmentization

Parchmentization is the process in which the cotton fabrics are treated with dilute sulphuric acid that result in a transparent and stiff fabric. This fabric is called organdie. This fabric is thin, transparent, light weight and stiff. They seem to be heavily starched but do not need starching.

14. Water Proofing

Finishing which does not allow the entry of water into the fabric is known as water proofing and the fabric is known as water proof fabric. A coating of rubber,

oxidized oil, varnish, resin, silicon etc. are applied on the fabric for making such fabrics. The openings of the fabric are filled up and water slips over it. Such fabrics are not comfortable to wear because heat is not conducted. They are used for rain coats, umbrellas etc.

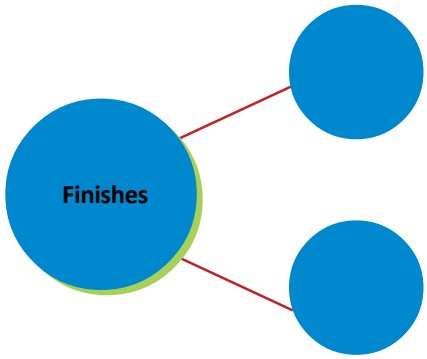
Conduct a seminar in your class on the topic "Common Fabric Finishes" and prepare notes.

Know your progress

1. Write short notes on:
   a. Beetling
   b. Singeing
   c. Mercerization
   d. Sanforisation
2. Write the advantages of bleaching

Let us conclude

The fabric that comes out after weaving or knitting may not have the desired appearance, feel or quality. They are subjected to certain finishing processes to make them acceptable to consumers. Finishing refers to the process that converts the fibre, yarn or fabric into suitable material. Finishes improve the feel, draping quality, change the texture, make the fabric durable and also bring variety. Finishes are classified into temporary, semi durable, durable, and permanent based on their life. Based on the process involved, finishes are classified into mechanical and chemical finishes and based on the function, they are grouped into aesthetic or basic finishes and functional or specific finishes. The common fabric finishes are beetling, inspection, singeing, desizing, scouring,



cleaning, bleaching, stiffening , sizing, weighting, calendaring, tendering, mercerization, sanforization, parchmentization and water proofing .

Let us assess

1. Classify the following finishes based on their life
   a. Starching
   b. Bleaching
   c. Shrinkage resistance
   d. Softening
2. Give the other name for the following processes
   a. Pre- shrinkage
   b. Burning the surface of the fabric
   c. Increasing the weight
   d. Pulling the fabric by width
   e. Removal of starch
3. Discuss the importance of finishes on fabrics
4. Complete the following illustration - Classification of finishes based on the process involved

5. When Raju bought a cotton cloth from the shop it was written Mercerized. Explain to him the advantages of mercerization.
6. You visited a silk manufacturing unit. There you saw silk threads being dipped into certain metallic salt solutions. Name the process and explain about it.
7. Correct the statement if it is wrong- Scouring is the process of giving stiffness to fabrics.

10 Finishing With Colour: Dyeing and Printing

Key Concepts

10.1 Dyeing: Dye classes, Stages of dyeing

10.2 Printing: Basic styles

10.3 Designing using dyeing and printing

Significant Learning Outcomes

After the completion of this chapter, the learner:

- defines dyeing and identifies dye classes
- differentiates stages of dyeing
- defines printing and discriminates the basic styles of printing
- explains roller printing, stencil printing and screen printing
- demonstrates tie and dye batik and block printing methods
- develops a positive attitude towards weaving eco-friendly dresses

The widely used classifications of finishes have been described in the previous chapter. Finishing is also done with the help of colours. Colouring is also considered finishing as it adds colour to the fabric and increases its beauty.

Finishing with colours comprises the processes of applying colour on the fabric and fixing it. This finishing can be done through two techniques. They are dyeing and printing.

10.1 Dyeing

You know that fabrics are available in a wide variety of colours. How do we get such varieties?

Dyeing is the irreversible application of colour on a textile substrate. In this process the fibre, yarn or fabric is impregnated with dye stuff.

From time immemorial man has been using colour to adorn his body and his clothes. In earlier years, fabrics were coloured with the juice of flowers, fruits, stems, leaves and barks of plants and trees. Later dye stuff from vegetable, animal and mineral sources came into use.

Do you know!

Vegetable dyes are obtained from the leaves, flowers, barks and branches of plants and trees like Jamun, Henna, Turmeric, saffron, Blue plants etc……

Animal dyes are obtained from insects, fishes, squid, sepia etc.

Minerals provide dyes like Prussian blue, Chrome yellow and iron buff. Bright yellow colour is obtained by putting pieces of iron and wood ash in vinegar.

All these dyes do not form bonds readily with fabrics, and hence some substances were used which fix the dyes on the fabric. The chemical agents that bind dyes to a fibre which otherwise has little or no affinity for dyes are called mordents. They act as bridges between dyes and the fabric.

The art of dyeing with natural dye stuff is being practised in India from centuries and is still in use. The Patolas of Gujarat, the Kalamkaris of Andhra Pradesh are some of the examples of the mastery of Indian dyers.

Later on chemicals or dyes were discovered and they were used widely in textile industry. A majority of dyes used today in the field of textiles are

chemically synthesized in the laboratory. Now as an environmental friendly initiative, the use of natural dyes are back. Many customers prefer using clothes dyed with natural colours.

Collect pieces of fabric with different colours and prepare an album showing the variety of colours used in fabrics.

A. Dye Classes

Dye is a compound with two components: chromophore which imparts colour and auxochrome that helps substantively and enhances the colour intensity.

The dyes that we use today can be classified based on their chemical composition. They are:

1. Acid dyes / Anionic dyes

Acid dyes require an acidic bath for their application. It is mostly used for protein fibres like wool and silk. They are also being more widely used for dyeing acetate, nylon, acrylics etc. Acid dyes or anionic dyes are inexpensive and fairly fast to light, but they are not fast to washing and have only fair fastness to dry cleaning. They have low resistance to perspiration. These dyes are not suitable for cottons and other cellulose fibres as they harm the fibre. Wool may be given increased fastness to both light and washing by boiling the fabric in a chromate solution after the first dye and bath. This is called after chroming.

2. Basic dyes / Cationic dyes

Basic dyes are salts of carbon. Basic dyes are used with mordents for cottons, linen acetate, nylon, polyester, acrylics etc. When used with natural fibres,

basic dyes are not fast to light, washing, perspiration or atmospheric gases. They give fastness and bright shades to acrylics for which they are mainly used. Basic dyes are frequently used as an after treatment for fabrics that have been previously dyed with acid colours. Because of the special lustre of basic dyes they are used for dyeing fabrics and is very cheap.

3. Disperse dyes

Disperse dyes are not soluble in water; they are supplied in finely ground form that will disperse in water. The particle will dissolve in the fibres and by this action, the fabric is dyed. They are mostly used for polyester, nylon and cellulose acetate although they will dye some other fibres. The disperse dyes especially blue shades are susceptible to nitrous oxide gas in the atmosphere and will gradually fade to pink colour. Inhibitors are applied to slow down the process. Disperse dyes are fairly fast dyes.

4. Vat dyes

These dyes were initially applied on large wooden tanks known as vats and thus acquired this name. They are insoluble pigments, but are made soluble in water by the use of strong reducing agents. They are the fastest dyes for cotton, linen and rayon. They may also be applied to wool, nylon, polyesters and acrylics with the use of mordants. Vat dyes are not only resistant to light and to acids and alkalis, but are also equally resistant to strong oxidizing bleaches. Vat dyes are expensive because of the initial cost as well as the method of application. Vat dyes are used for fabrics that are washed regularly as they are fast and durable and can resist light, sweat, acid, alkali, washing etc.

5. Azoic dyes / Napthol dyes

Azoic dyes are widely used on cellulose fibres but have limited application on acrylic, nylon and polyester. They are also referred to as 'ice colours' since their application sometimes involves the use of ice to lower the temperature and to assure efficient dye formation. Bright colours are produced at relatively low cost with the added advantage of colour fasteners to washing and light. A complete colour range is available but these dyes are used primarily for bright red, yellow and blacks. Batik printing uses azoic dyes. Because of the

use of napthol as a component in dyeing they are called napthol dyes.

6. Direct dyes

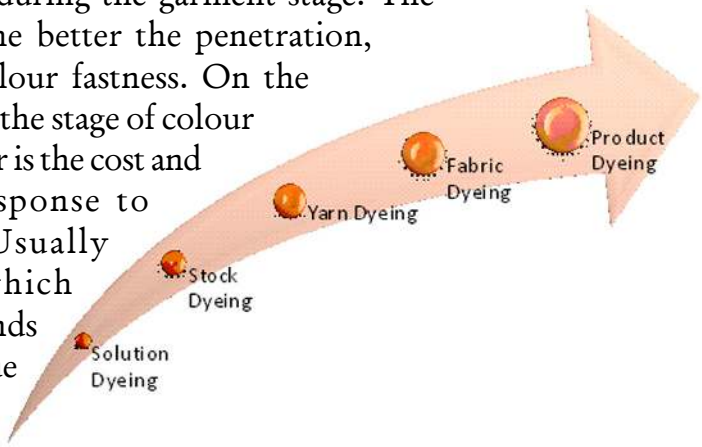
Direct dyes have a natural affinity to cellulose and can be applied without using a mordant. Because of the simplicity of application and the great choice of products available, direct dyes are used today on cotton and rayon. They can be dyed easily at a low cost, but the colours are not fast and durable. These colours cannot resist sunlight and washing. Normally cheap fabrics are dyed with these dyes. Sometimes direct dyes are also used on wool, silk and nylon.

7. Reactive dyes

Reactive dyes are sometimes called fibre reactive dyes. They react with fibre molecules to form a chemical compound. These dyes were initially meant for cellulose fibres but they are now used for wool, silk, nylon, acrylics and blends of these fibres. Reactive dyes have excellent fastness to light and washing and they also give brilliant shades. The limitations of reactive dyes include higher cost and poor fastness to chlorine.

B. Stages of dyeing

Dye can be applied at any stage of production namely spinning fibre, yarn and fabric or during the garment stage. The earlier the stage, the better the penetration, results in better colour fastness. On the other hand the later the stage of colour application the lower is the cost and quicker is the response to fashion trends. Usually staple colours which always stay in trends like black, navy blue etc. are dyed in spinning and fibre stages whereas some 'fad' colours which remain only for a short period are dyed at fabric or garment stage.



There are five stages of dyeing. They are:

1. Solution dyeing or dope dyeing

During the production of man-made or synthetic fibres, the dyes or pigment is added to the solution before it is extruded through the spinnerets into filaments. This process is called solution dyeing or dope dyeing. This method produces fabrics which have greater degree of colour fastness. This method is also called mass pigmentation. It is used for fibres which are otherwise difficult to dye and for dyeing fibres that require excellent colour fastness properties. Because the colour becomes a part of the fibre, solution dyed materials have excellent colour fastness to light, washing, cracking (rubbing), perspiration and bleach. Solution dyeing is more expensive since the equipment has to be cleaned thoroughly each time a different colour is produced. Decisions regarding dyeing has to be made early in the manufacturing process. This stage of dyeing is not usually used for apparels.

2. Stock dyeing / Fibre dyeing

Stock dyeing refers to dyeing a textile fibre in a loose condition before it is spun. This is done by putting it in large vats and circulating dye liquor through the mass of fibre at elevated temperature. In stock dyeing, which is the least expensive method of colouring, the colour is well penetrated into the fibre and does not crock easily. But this is a time consuming process and stock dyed fibres do not spin readily. As in a dyed fibre, it loses some of its flexibility. Some lubricants are added in the final rinsing to overcome this problem. Woollens are often stock dyed. As a variation, wool fibres are combed to remove the long fibres or tops. The tops are then wound on perforated spools and dyed. This is called top dyeing. Even dyeing is possible with this method.

3. Yarn dyeing

When dyeing is done after the fibre has been spun into yarns, it is described as yarn dyeing. Cloth made of dyed yarn is called yarn dyed. Yarn dyed fabrics are usually deeper and richer in colour. They provide

adequate colour, absorption and penetration for most colours. Thick and highly twisted yarns may not have good penetration. Yarn dyeing is used to create interesting checks, stripes and is placed with different coloured yarns in the weaving process. There are certain traditional textile crafts which require yarn dyeing. Some of these are Pochampallies of Andhra Pradesh, Patolas and Gharcholas of Gujarat and Ikats of Orissa. Here laborious tie and dyeing of the yarns is done to produce elaborate patterns by plain weaving on sarees, duppattas etc.

4. Fabric dyeing

Fabric dyeing is also known as piece dyeing. It is dyeing fabric, after it has been constructed. It is economical and the most common method of dyeing solid coloured fabrics. Dye penetration may not be good on thicker fabrics. When the fabric is made of one kind of fibre or yarn then the dyeing is with one appropriate dye.

5. Product dyeing

Product dyeing also known as garment dyeing, is the process of dyeing products such as hosiery, sweaters and carpet after they are produced. This method is used to dye sheer hosiery since it is knitted using tubular knitted machines and then stitched prior to dyeing. This method is not suitable for apparel with many components such as lining zippers and sewing threads as each component may dye differently. The exception is tinting jeans with pigments for vintage look. Dyeing at this stage is ideal for quick response. Many t-shirts, sweaters and other casual clothing are dyed with popular colours.

Based on the above topic collect information from internet and prepare a set of questions and conducta quiz in the class.

Know your progress

1. Define dyeing and dye
2. List different dye classes
3. Explain stages of dyeing

9.2 Printing

Apart from the dyeing there are other methods to beautify fabrics. Can you name a method?

- .....

Printing is a kind of localized dyeing. Here concentrated dye pastes with other additives are applied to the fabric. A pattern or a design is generally imprinted on the fabric with one or more colours by using dyes in paste form or some related means. Printing can be done with dyes or pigments.

Fabrics printed with dyes are called wet prints. The printed fabric is exposed to steam. This is called ageing. Following dyeing the fabric is passed through soap baths to remove thickness and other substances used in making the paste. This is called soaping. The dyes used for printing include vat dyes, reactive dyes and disperse dyes which have good colour fastness.

The pigments which are not truly dyes are also used extensively for printing. These are called dry prints. These colours are fixed to the fibre through resins that are very resistant to laundering or dry cleaning. When pigments are used instead of dyes it is referred to as pigment printing. The fabric is put through dry heat at temperature up to 400° F to set the binder which holds the pigment. This is called curing. Soaping process is not needed in this method.

Basic styles or Principles of printing

There are five basic styles of printing. They are

1. Direct printing
2. Resist printing

3. Discharge printing
4. Mordant printing
5. Transfer printing

Direct printing, resist printing, discharge printing and mordant printing are termed as conventional methods while transfer printing is referred to as unconventional method.

1. Direct printing

This is the oldest style of printing. This involves direct application of print paste on the surface of a white fabric or previously dyed fabric. When a dyed fabric is used, the fabric is called over print. The dyes are usually dissolved in water to which a thickening agent has been added to give the necessary viscosity to the print paste. Initially corn starch was used in printing cotton; today yarns derived from sea weeds are preferred. In pigment printing resins, solvents and water can be used to produce the required viscosity. Block printing and roller printing are two methods which use the principle of printing. Until chemically produced dye stuffs were discovered, pigments were used for direct printing. Pigments merely coat the surface of the fabric and do not penetrate the fibres.

2. Resist printing

In resist printing, certain portions of the fabric or yarn are resisted or held back from taking up the print paste. The resisting agents may be physical or chemical in nature. In a tie and dye process a thread may be used to tie certain yarn or fabric. Molten wax is used to resist white or coloured areas in batik printing technique and in dabu printing mud acts as barrier for colour uptake. Stencil printing and screen printing are also done based on resist printing principle. The resist paste is imprinted on the fabric and the fabric is then dyed. A resist paste is a resinous substance that does not allow the dyes to penetrate. The resist paste is applied by passing the

fabric through cylinders which imprints the pattern using the resist paste. The fabric is then immersed in a dye bath and the dye will penetrate only in those areas where the fabric is not covered with resist paste. After the dyeing process the resist paste is removed, leaving a pattern on a dark background. The durability of the fabric is not affected by resist printing.

3. Discharge printing

In discharge printing, a fabric is often piece-dyed and a discharge paste which contains chemicals to remove the colour is printed on the fabric. Sometimes, the base colour is removed and another colour is printed in its place, but usually a white area is desirable to brighten the overall design. When properly done discharge printing is usually satisfactory. However, discharge printing may weaken the fibre if it is not thoroughly washed after printing. The fabric is then steamed to develop the printed design either as white or as coloured area and it is washed to remove the chemicals. The discharge printing is usually favoured for fabrics with dark background to print designs such as polka dots.

4. Mordant printing

Mordant printing style is also called dyed style or mordant printing. Mordants are chemical substances used in dyeing and printing with natural dyes. They have the capacity of combining with both the substrate and dye stuff thus forming a link between the two.

Application of mordant can be done before printing (pre mordanting) or after printing (post mordanting) or it may be applied along with the dye stuff (simultaneous mordanting). Tannic acid is the mordant commonly used for cottons while metallic salts are applied on wool. Natural dyes produce different colours when combined with various mordants.

Do you know!

The word Mordant comes from French which means "to bite".

5. Transfer printing

Transfer printing transfers thermoplastic ink designs from a roll of paper to the fabric. The design is first printed on to a flexible non textile substrate and later it is transferred to a fabric. The patterns are transferred by the application of heat and pressure. So this technique is sometimes referred to as heat – transfer printing. The disperse dyes on the paper sublimate in pattern form directly into the fabric. This type of transfer printing is called sublimation transfer.

The transfer printing process is very fast, economical and pollution problems are eliminated since there is no need of treatments like washing off, steaming, ageing or drying. Clarity of design and brightness of the colour are good.

Know your progress

1. What do you mean by resist printing?
2. Differentiate between discharge printing and mordant printing

9. 3 Designing using Dyeing and Printing

What are the methods that can be adopted to create beautiful designs on fabrics?

- .....

Dyeing and printing differ in the method by which colour is applied to fabric. In a proper printed fabric, the colour is affixed to the fibre, so that it may not be affected by washing and friction. Whether a fabric is dyed or printed can be known by examining the outline of the design. On a printed fabric, the outline of the design is sharply defined on the outside. The design generally does not penetrate to the back of the cloth. However the design may show up on the reverse side of transparently thin fabric. If the design is printed the yarns will show some areas where the colour is not equally distributed. Various methods have been adopted to produce patterns on the fabric.

Some of them are:-

1. Tie and Dye
2. Batik
3. Block printing
4. Roller printing

5. Stencil printing
6. Screen printing

1. Tie and dye

The tie and dye was in practice as far back as the 16th century in India. It is a resist dyeing process. The fabric or yarn to be dyed is folded and tied with strings or narrow strips of cloth. The strings or strips are waxed to increase the resistance and get better results. This prevents the dye from reaching some parts of the fabric, and restricts the amount absorbed on other parts so that a pattern is created. The skin of yarn or the fabric is then dipped in dye bath and dyed a number of times in different colours. It is refolded and tied before dipping in each colour. It is then dried and the strings are removed. Only that portion of the fabric that is not tied will absorb the dye, as the string on the cloth serves as a resist. The dyes may accumulate.

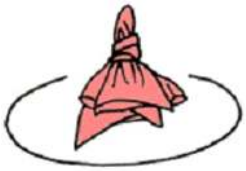
For example a yellow fabric placed in blue dye bath will become green. Beautiful and complex patterns can be produced in this method. The Pochampalli of Andhra Pradesh and Patola of Gujarath are made by the tying and dyeing of yarns whereas, the Bandani of Gujarat, Kathiawar of Rajasthan is done by tie and dyeing of woven materials. Designs are created in tie and dye through the following processes

a. **Marbling:** Take the fabric and crumble it to form a ball. Tie it with a thread at different areas, randomly. Then dye the fabric. Open it and dry. The dyed fabric will have a marble effect.

b. **Binding:** Pick up the fabric from one point and tie with a thread at intervals and dye it.

c. **Knotting:** Put knots on the fabrics wherever desired and dye it.

d. **Folding:** Put the fabric flat on a table. Pleat and fold it uniformly in lengthwise direction. Tie it with yarn at regular intervals, to get width wise lines after dyeing. For horizontal lines, pleat and fold the fabric width wise. Roll or fold the fabric from one corner to the diagonally opposite corner and tie at regular intervals to get diagonal lines.



d. **Clump tying**: Take some beads or pebbles and put them in the fabric and then tie.

2. Batik

Batik is resist dyeing process whereby designs are made with wax on a fabric which is subsequently immersed in dye bath to absorb the colour on the unwaxed portions. It has been done in India, Japan and Java in Indonesia.

Batik works best on absorbent fabrics such as silk or cotton. Synthetic fibres do not absorb the wax or dye readily. The fabric is stretched on a frame and hot melted wax is applied using 'tjanting' tool or a brush. When the wax is set, the fabric is piece dyed in cold water dye bath. After drying more wax is applied on the design and again piece dyed. In this dyeing, colours accumulate, so light colours are dyed first. The wax is removed by using a solvent or placing the fabric in boiling water for few minutes. The wax can also be removed by ironing the fabric between 2 pieces of absorbent paper. Batik can also be done using 'Tjap' or a stamp of pattern made of copper. This is pressed on a pad of cloth saturated with

Do you know!

"Tjanting" is a small instrument used in bulk dyeing. It is made of short straight reed handle to which a small funnel shaped copper cup with spout is attached.

liquid wax and it is applied on the cloth by pressing the tjap on it. Reverse Batik involves covering all the fabric with wax and then scraping off areas where the design is required. Fine designs can be achieved using this method.

Block printing and roller printing are direct printing, whereas stencil printing and screen printing are resist printing methods.

3. Block printing

Block printing is a hand method and the oldest method of printing design on fabric. To make hand blocked prints, the design must be carved on wooden or metal blocks first. The dye stuff is applied in paste form to the design on the face of the block. The block is pressed down firmly by hand on selected portions of the fabric, imprinting the carved design as many times as desired on specific length of the cloth. To obtain variations of colour in the same design, as many additional blocks must be carved as there are additional colours. The portions of the design that will appear in different colours must be separately imprinted by hand.

This method is practised in India from the 12th century. It is an intense and laborious process. The cloth must be stretched on the table before printing. This very slow and expensive method of printing but each piece produces unique designs.

The hand block printed fabrics of Rajasthan and Gujarat are famous for their intricate designs and richness of colour. Traditionally material and vegetable dyes were used but now synthetic dyes are also being used.

4. Roller printing

Roller printing is a machine counterpart of block printing. Here designs are imprinted on the

Roller printing machine

cloth by engraved copper cylinders or rollers. There are large numbers of engraved rollers as there are colours in the design to be imprinted. The rollers rotate in the print paste. The engraved patterns pick up the print paste and transport it to the fabric. The excess paste is removed by a "doctor blade". At each revolution of the roller of the design is repeated. A mordant is generally used in the dye paste to fix the colours. Roller printing is a high speed process which can produce up to 6000 yards of printed fabric in an hour. The speed is determined by the complexity of the pattern printed. This method is a relatively inexpensive to produce attractive designs. It gives highest resolution and highest quality fine line details. Excellent colour definition can also be achieved.

Do you know!

Roller printing accounts for one half of the printing done worldwide.

5. Stencil printing

Stencil printing originated in Japan. The design is first cut in card board, wood or metal. After positioning the stencil, colour is brushed or sprayed across the stencil cut. The die penetrates through the open area in the stencil. Colour can be applied with brushes, sponge, spray or toll to achieve various effects. This process has very limited application. Stencil fitting is difficult and certain delicate patterns may not be effectively produced. Usually the application is limited to only one colour.

6. Screen printing

Originally Screen printing was referred to as silk screen printing because the screens were made of fine, strong silk threads. Today they are also made of nylon, polyester, and metal. Screen printing can be used for the production of larger patterns. The colours can be produced in brighter, clear shades than with roller printing.

Screen printing is done with the use of flat or cylindrical screen.

a. **Flat screen printing:** The required designs are copied to very fine flat screens. Today designs are photographed and negative is used to make the screen. One screen is used for one colour. These are then fitted on wooden or metal frame. The printing paste or dye is poured on the screen and forced through the unblocked areas into the fabric with the help of a rubber edged squeege. Earlier flat screen printing was done by hands, now electronically operated automatic machines are used in screen printing.

Screen printed T- shirt

b. **Rotary screen printing:** Today most screen printing is done on a rotary screen. It combines the simplicity and flexibility of screen printing with the production capability of roller printing. The screen is curved into a cylinder, and the dye is fed through the openings from the ends of the cylinder. The rotary screen is placed on a printing frame. The fabric passes under the rotating screens through which the printing paste is automatically pumped. A squeegee forces the paste through the screen into the fabric. The cloth is then passed through a dying oven. Rotaries operate continuously. The production output is much higher than that of a flat screen printing.

7. Digital Printing

The latest advance in textile printing is the introduction of digital ink jet printing machine capable of printing fabrics up to 2m in width. This printing is designed for natural fibres and polyester fabrics. They produce latest innovative and creative designs. This technology uses large format digital inkjet printers. Digital printing has various advantages over traditional printing. Some of these include:

- With the advent of digital printing technology, photographic & tonal graphics with multiple shades as well as colours can be printed on textiles
- Unlike Traditional printing techniques (like Rotary & Screen printing), there is no limitation on the number of colours. With this printing technique any number of colours can be printed in fabrics

- There is no limitation on repeat size as in the case of traditional printing methods
- It offers faster processing speed where everything that is required in the print can be prepared on computer digitally
- It allows the user to print even smaller quantity. Therefore there is no minimum order quantity
- High Precision printing is possible, which is usually a drawback with other forms of printing
- Overall cost of production of a sample is cheaper in comparison to the other forms of printing.

To get first hand information about designing using dyeing and printing prepare samples of tie and dye, batik and hand block printing.

Know your progress

1. Explain roller printing.
2. Differentiate between stencil printing and screen printing.

Let us conclude

Fabrics are coloured to enhance their beauty. Application of colour can be done by dyeing and printing. Dying is the application of colour on textiles using dye stuff. Various classes of dyes like acidic dyes, basic dyes, disperse dyes, reactive dyes, direct dyes; azoic dyes are used to dye fabrics in their various stages. The stages of dying are solution dyeing, stock dyeing, yarn dyeing, fabric dyeing and product dyeing. Printing is imprinting of designs or patterns using dye paste. The basic styles of printing are direct printing, resist printing, discharge printing, mordant printing and transfer printing. In order to produce patterns, certain methods of dyeing and printing like tie and dye, bathik printing, block printing, roller printing, stencil printing and screen printing are used.

Lab activity

Make samples of

a. Tie and Dye
b. Batik
c. Hand block Printing

Let us assess

1. Rema is confused whether her newly bought saree is original tie and dye or is it tie and dye print. How can you help her in differentiating printing and dyeing on clothes?
2. Which is the traditional saree made by yarn dyeing?
   (Bathik, tie and dye, Pochampally)
3. In a certain type of printing, first printing is done on paper or other materials which is then transferred to the cloth. Name the method and explain it.
4. The shopkeeper showed you two pieces of clothes. One is stock dyed and the other is product dyed. Which fabric has more colour fastness? Give reason
5. Name the various stages at which textiles can be dyed.
6. List out the advantages of digital printing over traditional printing methods
7. Pick the most suitable statement
   a. Screen printing is also known as Sublimation Printing
   b. Tie and dye is a new method of dyeing
   c. In India block printing is largely done in Rajasthan and Gujarat
8. Match the following:-

Acidic dyes	Ice colours	Good colour fastness
Basic dyes	Low resistance to perspiration	Anionic dyes
Disperse dyes	Salts of carbon	Naphol dyes
Azoic dyes	Fairly fast colours	Not soluble in water

9. Fill up the blanks choosing the correct answer:-
   Block printing and roller printing are, ——————————whereas stencil printing and screen printing are ——————————— methods.
   (Direct printing, resist printing, mordant printing, discharge printing)
10. Explain the different types of fabric dyeing.

11 Introduction to Extension Education

Key Concepts

11.1 Extension Education - meaning, concept, objectives, scope, principles, methods and difference between formal and informal education.

11.2 Steps in Extension teaching - Extension teaching methods.

11.3 Home Science Extension - characteristics and the role of home-Science extension in national development

Significant Learning Outcomes

After the completion of this chapter, the learner:

- explains the scope, principles and methods of extension education.
- describes characteristics of Home Science extension education.
- identifies the role of Home Science extension education in development

Have you ever heard about Extension Education?

The term "extension" was first used in the United States of America in the first decade of this century to connote the extension of knowledge from land grant colleges to farmers through the process of informal education. In India, extension work was primarily started by F.L. Brayne (1920) in Punjab. The terms 'community development' and 'extension education' became more popular with the launching of

community development projects in 1952 and with the establishment of the National Extension Service in 1953. Since then, Community Development has been regarded as a programme for the all-round development of rural people and extension education as the means to achieve this objective.

In fact, the ultimate goal of any educational system is to change existing knowledge, attitude, behaviour, skills, understanding etc. of the people in society. At one hand, we have centres of higher learning, usually referred to as "research centres", and on the other hand, we have the ordinary people. The findings of these research centres will become fruitful, only when they reach the ordinary life of the people. There is a huge gap between these two, and it can only be bridged by an informal system of education, which is known as "Extension Education", and the persons who work for bridging this gap is known as 'extension workers'.

11.1 Extension Education

We know that awareness classes are conducted for women and adolescents through *Anganvadies* or other such centres. What type of education is this?

- .....

A. Meaning

The term '**Extension Education'** means that type of education which is 'stretched out' into villages and fields, beyond the limits of schools and colleges, where the formal type of education is normally confined. In other words the word 'Extension' used in this context signifies ***an out of school system of education.***

Extension education helps to decrease the gap created by culture.

In simple terms, extension education is defined as the scientific dissemination of technology, to improve the standard of living of the people, especially

Do you know!

The word 'Extension' is derived from the Latin roots "tension" meaning 'stretching' and 'ex' meaning 'out'.

those living in rural areas and in deprived conditions. It is a science which deals with the creation, transmission and application of knowledge designed to bring about planned changes in the behaviour-complex of people; with a view to help them live better by learning the ways of improving their vocations, enterprises and institutions. It is a system where people are motivated through a proper approach to help them by applying science in their daily lives, in farming, home making and community living.

a. Why extension?

Extension simply, refers to the mechanism which facilitates the social use of knowledge, which is already acquired and researched. It forms a live contact between the knowledge sources (institutions) and the social situation (community) by way of addressing the problem and issues. The objective of extension work is to extend knowledge with socio- cultural realities. Extension involves the transmission of knowledge, skills and values to individuals, groups or community at large.

Do you know!

The ultimate goal of any educational programme is to bring significant changes in the community, thereby improving the quality of life of the people. And it is only through, extension that we can transform the lives of the deprived people. So extension education has greater significance, in the development of a community. And without extension, no community development is possible for any nation.

The aim of all extension work is to teach people living in rural areas how to raise their standard of living, by their own efforts, using their own resources of manpower and materials with minimum assistance from Government.

The rural people should know and adopt useful research findings from time to time and also transmit their problems to the research workers for solution. It is impracticable for the millions of people to visit the research station and learn things by themselves. Thus an agency is required to bridge the gulf between the research workers and the people at large to play the dual role of interpreting the results of research to the people (in such a way that they accept and adopt the recommendations) as well as of conveying the people's problems to the research stations for solution. This agency is termed as

"Extension" and the personnel manning this agency or organization are called "Extension workers". To equip the prospective extension workers for their job, it is necessary for them to be trained adequately in formal teaching institutions. Thus we find that three kinds of inter-related services are essential in the process of rural development as illustrated below.

B. Concept of extension educational process

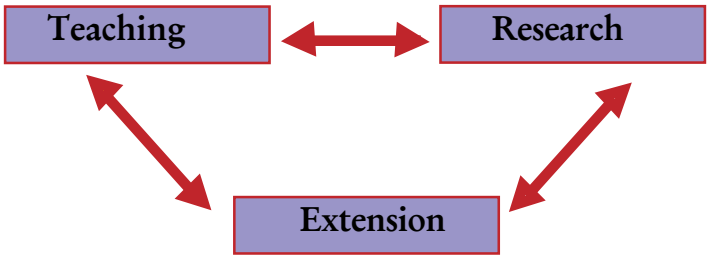


Illustration 11.1 Inter Relationship between Teaching, Research and Extension

The basic concept of Extension is that it is education. It is a teaching and learning process which brings out three types of changes in human behaviour

- Change in knowledge
- Change in skills
- Change in attitude.

The concept of extension education developed by Dr. J.Paul Leagans identifies five essential phases. Illustration 11.2 shows the sequence of steps in a cycle that may be expected to result in progress from a given situation to a new or more desirable situation.

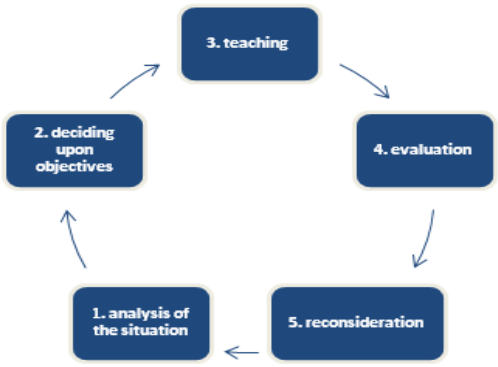


Illustration 11.2 Concept of Extension Educational Process

a. Analysis of the situation: This requires a large amount of facts about all aspects of the situation. Facts are needed about the people, their physical situation, problems and the resources that are available. New facts and research findings should be introduced by the extension workers to stimulate a fresh approach to the problems of the people. A thorough analysis will examine changing conditions and take a careful look ahead, comparing 'what is' with 'what should be'.

b. Deciding upon objectives: It is necessary to distinguish between levels of objectives by separating the general objectives from the specific or working objectives. The planning process must enable the people to select a limited number of problems and to state their objectives clearly. The solutions to be offered must give satisfaction. Objectives should express the behavioural changes in people as well as the economic or social outcomes which are desired.

c. Teaching: It involves choosing the content or what is to be taught and methods and techniques of communication. Six to nine different methods of communication must be used to create learning situations and to stimulate learning. The ability to choose and use those methods best adapted to particular objectives is the measure of an extension worker's effectiveness.

d. Evaluation: Evaluation determines the extent to which objectives have been achieved. This will also be a test of how accurately and clearly the objectives have been stated. Plans for evaluation should be built into the plans of work during earlier phases. Distinction should be made between mere records of accomplishments and the process of comparing these results with original objectives. The process of evaluation may be simple and informal or it may be formal and very complex.

e. Reconsideration: This step consists of a review of previous efforts and results which reveal a new situation. If this new situation shows the need for further work, then the whole process may begin again, with new or modified objectives. Hence this process is continuous. The new situation is different because 1) the people have changed 2) physical, economic and social changes may have occurred 3) the extension worker is better prepared to recognize new needs and interests.

This concept is intended only to clarify the steps necessary in carrying out a planned educational effort. It is not intended to imply that these steps

are definitely separate from each other. Experience shows that planning, learning and evaluation are taking place continuously in varying degrees throughout all the phases of extension activities.

C. Objectives of extension education

The fundamental objective of extension is the 'the development of the people' or 'the destination of man'.

a. General objectives

More specifically stated, the following are the general objectives or functions of extension

i. To assist people discover and analyse their problems, their felt needs and unfelt needs.

ii. To develop leadership among people and help them in organizing groups to solve their problems.

iii. To disseminate information based on research and /or practical experience, in such a manner that the people would accept it and put it into actual practice.

iv. To keep the research workers informed of the people's problems from time to time, so that they may offer solutions based on necessary research.

b. Major objectives

The major objectives of Extension may also be categorised as follows.

i. **Material:** increase production, income

ii. **Educational:** change the outlook of people or transform the individuals

iii. **Social and cultural:** development of the community.

D. Scope of extension education

Extension is fundamentally a system of out-of-school education for adults and the youth alike. It is a system where people are motivated through a proper approach to help themselves by applying science in their daily lives, in farming, home making and community living. The unlimited scope of extension appears in the situations where there is need for creating awareness amongst the people and changing their behaviour by informing and educating them.

The following statements will amplify the scope of extension

- Extension is education for all village people.
- Extension is bringing about desirable changes in the knowledge, attitudes and skills of people.
- Extension is helping people to help themselves.
- Extension is working with men and women, boys and girls to answer their felt needs and wants.
- Extension is teaching people what to want, as well as how to work out ways of satisfying their wants and inspiring them to achieve their desires.
- Extension is teaching through 'learning by doing' and 'seeing is believing'.
- Extension is working in harmony with the culture of the people.
- Extension is a two way channel; it brings scientific information to village people and it also takes the problems of the village people to the scientific institutions for solution.
- Extension is working together (in groups) to expand the welfare and happiness of the people with their own families, their own villages, their own country and the world.
- Extension is living relationship between the village workers and the village people.
- Extension is development of individuals in their day to day living, development of their leaders, their society and their world as a whole.

E. Principles of extension education

According to Milred Horton, the four great principles underlying extension services are: (1) The individual is supreme in democracy (2) The home is a fundamental unit in a civilization (3) The family is the first training group of the human race and (4) The foundation of any permanent civilization must rest on the partnership of man and the land. Apart from these principles,there are some other general principles upon which the extension activities are carried out. They are detailed below:

a. Principle of interest and needs

Extension work must be based on the needs and interests of the people. These needs and interests differ from individual to individual, from village to village, from block to block and from state to state and therefore there cannot be one programme for all people.

b. Principle of cultural difference

Extension work is based on the cultural background of the people with whom the work is done. Improvement can only begin from the level of the people they are. This means that extension worker has to know the level of the traditions, beliefs, values etc. before starting the programme.

c. Principle of participation

Extension helps people to help themselves. Good extension work is directed towards assisting rural families to work out their own problems rather than giving them readymade solutions. Actual participation and experience of people in these programmes create self confidence in them, and they learn more by doing.

d. Principle of adaptability

People differ from each other, one group differs from another group and conditions also differ from place to place. An extension programme should be flexible, so that necessary changes can be made whenever needed to meet the varying conditions.

e. The grassroots principle of organization

A group of rural people in a local community should sponsor extension work. The programme should fit in with the local conditions. The aim of organising the local group is to demonstrate the value of the new practices or programmes so that more and more people would participate.

f. The leadership principle

Extension work is based on the full utilization of local leadership. The selection and training of local leaders to enable them to help to carry out extension work is essential to the success of the programme. People have more faith in local leaders and they should be used to put across a new idea so that it is accepted with the least resistance.

g. The whole family principle

Extension work will have a better chance of success if extension workers have a whole family approach instead of the piecemeal approach or separate or integrated approach. Extension work therefore is for the whole family i.e. male, female and youth.

h. Principle of co-operation

Extension is a co-operative venture. It is a joint democratic enterprise in which rural people co-operate with their village, block and state officials to pursue a common cause.

i. Principle of satisfaction

The end product of the effort of extension teaching is the satisfaction that comes to the people as a result of solving a problem, meeting a need, or acquiring a new skill or some other changes in behaviour. Satisfaction is the key to success in extension work.

j. The evaluation principle

Extension is based upon the methods of science and it needs constant evaluation. The effectiveness of the work is measured in terms of the changes brought about in the knowledge, skill, attitude and adoption behaviour of the people.

F. Differences between formal education and extension education

When extension education is put into action for educating the rural people it does not remain formal education. In that sense there are several differences between the two. Table 11.1 shows the difference between formal education and extension education.

No.	Formal education	Extension education
1.	The teacher starts with theory and works up to practicals	The teacher(extension worker) starts with practicals and may take up theory later on
2.	Students must adapt themselves to the fixed curriculum offered	It has no fixed curriculum or course of study
3.	Authority rests with the teacher	Authority rests with the people
4.	Class attendance is compulsory	Participation is voluntary
5.	Teacher instructs the students	Teacher teaches and also learns from the people
6.	Teaching is mainly vertical	Teaching is mainly horizontal
7.	The teacher has more or less a homogeneous audience	The teacher has a large and heterogeneous audience
8.	It is rigid	It is flexible
9.	It has all pre-planned and pre-decided programme desires of the people	It has freedom to develop locally and they are the expressed
10.	It is more theoretical	It is more practical and in the application of solution of problems

Table 11.1 Difference between formal education and extension education

11.2 Steps in Extension Teaching and Extension Teaching Methods

A. Steps in extension teaching

In order to bring about the desired changes in the behaviour of people, the extension teacher should organize activities so that there will be repetition of the desired behaviour, each successive repetition building on the one before it. The extension teacher therefore plans and arranges situations and activities whereby the thing to be learned is called to the attention of the prospective learner, his interest developed, desire aroused, conviction created, action promoted and satisfaction ensured. The unlimited scope of extension appears in the situations where there is need for creating awareness amongst the people and changing their behaviour by informing and educating them.(See illustration 11.3)

Step -1. Getting the attention of the learner

The first task of the extension worker is to direct the attention of the people to the new or better idea. Until the individual's attention has been focused upon the change that is considered desirable, there is no recognition of a problem to be solved or want to be satisfied. Attention is the starting point to the arousing of interest. In addition to supplying information to those desiring to learn, the extension worker creates a desire for information on the part of those who are indifferent to improvements. In some instances it may even be necessary to overcome strong resistance to change.

Step-2. Stimulating the learner's interest

Once attention has been captured, it becomes possible for the extension worker to appeal to the basic needs or urges of the individual and arouse his interest in further consideration of the idea. The instructors' message should be presented attractively and in a manner that requires little mental effort on the part of the learner. The presenting of one idea at a time, which is definite and specific, is another important factor in building interest.

Step-3. Arousing the learner's desire for information

The extension worker/ instructor is concerned with the continued stimulation of the learner's interest in the new idea or better practice until that interest becomes a desire or motivating force sufficiently strong to compel action.

The teacher explains to the learner that the information applies directly to the learner's situation; that the doing of the thing will satisfy a significant want or need of the learner.

Step-4. Convincing the learner that he should act

Action follows when desire, conviction and the prospect of satisfaction make it easier for the person to act than not to act. The extension worker sees to it that the learner knows what action is necessary and just how to take that action. He/she also makes sure that the learner visualizes the action in terms of his/her own peculiar situation and has acquired confidence in his own ability to do the thing.

Step-5 Getting action by the learner

Unless conviction is converted into action, the teaching effort is fruitless. It is the job of the extension worker to make it easy for the learner to act. Blocks and annoyances that might prevent action should be anticipated by the extension worker and steps taken to remove them should be encouraged. If action does not follow soon after the desire and conviction have been created, the new desire soon fades away and people continue as before. This phase of extension teaching is often neglected.

Step-6 Making certain that the learner obtains satisfaction from his action

The end product of the extension teaching effort is the satisfaction that comes

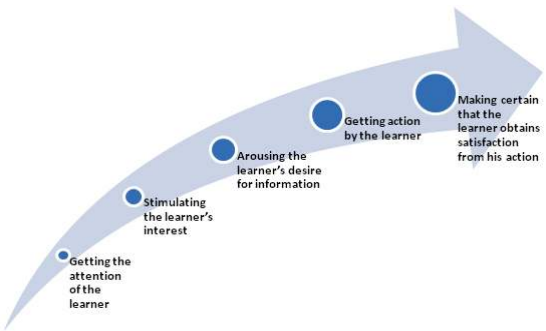


Illustration 11.3 Steps in Extension Teaching

to the people as the result of solving a problem, meeting a need, acquiring a new skill or some other change in behaviour. Follow up by the extension

worker helps the learner to evaluate the progress made, strengthens satisfaction, minimizes the annoyances and builds the learners' confidence in his ability to continue the action with increasing satisfaction. The satisfaction and confidence resulting from the successful completion of each small job will lead them logically to the accomplishment of the difficult job.

B. Extension teaching methods

Extension teaching methods are the methods needed for teaching to disseminate or communicate the subject matter or message more effectively.

It facilitates the process of extension education. Extension teaching methods are used to communicate the lesson or information to the learner or target people more effectively. The appropriate selection of extension method helps to initiate the thought process of the learner, who is taking the lesson from the teaching end. It is also to be remembered that, one teaching method, cannot individually be used in a particular learning situation. The combination of two or more methods is necessary to create attention, arouse interest and convince the people to take action for their satisfaction. There are mainly three methods in extension teaching.

a. Individual method
b. Group method
c. Mass method

a. Individual method

This kind of extension teaching method is used to contact the target people or learner individually. Greater interpersonal communication and face to face contact are the essence of this particular contact method. The greatest advantage of this method is that, it helps to create a good rapport between the extension worker and the target people. It facilitates in gaining firsthand knowledge on farm and home and also helps in changing the attitude of the people and helps in conveying complex ideas. The disadvantage of this method, is that, it is time consuming and relatively expensive and has low coverage of audience. Due to personalisation, there is always a chance of bias.

b. Group method

This teaching method is used to contact a group of people, which comprises

of 5 persons to a maximum of 50 persons. It is very helpful for highlighting a target group embedded with a specific problem. This method helps to motivate the people in a group to accept change. It is comparatively less expensive and has more coverage, whereas, free interaction and decision-making may be hindered by the vested interest of the group members.

c. Mass method

This kind of extension teaching method is used for the dissemination of information to a heterogeneous mass of people. In such a method, no face to face contact is found. This method is suitable for creating general awareness and large number of people may be communicated within a short time. The disadvantage of this method is that there is always difficulty in getting feedback and is less intensive.

Know your progress

1. Define extension education
2. Explain the concept of extension education process
3. List the principles of extension education.
4. What are the extension teaching methods? Explain.

11.3 Home Science Extension

How can we extend the knowledge related to the subject of Home Science to the community?

Literally, the word Home Science can be interpreted as systematic education for home living. The art of home making has a significant place among the sixty four arts an individual has to master for a successful living. "Home Science deals with all aspects of the life of the community and the nation. It integrates the application of knowledge synthesised from different sciences and humanities to improve the human environment, family nutrition, management of resources, child development, and community resource management and consumer competence."

The concept of extension education in general is to bring positive changes in the behaviour of individuals in terms of knowledge, skill and attitude. The major objective of this process is to develop the capacity of individuals in

order to make them self reliant and productive citizens of the society. When this concept of extension is applied to Home Science, it is called Home Science Extension, which aims at further developing the capacities of girls and women mainly involved in farm and home making activities. According to Chandra, the term 'Home Science Extension' is "the dimension of social science which concerns itself with functional and attitudinal changes in the home and the family through scientific and technological knowledge. Thus Home science extension is an applied science which aims at bringing about change in the behaviour of the target groups through dissemination of scientific and technical information in the areas of Home Science.

Seth has described three important components of home science extension:

(See illustration 11.4)

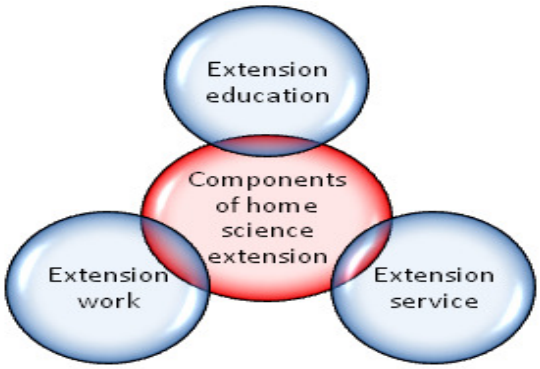


Illustration 11.4 Components of Home Science Extension

Home Science Extension is concerned with teaching, research and extension which are the functions of the Universities and institutes of research, extension and higher learning. It is a need based programme which adopts a problem-solving approach and utilizes locally available resources. It aims at bringing about desirable behavioural changes in people by using various methods of extension.

Home Science Extension service performs the task of bridging the gap between research centres and home-makers by working as a linkage between the institutions of higher learning and the organisations for home makers. To do this the help of government and voluntary organizations is sought in the

planning and implementation of home science extension programmes as well as by utilizing their resources. Thus home science extension also aims at strengthening the work of the government and voluntary organizations.

A. Characteristics of home science extension

Home Science Extension is characterized by the following features.(See illustration 11.5.)

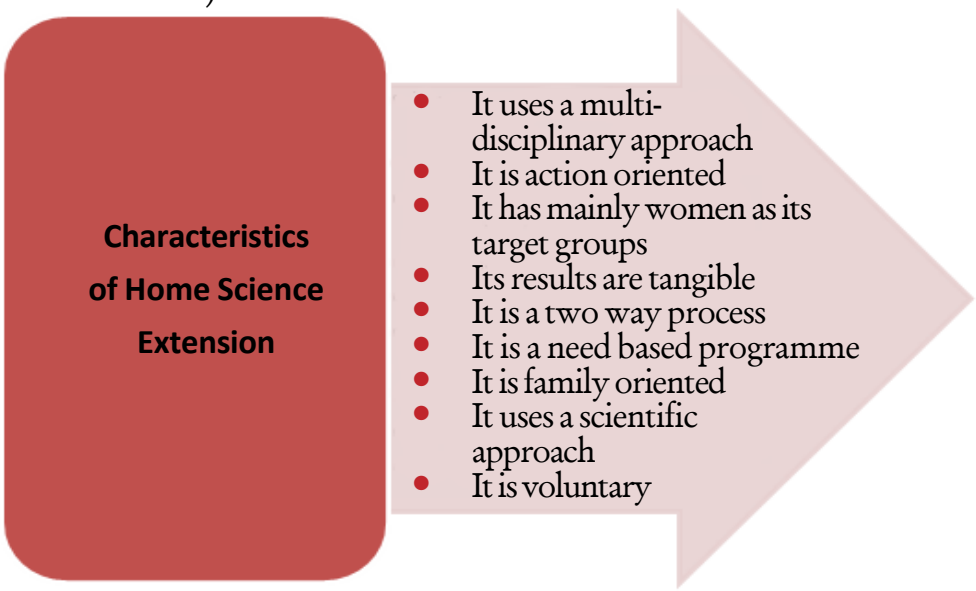


Illustration 11.5 Characterestics of Home Science Extension

a. It uses a multi-disciplinary approach

Home Science is a multi-disciplinary discipline. It derives its body of knowledge from physical and behavioural sciences, from which five major areas of Home Science have emerged, which are, Child Development, Clothing and Textiles, Extension education, Food and nutrition and lastly Family Resource management. The process of Home Science extension derives knowledge from areas like Sociology, Psychology, Communication, Economics, Social Work, Management and Education.

b. It is action oriented

Home science extension refers to a series of activities which impart knowledge on a selected topic or subject, and help the target groups to develop necessary skills for its application. Thus after carrying out the activity of the programme, the target group is expected to use the knowledge acquired for their own improvement.

c. It has mainly women as its target group

Though adolescent girls, boys and children are included in their extension activities, women have always remained the focus of home scientists because the influence of technology, changing value systems and economic activities affects the lives of women the most. Moreover, home science has family as the nucleus of its philosophy and women are the key persons in the family circle. Therefore, home science extension has mainly women as its target group.

d. It's results are tangible

The main aim of home science extension is to bring about attitudinal changes. These are often intangible, that is, they cannot be seen as anything concrete. Home science extension assists women in the fullest utilization of human and non-human resources for their self and family improvement. This attitudinal change is a very slow process. Therefore sometimes it is difficult to perceive concrete results and therefore this should not be taken as a measure of the effectiveness or ineffectiveness of a programme.

e. It is a two way process

Home Science extension establishes a two way communication channel by bridging the gap between centres of higher education and research and the beneficiaries. It carries new knowledge and research results to its target groups by establishing proper coordination between the centres of higher education and the organization working for the development of its beneficiaries. Thus the new technology is transferred to the field through various communication media and methods and target groups are helped to realize the importance of using it for improving their standard of living.

f. It is a need based programme

Home Science extension begins with the needs of women. Need-based programmes receive co-operation and participation easily from people because it satisfies their long term needs.

g. It is family oriented

Home Science extension aims at the development of the family through the development of women since women are the centres of every family.

h. It uses a scientific approach

As discussed earlier Home Science extension is a multi disciplinary approach.

It derives its body of knowledge from other behavioural sciences and moreover it uses principles of psychology for discerning individual differences while offering extension services. The findings of the research and viewpoints of the experts in the various fields are translated to the target groups through properly selected media and methods and an effort is made to convince them to adopt new knowledge to improve their living conditions. Thus the whole approach of home science is scientific in nature.

i. It is voluntary

Participation of the beneficiaries of home science extension programmes is totally voluntary. There is no compulsion on them for participating in the programme. In the process of establishing rapport with the beneficiaries, they are made to realize the need for participation. If they are convinced, they volunteer to take active part in the programme and benefit through it.

B. Role of home science extension in national development

Today Home Science is described as a multipurpose programme of study which takes care of individual's needs and interests and develops abilities and capacities for successful homemaking in a dynamic society. Home Science extension aims at the dissemination of scientific knowledge and technology among the rural masses, in order to improve their quality of life. The social, technological and economic development of the country has its ultimate objective in improving the quality of life of its population. Hence, the overall goals of all national development programmes are to make adequate provision for fulfilling the basic needs of the people- like good food, clothing, adequate housing, good health care facilities, education, recreation and job opportunities. In the age of globalization, a multitude of pressures and problems of physical, social, emotional and psychological nature confront the individuals, families and communities.

Extension focuses on the dissemination of information relating to advanced technology in agricultural production, which includes the use of improved seeds, methods of the use of chemical fertilizers, application of advanced scientific knowledge to the farms and homes of the rural people. Scientific management of land based farming such as horticulture, sericulture, dairying, poultry etc, by the farming community; overall improvement of the quality of life of the rural people within the framework of the national economic

and social policies as a whole. The eradication of extreme poverty and hunger, promotion of gender eqality and the empowerment of women combating HIV/AIDS, malaria and other diseases, and ensuring environmental sustainability, are among the declared United Nations' Millennium Development Goals, which are closely related to the extension function.

In this context of growing pressures in the work environment and the external world of competitions, the family assumes a vital role in shaping the citizens of tomorrow. Here comes the major role of Home Science Extension Education, as it equips the future citizens with relevant knowledge and competence, and prepares them to become efficient custodians of the nation's future.

Through its various spheres of involvements, it aims at developing the nation through the eradication of poverty and illiteracy, infusing creativity in all aspects of life, social reform and enlightenment, increasing food production: its better distribution and preservation, reduction in unemployment by promoting self employment, rural development, urban development, population education, income generation, resource mobilization and utilization.

Apart from providing nutrition education to the community, extension education helps the community to know the trends in income, employment, poverty, unemployment, labour force participation, and other social and economic statistics which are very crucial for the development of the nation.

Home Science extension has played an important role in strengthening the inner ability of our women by enhancing their level of education and by imparting financial independence. The establishment of adult education, continuing education and community resource centres all over the world is a reflection of the need, necessity and relevance of extension education.

Do you know!

The eight "Millenium Development Goals (MDG)" are international targets for reducing poverty by 2015. They were adopted unanimously by the UN's General Assembly in 2000 as part of the Millennium Declaration.

Being one of the major roles of University, extension education acts as change agents in conveying messages, ideas, knowledge, technology, information and

skills to a captive target audience, and brings back the viewpoints and feed back of the people back to the sources for further improvement.

Plan a field visit to a rural community and prepare a report on the observation made from the visit.

Know your progress

1. Define home science extension education.
2. Name the three components of home science extension education.
3. Briefly describe the characteristics of Home Science Extension education.

Let us conclude

Extension Education is a science which deals with the creation, transmission and application of knowledge designed to bring about planned changes in the behaviour-complex of people with a view to help them live better, by learning the ways of improving their vocations, enterprises and institutions. Extension is an agency to bridge the gulf between research workers and the people at large to play the dual role of interpreting the results of research to the people.

The concept of extension education developed by Dr. J.Paul Leagans identifies five essential phases. They are analysis of the situation, deciding upon the objectives, teaching, evaluation and reconsideration. The fundamental objective of extension is the 'development of the people' or 'destination man'.

The six steps in extension teaching are getting the attention of the learner, stimulating the learner's interest, arousing the learner's desire for information, convincing the learner that he should act, getting action by the learner and making certain that the learner obtains satisfaction from his action.

Home science extension is an applied science which aims at bringing about change in the behaviour of the target groups through dissemination of scientific and technical information in the areas of Home Science. The philosophy of Home Science extension is based on the development of the 'individual'- the most important component of the community and of national development.

Application of the extension principles and methods need not be confined to the rural people and rural areas only. It may very well be applied to the urban people and in urban situations. There is considerable scope for systematically applying the principles and methods of extension, wherever there is need for creating awareness amongst people and developing human resources.

In community development, extension education is used for conducting educational programme which help people in improving their own economic and social conditions and thereby seeking their contribution to national development.

Let us assess

1. Explain the steps in extension teaching.
2. Differentiate between formal education and extension education.
3. Home science extension has certain characteristic features. Analyse.
4. "The extension work is based upon some general principles". Justify the statement.
5. Evaluate the phases in the concept of 'Extension Education' developed by Dr. J. Paul Leagans.
6. Describe the general objectives or functions of extension.
7. Comment on the role of Home Science extension in "national development".

12 Communication in Home Science Extension

Key Concepts

12.1 Communication: definition, objectives, nature and importance

12.2 Elements of communication, types and factors influencing

12.3 Functions of communication

12.4 Cone of Experience

Significant Learning Outcomes

After the completion of this chapter, the learner:

- defines communication and explains objectives of communication
- describes the nature and importance of communication
- discriminates the elements of communication
- classifies and differentiates the types of communication
- explains factors influencing communication
- illustrates cone of experience
- develops skill in good communication
- develops a positive attitude for empathetic communication

Community development is the process of helping a community to strengthen itself and develop towards its full potential. Communication is a key component of sustainable development.

Communication in relation to community/rural development means an interactive process in which information, knowledge and skills relevant for development are exchanged between community members and information providers either personally or through media such as radio, print, telephones and

cybernetics. The aim of effective rural communication is to place the rural people in a position to have the necessary information for decision making and the relevant skills to improve their livelihood.

The word "Communication" is derived from the Latin root 'communis' meaning common.

12.1 Communication

What do you mean by communication?

- .....

Communication is the science and art of making sense with words. As a science, it consists of a set of principles for discovering truth. As an art, it offers abundant opportunities for self expression and self realization.

A. Definition

According to J.Paul Leagans, "Communication is a process by which two or more people exchange facts, ideas, feelings or impressions in ways that each gain a common understanding of meaning, intent and use of message".

Communication in the context of development can be defined as a process by which persons exchange attitude and share knowledge and skills on behalf of an organisation with people in ways that each gain comprehension, understanding and use of the message.

B. Objectives of communication

The following are the objectives of communication.

a. **Human relations :** Communication is to help and promote human relations, making use of it among other things, in the medium or media. There can be no mutual understanding without communication.

b. **Empathy :** Empathy is the ability to feel and share another person's emotions.

c. **Persuasion :** It is a process of convincing and motivating a person to get things done. Speech is one of the methods to persuade a person.

d. **Dialogue**: It involves exchange of ideas. Dialogue is a democratic, civilized and constructive weapon.

e. **Information:** In the new information order of the world, information transmission is the process of getting things done.

f. **Influencing:** Communication is aimed at influencing, persuading, motivating or activating towards desired goals.

g. **Understanding:** Mutual understanding is another objective of communication.

h. **Discouraging misinformation:** Communication is used to discourage the spread of mis-information, rumours, gossip and release of emotional tensions of the workers.

i. **Suggestions and complaints:** To encourage ideas, suggestions for improvement in the product and work conditions for reduction in time and cost.

j. **Free exchange:** The two way communication model ensures free exchange of information and ideas for proper understanding and accepting of messages, action and feedback.

k. **Better relations:** It promotes good understanding by mutual exchange of ideas.

l. **Fostering attitude:** Communication fosters an attitude which is necessary for motivation, co-operation and job satisfaction.

C. Nature of communication

The nature of communication can be explained as follows:

a. **Pervasive function**: Communication is required at all levels of management and in all departments of the organization. It is an activity of each and every manager; therefore communication is regarded as a pervasive function.

b. **Continuous process**: Communication is an ongoing process. Managers have to be in regular touch with their subordinates and superiors to maintain and improve performance.

c. **Two-way process**: Communication is a two way process. It includes sending of a message and response to that message. The reaction or response is known as feedback.

d. **Circular process:** Communication becomes a circular process with feedback. The flow of communication is a circular one.

e. **Two or more parties:** It requires at least two persons to complete the process of communication-a sender of the message and a receiver who must understand the message and respond to it.

f. **Understanding:** For communication to be complete, the receiver must understand the message in the same sense as intended by the sender.

g. **Several forms:** Several methods such as oral words, written words, pictures and gestures are used to transmit messages.

h. **Mutual understanding:** The purpose of communication is to create an impression or understanding in the mind of the receiver of the message.

D. Importance of communication

- What is the message in the picture?
- .....

You may know that it is a way to communicate. The world of modern day is often called the "age of information and communication". Man's need for communication is as strong and as basic as his need to eat, sleep and love. Communication involves interaction with our environments physical, biological and social. Sensory communication alone was not enough for man to survive. Hence the invention of symbolic communication called language- from non verbal gestures, grunts and grimaces to the verbal, and then to the evolution of written and printed word. Communication is a basic social process. It is essential for the growth and development of the individual, to the formation and continued existence of groups, and to the inter relations among groups.

Its importance is self explanatory and is a common experience of all as well. Communication is important in the following ways:

a. **Coordination** : An effective system of communication promotes better coordination among people and organisations. It helps a lot in coordination.

b. **Smooth working** : Smooth and uninterrupted working of an enterprise is to a great extent dependent on good communication network. Communication assumes a greater role in this direction. Corrective decision making and efficiency of the organisation are based on the information supply. If the messages are not flowing freely across the organisation, smooth functioning and unrestricted working of the organisation is not possible.

c. **Effective decision making** : Communication is the primary basis of an effective network which supplies information which helps in arriving at quick decisions. Problem defining, alternative courses of action, selection of the best course of action are all possible only with necessary information supplied to the decision maker.

d. **Managerial efficiency:** Communication promotes managerial efficiency. Efficiency lies in the way in which an individual or group is informed towards common goals. Functions like planning, controlling, co-ordination and motivation cannot be discharged without communication.

e. **Cooperation**: Cooperation among workers, collective or joint efforts, are possible only with the exchange of information between individuals and groups. The two way communication network develops co-operation between people. Faith and confidence will be promoted through communication.

f. **Effective leadership**: Communication is the basis for direction, motivation as well as establishment of effective leadership. It is through the medium of communication that the followers convey their opinions, ideas, feelings, facts etc to their leader.

g. **Job satisfaction**: Two way communication create confidence which leads to job satisfaction.

h. **Increases productivity**: Communication helps in achieving maximum productivity with minimum cost and eliminates waste.

i. **Morale building:** Participatory communication is the best technique for morale building and motivation.

j. **Achieve managerial roles:** Communication plays a vital role in interpersonal, informational and decisional roles.

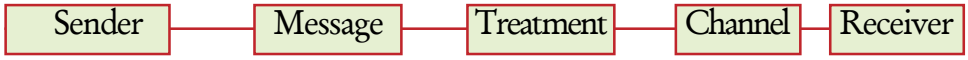
Know your progress

1. Define communication.
2. State the objectives of communication.
3. Explain the importance of communication.
4. What is the nature of communication?

12.2 Elements of Communication, Types and Factors Influencing Communication

How does communication take place?

Communication takes place when the sender selects a certain message and gives it a special treatment for transmission over a selected channel to a receiver who interprets the message before taking the desired action. This can be represented through a diagram as follows.



These become the elements of communication.

A. Elements of communication

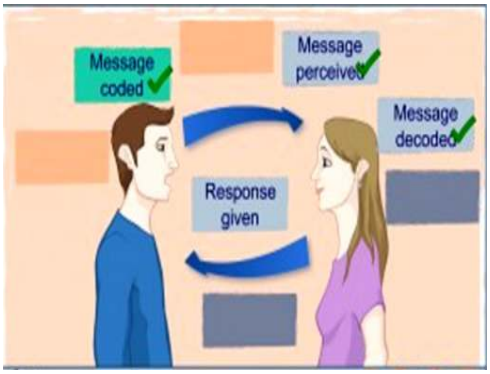
a. **The sender:** We may call him the communicator/speaker/source. It is the person or apparatus that puts the process into operation. The sender may be the extension worker/ teacher. He/she decides what message to send, how to treat it, so that his audience can follow it and what channels to use and which receivers or audience to reach. If he/she makes a poor choice, his communication is likely to fail.

b. **The message:** A message is the idea, fact, impression or information that a communicator wishes his audience to receive, comprehend, accept and act upon. This may be the information package, the technical knowhow for improving the living status of the people. It can be a single signal as on poster or complete information through a pamphlet about the package of practices, instructions etc. Message must arouse personality

needs in the dissemination and suggest ways to meet those needs.

c. **The treatment of the message:** Treatment deals with design of methods for presenting messages. It is the ways of processing message so that it can be sent over the channels with the maximum probability of reaching the destination effectively. In other words, it refers to the ways in which the message is handled before it is placed on the channel. Its purpose is to make the message clear, understandable and realistic to the audience.

d. **The channel:** Channels are the transmission lines used for carrying the messages to their destination. A channel may be anything used by a sender to connect the messages to the receiver. It is the avenue of communication i.e. in a radio talk it is the radio station, studio and wire ways; in an article the newspaper in which the message is to appear.



e. **The receiver/audience:** The intended recipient of a message is the audience. The goal of communication is reached when the receiver accepts the message. The audience or receiver must attend to, interpret and respond to the message. Attention and comprehension are the means necessary for the acceptance of the message by the receiver. The receiver may be a single person when we write a letter; it may be a group of people when we read a message or masses who see television. The more homogeneous the audience is, the greater are the chances of effective communication.

B. Types of communication

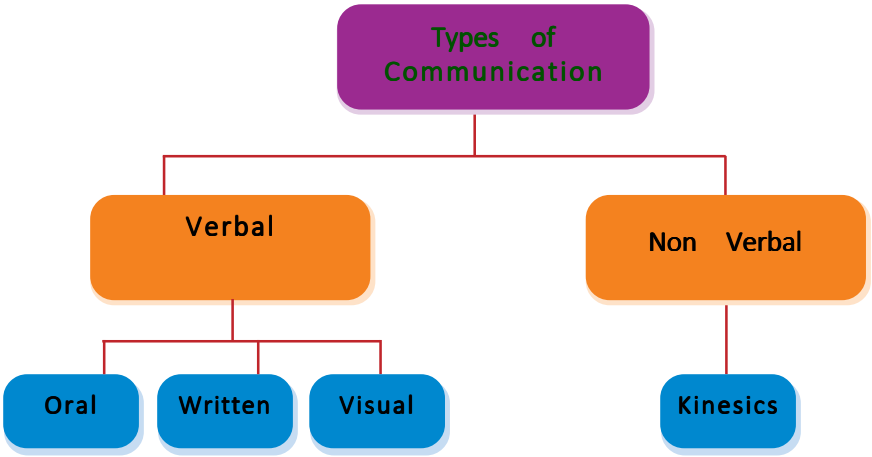
Observe the cartoons. What is the difference in communication in these two types of cartoons?

- .....

Communication occurs in many forms. On the basis of expression communication may be of two types.

a. Verbal communication
b. Non verbal communication

Communication with words is called verbal communication, which can be written, oral or visual. Communication based on physical gestures, facial expressions, and other non verbal cues is known as non verbal communication. These forms of communication can be represented as follows.



a. Verbal communication

Language is the most common medium of communication. Most of our communication take place through words. There are many forms in which verbal communication can take place. The medium of verbal communication is chiefly of three types.

I. Oral communication
II. Written communication
III. Visual communication

i. **Oral communication:** It is the communication using speech that is understood by all parties. In other words, it is talking. Verbal communication is used most often and is popular in the form of speeches and group discussions.

The advantages of oral communication are that it is concise and its feedback takes place immediately. It is thus possible to determine whether the message was received correctly.

The disadvantage of oral communication is that if the message is to be conveyed by various people, it can lose much of its accuracy.

ii. Written communication

What do you mean by written communication? Site one or two examples of written communication.

- .....

Written communication includes notices, letters and anything else that can be put into written words and symbols.

The advantage of written communication is that it is tangible, lasting and controllable. The message can thus be kept for an unlimited time and is particularly suited to extended communication.

The disadvantage of written communication is that it is time consuming. Although the written word may be more accurate it takes much longer than spoken messages. There is also no automatic feedback.

iii. Visual communication

It is communication through a visual aid and is often described as the conveyance of ideas and information in forms that can be read or looked upon. This type of communication, relies on vision, and is presented or expressed with two dimensional images, like signs, drawings, graphic design, illustrations, animation etc. It also explores the idea that a visual message accompanying text has a greater power to inform, educate, or persuade a person or audience.

Non verbal communication

Have you noticed the communication made by a one year old child with his mother? How is it?

Non verbal communication is communication that is neither written nor verbal. It is important to note that approximately 60 percent of all communication between people is non-verbal. Non verbal communication refers to the communication of messages without the use of words. The term body language technically known as kinesics or unspoken messages can be used synonymously. Facial expressions and gestures enable people to communicate without words.

Kinesics/Body language is the way the body communicates without words i.e through various movements of its parts. No doubt, we express our emotions through words, but often the inner states of emotions are expressed through different parts of the body and their physical movements. We can communicate or send message even by nodding the head, blinking our eyes, shrugging our shoulders or waving our hands.

The purpose behind non verbal communication is to convey the feeling or attitude behind the message. Non verbal communication is also intended to promote relationships.

The advantages of non verbal communication are that it is spontaneous, reliable, economical and saves time. It is central to interpersonal relationships.

The disadvantage is that it is less structured so it is difficult to study.

Organize a skit / mime to differentiate and to understand the effectiveness of verbal and non verbal communication on a particular topic.

C. Factors influencing effective communication

There are certain factors that influence the process of communication, which are described as follows:

a. Attitude: Attitude is referred to the internal predisposition of a person to act in a certain way towards a situation. The attitude of a person towards the given situation is influenced by the peers, parents, environment, life experiences, perception and intellectual processes. A

person may have the attitude of accepting, being prejudiced, judgmental, negative, open close etc.

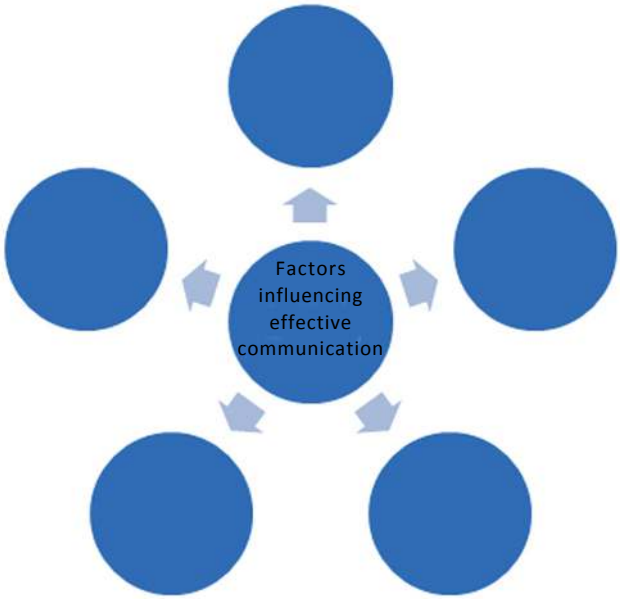
b. **Socio cultural background:** Various cultures and ethnic groups display different communication patterns.

c. **Past experiences:** Previous positive or negative experiences influence one's ability to communicate. For example teenagers who have been criticized by parents whenever attempting to express any feelings may develop a poor self image and feel that their opinions are not worthwhile. As a result they may avoid interacting with others, become indecisive when asked to give an opinion.

d. **Knowledge of subject matter:** A person who is well educated or knowledgeable about certain topics may communicate with others at a high level of understanding.

e. **Environmental factors:** Environmental factors such as time, place, number of people present, and noise level can influence communication between people in that particular surrounding.

Complete the illustration showing factors in fluencing effective communication.



Know your progress

1. List the elements of communication
2. Explain the factors influencing communication.

12.3 Functions of Communication

Communication performs a variety of functions.

a. **Persuasion function:** Persuasion is the ability to change the attitude or behaviour of the target audience. Logical and emotional appeals, one sided and two sided arguments, use of different media etc. form the persuasive function of communication.

b. **Interaction function:** Coordination among group and people, sharing of knowledge about activities and programmes

c. **Information function:** The idea of informing is to provide data and information so that people can effectively understand the nature of work they need to carry out. Communication can help in rapid access to needed information at different levels in understandable form.

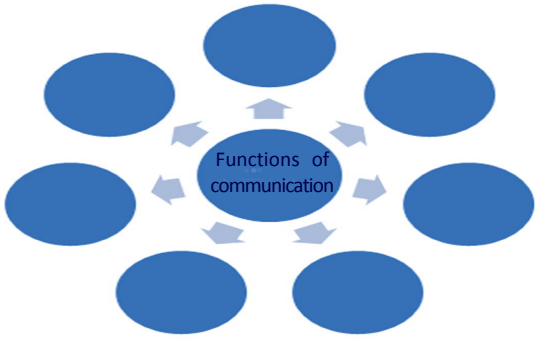
d. **Entertainment function:** Communication facilities are used everywhere for entertainment. Folk media, electronic and print media etc. help in transmitting the rich cultural heritage.

e. **Emotional function:** Communication presents ideas, feelings, and situations in touching ways; encourages people, clarifies doubts and suggests new practices. Social interaction in the form of work group communications provides a way for people to express themselves.

f. **Decision making function:** Problem solving process is necessary to bring desirable changes in attitude, behaviour and practices.

G. **Education/ Training function:** Communication helps in creating conducive environment for effective teaching –learning process.

Complete the chart given below.



12.4 Cone of Experience

One of the greatest and challenging roles a home scientist faces is that of her/his work with a community or with a group of people. For this, she needs to create situations, in which communication takes place, between the extension/community worker and the learners/ target audience. There are certain devices that serve the said purposes and are collectively called as "Extension teaching methods". Depending upon, the nature of the audience, their size, age groups, educational and socio economic backgrounds and many other factors, we have individual method, group methods and mass methods for carrying out the extension activity.

Whatever may be the teaching method, used for the extension/ community work; there are certain devices that can be used to transfer the message to the target audience, effectively and interestingly. It can be a radio talk, motion picture, documentary, video clippings, dramas, an exhibition, or even a demonstration. Such devices are known as audio visual aids.

Do you know!

An audio aid is an instructional device in which the message can be heard, but not seen. eg. a radio. A visual aid is an instructional or communicating device in which the message can be seen but not heard. eg. photographs, specimens, exhibits etc. An audio visual aid is an instructional device through which the messages can be heard as well as seen. eg.: dramas, television, puppet show etc.

A. Purpose of audio-visual aids

Audio-visual aids are used to improve teaching, i.e. to increase clarity, create interest, motivate and to transfer the ideas more meaningfully and quickly. It also helps the learner to learn fast, more thoroughly and to remember longer, since, it involves a maximum number of senses at a time.

Edgar Dale, an educationist devised the "Cone of Experience" to explain the interrelationships of various types of audio visual materials, as well as their individual position in the learning process. At the bottom of the cone, the source of experience is most effective in view of producing the desired quality and quantity of learning. While at the top, the source of experience is the least effective. As one moves upward from the bottom of the cone, the

involvements of sensory organs reduce, on the contrary towards downward, use of sensory organs increase. Thus the bottom most and the top most sources show the two extremes in the use of sensory organs.

Do you know!

Edgar Dale (April 27, 1900 in Benson, Minnesota, - March 8, 1985 in Columbus, Ohio) was an American educationist who developed the Cone of Experience. He made several contributions to audio and visual instruction, including a methodology for analyzing the content of motion pictures. Born and raised in North Dakota he received a B.A. and M.A. from the University of North Dakota and a Ph.D from the University of Chicago. He was a professor of education at Ohio State University.

In the cone, each division represents a stage between the two extremes, direct experience at the base and pure abstraction at the apex.

We can discuss each division in detail.

a. **Direct, purposeful experiences**: Learning by doing is the best type of learning. Actual experience is very effective in learning. It represents the reality or the closest to real, everyday life, with three elements: directness, purposefulness and responsibility for the outcome.eg. making a piece of furniture, cultivating any crop.

b. **Contrived experiences**: Contrived experiences are edited copies of reality and are used as substitutes for real things when it is not practical or not possible to bring or do the real thing in the classroom.These include models, mock ups, specimens, simulations and games.

c. **Dramatised experiences**: It is essentially a process of communication in which both participants and spectators are engaged. A creative reaction and sharing of ideas take place. eg. dramas, puppet shows, tableau, role playing, pantomime, pageants.

d. **Demonstrations**: Demonstarions help to visualize a process that might be difficult to understand completely only through verbal description.

It is an act of showing that something exists or is true by giving proof or evidence or it is a practical exhibition and explanation of how something works or is performed. There are three types of demonstration; Method, Result and Composite Demonstrations.

e. **Field trips**: During field trips the learner acquires first hand and direct experience of the existing situation through observation. But in this source of experience, the learners, can only see and occasionally hear about the situation or thing. Thus manipulative skill is not used in this case.

f. **Exhibits**: Exhibits are systematic representations of the reality. These are only seen, therefore positioned at less effective source in cone of experience.

g. **Motion pictures/ Television**: Motion picture is not as popular as television. That is why it is placed above in the cone of experience. Television has been universally acclaimed as the powerful medium of mass communication. Television and motion pictures can reconstruct the reality of the past so effectively that we are made to feel we are there. Motion pictures can be used in trainings programmes, group meetings, campaign, exhibition etc. Television is a multimedia equipment that combines the immediacy of radio with the mobility of cinema and can carry messages over long distances at a relatively low unit cost.

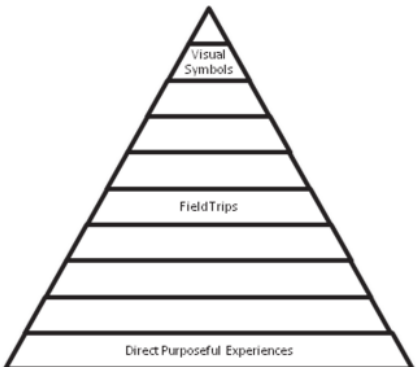
h. **Recordings, radio and still pictures**: These sources of experience involve only one sensory organ; either hearing or seeing. Radio is suitable for creating general awareness among people, help them change their attitude and reinforce learning. Recordings are done on disc, tape or wire. Still pictures can be projected or non- projected.

i. **Visual symbols**: These consist of a device used to assist teaching by visible means, in order to create an impression of realism in the learner's mind. Examples are charts, graphs, maps, and diagrams.

j. **Verbal Symbols**: Verbal symbols are least effective in terms of producing learning among learners. They usually do not contain visual clues to their meaning. Words and spoken language is less interesting than all other methods. That is why these are placed at the pinnacle of the cone of experience. But it is reality that these are used mostly in learning situations. These are used together with every other material on the "cone of experience".

As an educationist Dale explains cone of experience in the context of a classroom but as a Home science person we can utilize the ideas in the cone to enhance our communication with other people especially for extension services and programs.

Based on the explanations given above complete the following figure appropriately.



Conduct an awareness class for a group of adolescents on any of the selected topic, with any one aid.

Know your progress

1. What do you mean by contrived experiences?
2. Illustrate cone of experience

Let us conclude

Communication in the context of development can be defined as a process by which persons exchange attitude and share knowledge or skills on behalf of an organisation with people in ways that each gain comprehension, understanding and use of the message.

The objectives of communication are to promote human relations, develop empathy, to persuade, to exchange ideas, to inform, to influence, to understand etc. The nature of communications are pervasive function, continuous process, two way process, circular process, two or more parties, understanding, several forms and mutual understanding.

The sender, message, treatment, channel and receiver are the five elements of communication. Verbal and non verbal communications are different types of communication. Verbal and written communications are the two forms

of verbal communication. Factors influencing effective communication are attitude, socio-cultural background, past experiences, knowledge of subject matter, ability to relate with others, interpersonal perception and environmental factors.

Edgar Dale, an educationist devised the "Cone of Experience" to explain the interrelationships of various types of audio visual materials, as well as their individual position in the learning process. The following are the ten divisions in the cone.

1. Direct, purposeful experiences
2. Contrived experiences
3. Dramatised experiences
4. Demonstrations
5. Field trips
6. Exhibits
7. Motion pictures/ Television
8. Recordings, radio and still pictures
9. Visual symbols
10. Verbal Symbols

Lab activity

1. Prepare a poster on a selected theme

Let us assess

1. What are the objectives of communication?
2. Complete the flow chart and explain each of them.
   .....→ message → ..... → ..... → receiver
3. Critically examine the nature of communication
4. Differentiate between verbal and non verbal communication
5. Illustrate Dale's cone of experience.
6. The importance of communication is self explanatory and is a common experience of all as well. Justify the statement.
7. An extension worker conducts a talk on energy saving methods.
   (a) Name the approach in communication used in this case.
   (b) Describe
8. Explain the factors that influence the process of communication.

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