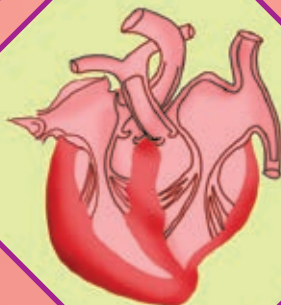
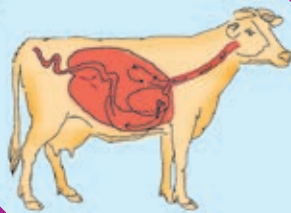




# ANIMAL SCIENCE AND TECHNOLOGY

## Standard XI



The Coordination Committee formed by GR No. Abhyas - 2116/(Pra.Kra.43/16) SD - 4 Dated 25.4.2016 has given approval to prescribe this textbook in its meeting held on 20.6.2019 and it has been decided to implement it from academic year 2019-20.

# Animal Science and Technology

Standard XI



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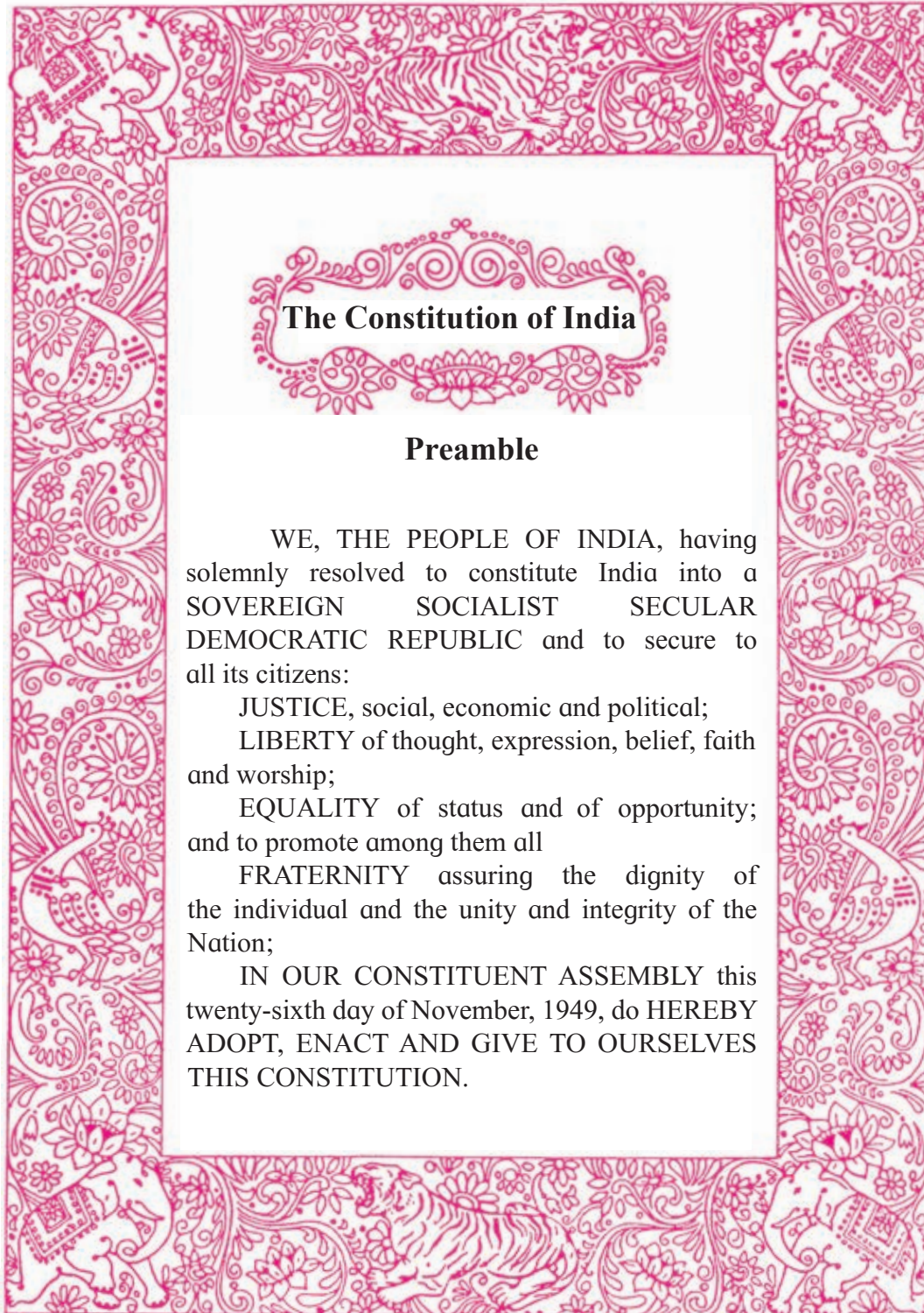
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## NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē  
Bhārata-bhāgya-vidhātā,

Panjāba-Sindhu-Gujarāta-Marāthā  
Drāvida-Utkala-Banga

Vindhya-Himāchala-Yamunā-Gangā  
uchchala-jaladhi-taranga

Tava subha nāmē jāgē, tava subha āsisa māgē,  
gāhē tava jaya-gāthā,

Jana-gana-mangala-dāyaka jaya hē  
Bhārata-bhāgya-vidhātā,

Jaya hē, Jaya hē, Jaya hē,  
Jaya jaya jaya, jaya hē.

## 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.

## Preface

**Dear Students,**

Welcome to std. XI. We have great pleasure in offering to you textbook of Animal Science and Technology based on the new syllabi. This textbook is designed to get you prepared for higher studies. The information and skill from this textbook will also help to develop entrepreneurship qualities.

The educational science understands a paradigm shift in our country. The student community is waiting for exploring new vistas to meet the demands and challenges. It was necessary to bring a change at +2 level of education. This stage deals with adolescents, who are hungry for knowledge and are sensitive as well. Efforts are made to make this text compatible and digestible for this age group.

Indian livestock plays an important role in the national economy and in the socioeconomic development of the country besides providing food and nutritional security to millions of people. Livestock are the best insurance against the vagaries in nature like draught, famine and other natural calamities. The increasing significance and visible impact of livestock gives stability to agriculture by supplementing family income and generating gainful employment in the rural sector. Thus, livestock provides sustenance to millions of peoples in the vast arid and drought prone area of country.

While studying this textbook the section ‘can you recall’ ‘recall a little’ and ‘can you tell’ are used for revision. Many activities given under the titles ‘observe and discuss’ and ‘try this’ ‘use your brain power’ think about it’ etc. will stimulate power of thinking. Ask your teachers, parents and classmates for help wherever you need it.

QR code is given by using you can get additional audio – visual information as supporting articles. The students form rural area, enrolling for this subject will certainly get advanced knowledge of livestock management, thereby they will educate their parents for the same advanced techniques of livestock management.

While studying the book make proper use of devices of information communication technology, which will make studies much easier. The efforts taken to prepare the textbook will not only enrich the learning experiences of the students, but also benefit other stakeholders such as teachers, parents as well as candidates appearing for the competitive examinations.

We look forward to a positive response from the teachers and students.  
Our best wishes to all!



(Dr. Sunil Magar)  
**Director**

Maharashtra State Bureau of  
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Date : 20 June 2019

Bharatiya Sour : 30 Jyeshtha 1941

**- For Teachers -**


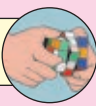



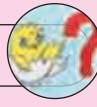

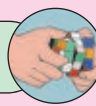
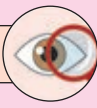

**Dear Teachers,**

We are happy to introduce the revised textbook of Animal Science and Technology for std. XI. This book is a sincere attempt to follow the maxims of teaching as well as develop a 'constructivist' approach to enhance the quality of learning. The demand for more activity based, experiential and innovative learning opportunities is the need of the time. The present curriculum has been restructured so as to bridge the credibility gap that exists in the experience in the outside world. Guidelines provided below will help to enrich the teaching - learning process and achieve the desired learning outcomes.

- To begin with, get familiar with the textbook yourself.
- The present book has been prepared for constructivism and activity based learning.
- Teachers must skillfully plan and organize the activities provided in each chapter to develop interest as well as to stimulate the thought process among the students.
- Always teach with proper planning.
- Use teaching aids as required for the proper understanding of the subject.
- Do not finish the chapter in short.
- Follow the order of the chapters strictly as listed in the contents because the units are introduced in a graded manner to facilitate knowledge building.

- Each unit is structured in a definite manner. It starts from the basic concepts of Animal Science required for each component comes under the subject. Application of technology is given in content. This knowledge will help students to understand further chapters in each unit.
- Each chapter provides various charts, pictures, diagrams for better understanding, so you can use this for effective teaching.
- Ask the students about the related information, background about the chapter. You are provided, for this with the different boxes like 'Can You Recall', 'Do you know?', 'Try this'.
- Encourage the students to collect related information by providing them the websites.
- Teaching- learning interactions, processes and participation of all students are necessary and so is your active guidance.
- Do not use the content of the boxes titles 'Do you know?' for evaluation.
- Exercises include parameters such as co-relation, critical thinking, analytical reasoning etc. Evaluation pattern should be based on the given parameters. Equal weightage should be assigned to all the topics. Use different combinations of questions.

**Components of chapter :**

<b>Remember</b> 	<b>Try this</b> 	<b>Can you recall?</b> 	<b>Can you tell?</b> 
<b>Use your brain power</b> 	<b>Do you know ?</b> 		
<b>Think about</b> 	<b>Just do it</b> 	<b>Can you imagine ?</b> 	
<b>Observe that</b> 	<b>Can you think</b> 	<b>Internet my friend</b> 	

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<b>Competency Statements - Standard XI</b>	
<b>Area/ Unit/ Lesson</b>	<b>After studying the contents in Textbook students.....</b>
<b><i>Livestock and Poultry Breeds</i></b>	<ul style="list-style-type: none"> <li>• Explain integrated livestock farming.</li> <li>• Suggest medicinal uses of livestock.</li> <li>• Analyse the data of livestock related components example, milk production, egg production, etc.</li> <li>• Understand the livestock population in Maharashtra.</li> <li>• Compare the livestock production in Maharashtra.</li> <li>• Explains the nutritive values of livestock production.</li> <li>• Calculate and compare the income from livestock production.</li> <li>• Selects and suggest organic farming</li> <li>• Understands the challenges in Livestock population and its Production</li> <li>• Nomenclature the parts of different livestock</li> <li>• Classify cattle, buffalo, goat, sheep, and poultry breeds</li> <li>• Explains the habitats, characteristics of different breeds</li> <li>• Understand the commercial importance of different breeds.</li> <li>• Explain the role of different livestock in economical development.</li> <li>• Correlate livestock and poultry breed with health and hygiene.</li> <li>• Take efforts to create awareness regarding agriculture supporting buisness.</li> <li>• Collect data of livestock in surrounding.</li> <li>• Analyse the collected information of livestock and made conclusions.</li> </ul>
<b><i>Livestock Nutrition</i></b>	<ul style="list-style-type: none"> <li>• Expalin feed nutrients.</li> <li>• Enlist the nutrients in feed.</li> <li>• Identify the importance and functions of feed nutrients.</li> <li>• Explain functions of nutrients.</li> <li>• Analyse nutrients with their functions.</li> <li>• Differentiate vitamins with their characteristics.</li> <li>• Explain the sources and functions of vitamins in livestock.</li> <li>• Identify symptoms of deficiencies of vitamins in livestock.</li> <li>• Explain the sources and functions of minerals in livestock.</li> <li>• Identify symptoms of deficiencies of minerals in livestock.</li> <li>• Classify feed stuffs.</li> <li>• Differentiate roughages and concentrates with their characterstics.</li> <li>• Explain special feeds.</li> <li>• Explain unconventional feed stuff with classification.</li> <li>• Understand projected demand supply and fooder deficits in India.</li> <li>• Classify fodder crops.</li> <li>• Explain the importance of nutrition</li> <li>• Classify the different nutrients and its importance</li> <li>• Understand the different cultivation practices related to forages, feeds and feed technology</li> <li>• Understand the feed technology</li> <li>• Expalin the process of pellet making machine.</li> <li>• Create feed blocks.</li> </ul>




<p><b>Anatomy and Physiology of Livestock and Poultry</b></p>	<ul style="list-style-type: none"> <li>• Explain the skeletal system in detail.</li> <li>• Identify and explain bone type.</li> <li>• Discuss the structure of bones.</li> <li>• Classify bones with diagrammatic representation.</li> <li>• Explain skeleton types with reference to joints.</li> <li>• Explain the respiratory system in detail with diagrammatic representation of different organs.</li> <li>• Explain the circulatory system with reference to different organs.</li> <li>• Explain blood composition.</li> <li>• Differentiate between Arteries and Veins.</li> <li>• Explain the digestive system with reference to different organs.</li> <li>• Draw structures of digestive system.</li> <li>• Differentiate digestive system of ruminants and non ruminants.</li> <li>• Explain the Urinary system with reference to different organs.</li> <li>• Explain the reproductive system with reference to different organs.</li> <li>• Explain the Nervous system and endocrine system with reference to different organs.</li> <li>• Explain endocrine organs and their functions.</li> </ul>
<p><b>Livestock Breeding</b></p>	<ul style="list-style-type: none"> <li>• Understand the concept of animal breeding and its development.</li> <li>• Understand the new technologies reference to reproductive technologies in livestock.</li> <li>• Explain the systems of breeding in detail (Advantages and disadvantages).</li> <li>• Explain transgenic animals, cloning technique.</li> <li>• Create awareness about the need and impact of technology on livestock breeding.</li> </ul>

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# 1. SCOPE AND OPPORTUNITIES IN ANIMAL HUSBANDRY

## Can you recall ?

1. Different sources of Indian economy 
2. Status of Livestock during “Mahabharta”
3. What do you mean by Animal Husbandry?
4. Intergrated Livestock Farming

India is basically an agricultural country having the primary source of livelihood for 54.6 per cent of India’s population and contributes 17.4 per cent to the country’s total Gross Domestic Product (GDP). Livestock is an integral part of Agriculture, in fact the Indian economy is closely knit with agriculture and livestock and both are crucial for overall food security. Now a day’s agriculture sector is undergoing a historic change as livestock has surpassed the economy of food grain and today finally the policy makers of country recognized livestock as the engine of agriculture growth.


## Remember...

Livestock sector contributes country’s 4.11 % of GDP and 25.67 % of total agriculture GDP. 

Besides providing cheap and nutritious food to millions of people, animal husbandry is playing a significant role in generating gainful employment in the rural areas, particularly among the landless, small and marginal farmers and women. According to National Survey Scheme (NSS,2013), 23 per cent agricultural households 16.44 million workers are engaged in the activities of farming of animals. Employment in livestock sector is fast catching and has implications for poverty too. It has been observed that rural poverty is less in states where livestock contributes more to farm income.

India is basically an agricultural country and it is likely to be so, in future to come. At present 54.6 per cent of Indians depend on agriculture for their livelihood. Out of the total land holding 30 per cent is held by small and marginal farmers. They manage 80 per cent of total livestock in the country. Livestock production is more impressive than that of food grain production. The activity of livestock production is largely confined to the rural sector as land, labour, capital and organization are the basic resources available in the rural sector. These four factors of livestock production are roped in proportionately to augment the production of finished goods; namely milk, meat, pork, wool and related multifarious products of commercial importance. These products follow their regular path-ways of processing, preservation, pricing and quality control. The age-old format of conventional dairy management is being transformed into a more meaningful and scientific form, based on improved breeding, feeding, heeding, housing and health cover practices. Apart from milk, meat, eggs, wool and leather, various animal species are also used for draught power, companionship, entertainment, research experimentation, sports, security etc. Fortunately, India has blessed with tremendous livestock wealth, both in terms of number as well as diversity. This is endeavored with the complexity to sustain under harsh climatic conditions with scarce resources.

## Do you know ?

India has the largest cattle population in the world. 

Livestock plays an important role in Indian economy. About 20.5 million people depend upon livestock for their livelihood. Livestock contributed 16 per cent to the income of small farm households as against an average of 14 per cent for all rural households.

**Internet my friend**

Collect information on different livestock products.



## 1.1 PRESENT POSITION OF LIVESTOCK AND POULTRY IN INDIA AND WORLD

**Can you tell ?**

1. Current Total Livestock and poultry breeds in India
2. Different livestock species found in India



Livestock comprising mainly cattle, buffaloes, sheep and goats have a complementary, supplementary, symbiotic and sustainable relationship with crop production under mixed farming system prevalent in our country. India has a distinguished livestock heritage and a place of pride in the history of livestock development in the world. It has shared its livestock resources with many countries all over world, thus contributing immensely in livestock development on a global scale.

India has the largest number of breeds of livestock and poultry in the World. After 15 new breeds of livestock and poultry registered with NBAGR (National Bureau of Animal Genetic Resources, Karnal) on 5<sup>th</sup> September, 2018, now India has total of 184 breeds of livestock and poultry. Among these we have 43 cattle, 16 buffalo, 34 goat, 44 sheep and 9 chicken breeds. One-seventh of all cattle breeds, nearly all buffalo breeds, one-third of the goat breeds and one-sixth of sheep breeds of the world are in India. Our zebu cattle are much prized for their hardiness, ability to digest coarse fibers, heat tolerance, disease resistance and adaptability to harsh tropical climatic conditions. Indian game fowl (Aseel) is reported to have contributed to the emergence of modern broiler breeds. Likewise, the Red Indian Jungle fowl has been used for evolution of modern laying birds.

As per 19<sup>th</sup> Livestock Census (2012) India is holding 11.60 percent of World's livestock population, consisting 57.83 percent buffaloes, 15.06 percent cattle, 17.93 percent goats and 7.14 percent sheep. India ranks first in the world in respect of buffalo and cattle while second in goat population and third in sheep population. However, the total livestock population of India decreased by about 3.33 per cent in 2012 census over the previous 2007 census. The cattle population in the 19<sup>th</sup> census decreased by 4.10 per cent, sheep by 9.07 percent, goat by 3.82 percent and pigs by 7.54 percent while buffalo population increased by 3.19 percent and poultry by 12.39 percent over the previous 2007 census. In India Uttar Pradesh is ranking first in buffalo population and the total livestock population while Andhra Pradesh ranks first in sheep and total poultry population.

**Do you know ?**

1. India is having highest livestock population in the world
2. First in cattle & buffalo population
3. Second in goat population
4. Third in sheep population
5. Fifth in poultry population

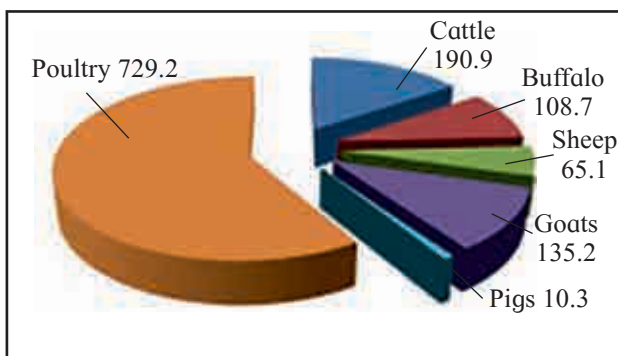


India has 729.20 million poultry resulted in 12.39 per cent growth over the previous census. Poultry in India developed very fast in Andhra Pradesh, Tamil Nadu, West Bengal, Karnataka, Assam and Jharkhand. The buffalo population in Maharashtra decreased from 6.94 million in 2007 to 5.59 million in 2012 and cattle population also decreased from 16.18 million in 2007 to 15.48 million in 2012. The sheep and goat population also decreased from 2.91 and 10.39 million in 2007 to 2.58 and 8.43 million in 2012, respectively. Only the poultry population has been tremendously increased from 16.27 million in 2007 to 77.80 million in 2012 showing nearly 5 times growth.

**Table 1.1 : Livestock and Poultry population (19<sup>th</sup> Livestock census-2012)**

Sr. No.	Species	India			Maharashtra		
		Population (Millions)	Per cent of World	Rank in World	Population (Millions)	Per cent of India	Rank in India
1.	Cattle	190.90	12.5	First	15.48	8.11	Fourth
2.	Buffalo	108.70	56.7	First	5.59	5.14	Eighth
3.	Sheep	65.10	20.4	Third	2.58	3.96	
4.	Goats	135.20		Second	8.43	6.23	
5.	Pigs	10.30	--	--	0.33	3.20	--
6.	Poultry	729.20	3.1	Fifth	77.80	10.67	Third

Source: Annual Report 2017-18, DAHDF, GOI



**Fig. 1.1: Livestock and Poultry population in millions (19<sup>th</sup> Livestock census-2012)**

### Can you tell ?

Different milk products manufactured in your area.



draft power and manure inputs to raise the crop. It also contributes to foreign exchange through the export of animal products. By using crop residues as feed, livestock saves land for food production that would otherwise be used for fodder production. Additionally, livestock contributes to environment conservation, supplies draft power, manure and domestic fuel that saves the use of petro-products.

### Remember...

Livestock also contributes in saving fuel/petrol products.



## 1.2 SCOPE AND LIMITATIONS FOR LIVESTOCK AND POULTRY FARMING IN INDIA

Livestock is an integral component of agriculture. It makes multifarious contributions to the growth and development of the agricultural sector. Though the GDP of agriculture has shown a declining trend during recent decades, it has a large scope to sort-out the causes of lacunae and correct them. Livestock helps to improve food production and provide nutritional security. It generates income, employment and act as a cushion against crop failure. It provides

The contribution of agriculture sector to the total GDP in 1950-51 was 50.50 per cent of which the share of Animal husbandry was 15.50 per cent. From 1980-81 to 2008-09 period the contribution of agricultural sector fell from 46.40 to 17.20 per cent, while the contribution of Animal Husbandry as per cent of agriculture went up from 18.63 in 1980-81 to 25.60 in 2017-18 which speaks about potential of Animal Husbandry sector to boost the national economy. The contribution of livestock sector to the total GDP was 4.11 per cent in 2017-18.

As per the Annual Report (2017-18) published by the Department of Animal Husbandry, Dairying and Fisheries, Government of India, Annual production and per capita availability of livestock products are shown in Table 1.2

**Table 1.2 : Annual production and per capita availability of Livestock products during 2016-17.**

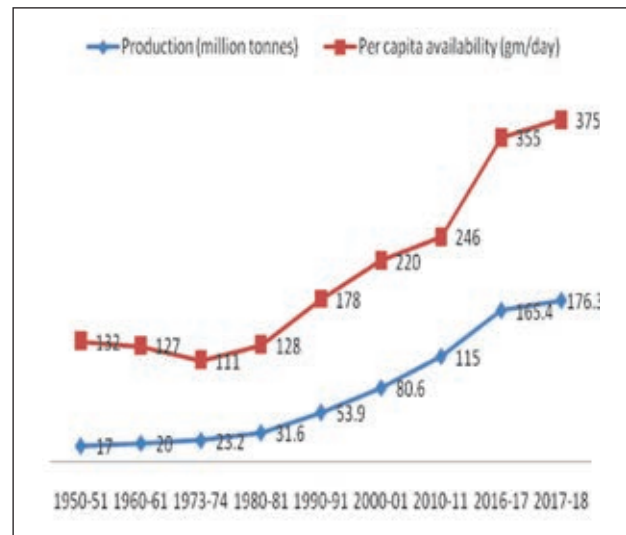
Sr. No.	Livestock Product	Annual production	Per capita availability	ICMR recommendation
1.	Milk	165.4 MMT	355 gm/day	280 gm/day
2.	Meat	7.4 MMT	2.96 kg/year	11 kg/year
3.	Eggs	88.1 billion	69 eggs/year	182 eggs/year

Source: Basic Animal Husbandry Statistics, 2017 DAHDF, GOI

India contributes 2.80 per cent of the total meat production of the world (212.31 MMT). The share of beef, buffalo meat, mutton, goat meat, pork and poultry meat in India was 4.62, 19.83, 7.60, 14.22, 6.41 and 47.32 per cent, respectively against the total meat production of 7.4 million metric tonnes in the Country.

**Internet my friend**

1. Current per capita availability of milk, meat and eggs in India.
2. Recommended per capita requirement of milk, meat and eggs in India.
3. Current Annual Milk production in India and Maharashtra



**Fig.1.2: Annual milk production and per capita availability**

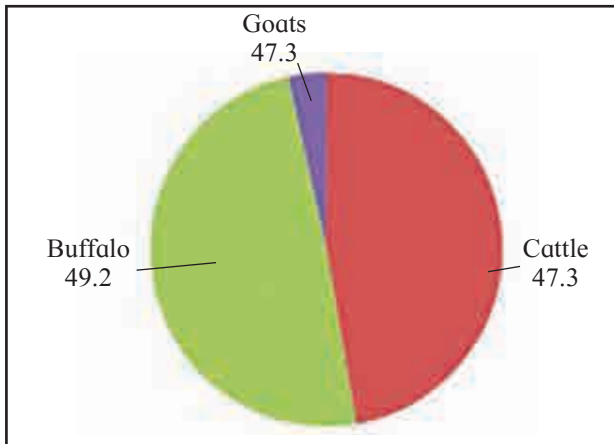
**Table 1.3 : Annual milk production and per capita availability from 1950-2017.**

Financial Year	Production (million tonnes)	Per capita availability (gm/day)
1950-51	17.00	132
1960-61	20.00	127
1973-74	23.20	111
1980-81	31.60	128
1990-91	53.90	178
2000-01	80.60	220
2010-11	115.00	246
2016-17	165.40	355
2017-18	176.30	375

India ranks first in the world with annual milk production of 176.30 million tones (2017-2018). The share of cow, buffalo and goat milk is 47.3, 49.2 and 3.5 percent, respectively. Uttar Pradesh produces maximum milk followed by Rajasthan, Andhra Pradesh, Gujarat and Punjab. Tamil Nadu produces highest crossbred cow milk followed by Maharashtra while Uttar Pradesh produces highest milk from Indigenous/ Deshi cows followed by Rajasthan. In case of buffalo milk, Uttar Pradesh is largest producer followed by Andhra Pradesh, Rajasthan, Punjab, Haryana, Gujarat, Madhya Pradesh and Maharashtra. Uttar Pradesh also produces highest Goat milk followed by Rajasthan. The per capita availability of milk is increased from 132 gm in 1950-51 to 375 gm in 2017-18. Per capita per day milk recommended by ICMR is 280 gm.

**Do you know ?**

1. **Uttar Pradesh is the largest milk producer state in India**
2. **Tamil Nadu is the largest crossbreed cow milk producer in India**
3. **Maharashtra is the second largest crossbreed cow milk producer in India**



**Fig.1.3: Species wise per cent milk production in India (2017-2018)**

The egg production in India has also been significantly increased from 53.6 billion in 2007-08 to 88.14 billion during 2016-17 with per capita availability of 69 eggs as against 47 egg in 2007-08. Andhra Pradesh is largest egg producer, followed by Tamil Nadu, West Bengal, Maharashtra and Haryana. Meat production in 2007-08 was 4 million tonnes, which increased to 7.4 million tonnes during 2016-17. Poultry contributes 47.32 per cent of the total meat production in India, followed by buffalo and goat meat. Uttar Pradesh produces highest meat followed by Andhra Pradesh, West Bengal, Maharashtra and Tamil Nadu

**Remember...**

1. **Andhra Pradesh is the largest eggs producer state in India.**
2. **Uttar Pradesh is the largest meat producer state in India.**
3. **Poultry contributes 47.32 per cent of total meat production in India.**



Wool production in India is showing declining trend. In 2006-07 it was 45.1 million Kg which marginally declined to 44.7 million Kg during 2011-12. Wool production was increased to 48.1 million Kg during 2014-15 which is again decreased to 43.5 million Kg during 2016-17. Wool production is maximum in the state of Rajasthan followed by Karnataka, Jammu & Kashmir, Andhra Pradesh and Gujarat.

**Upliftment of Farmer's economy**

Livestock plays an important role in upliftment of farmer's economy by number of ways. Farmers in India do the mixed farming i.e. combination of crop and livestock where the output of one enterprise becomes the input of another enterprise. Livestock keeping contributes to farmer's economy by following different ways...

1. **Income:** Livestock is a source of subsidiary income to many farmer's family especially poor or marginal farmers as sale of cow and buffalo milk provides regular and guaranteed income flow. Income from the sale of milk acts like ATM to farmers. Animals like sheep and goat serve as a source of income during emergencies like marriage, children's education, health cover or family and livestock, repair of house etc. Therefore, livestock acts as a secure source of income to farmers.

**Do you know ?**

Income from the sale of milk acts like ATM to farmers.

Sheep and goat serve as a source of income during emergencies like marriage, education, ill health, repair of house.



2. **Food security:** The different livestock products such as milk, eggs and meat serve as an important source of animal protein to human beings.
3. **Social Security:** The livestock keeping offers a social security to the owners in terms of status in the society. In the Mahabharata era there was a special

status to the Princes as those who hold more number of animals were said to be the richest Prince (Raja). The families especially the landless which own animals are better placed than those who do not. Gifting animals in marriages is a very common in different parts of country. Also animals are used for various socio-religious functions. Cows are worshiped during various religious functions.

4. **Draft:** Bullocks are the backbone of Indian agriculture. Many farmers especially marginal and small depends upon bullocks for different agricultural operations such as ploughing, carting and transport of various agriculture inputs and outputs.

**Do you know ?**

**Uses of dung and urine of livestock**



5. **Dung:** In rural areas dung is used as rich fertilizer, an efficient fuel and biogas producer. It acts as poor man's cement as it is used as plastering material for their houses. It is also used for flooring in and outside the farmer's houses and animal houses.
6. **Employment:** Many people depend on agriculture for their livelihood, but agriculture being a seasonal, provides only 180 days employment. The landless and marginal farmers depend upon livestock for utilizing their labour during lean season of agriculture. Thus livestock has enormous power to generate employment throughout the year.

**Limitations for improvement of livestock and poultry farming in India**

1. Inadequate feed and nutrition to support our vast livestock and poultry population.
2. Low genetic potentiality for high production due to the absence of selection for milk, meat, eggs and wool.

3. Poor organization of breeding programme for livestock.
4. Lack of efficient and scientific management.
5. Lack of uniformity in collection of data.
6. Poor adoption of modern techniques to control diseases.
7. In poultry farming, increasing prices of feed ingredients, lack of poultry export, lack of financial support and inadequate extension services.

**Can you tell ?**

- Major limitations in livestock farming in India.
- The nutritive value of milk, meat and eggs.



**1.3 NUTRITIVE VALUE OF ANIMAL PRODUCTS**

Milk is considered as complete food for human being. Cow milk contains fat (4.90%), protein (3.90%), lactose (5.10%), ash (0.80%), total solids (14.70%) with vitamins and minerals.

Meat is very good source of phosphorous, iron and protein with well balanced essential amino acids, and has protein 21 per cent, fat 6 per cent, minerals 1 per cent and water 72 per cent. It contains Cu, Zn, Na, K, Mg and low amount of Ca.

**Remember...**

**The poultry is considered as the most economical and fastest way of supplying animal protein for human consumption.**



Poultry meat has high nutritive value. Chicken meat contains high protein with almost all essential amino acids. It is low in calories. It is very good source of Vitamin B-complex and minerals like iron and phosphorus.

Egg is an important well balanced source of nutrients containing proteins, unsaturated fatty

acids, minerals especially iron, phosphorous and almost all the vitamins with the exception of Vit C. It's high nutrient content, low calorific value and easy digestibility make it a valuable protective food in human diet.

## 1.4 INTEGRATED LIVESTOCK FARMING

Integrated livestock farming plays an important role in India. The increasing human population in the India is warranting more production of food and milk from the limited area and productive livestock. Various enterprises that could be included in the integrated livestock farming system are crops, dairy, poultry, goat rearing, fishery, sericulture, agro-forestry, horticulture, mushroom cultivation etc. The knowledge of linkages and complementarities will help to develop integrated livestock farming in which the waste of one enterprise is more efficiently used as an input in another within the system.

### Example :

- Crop + Livestock + Poultry.
- Crop + Fish + Poultry + Duck
- Crop + Dairy + Goat + Sheep.

### Internet my friend

Search for medicinal uses of cow urine for human health



## 1.5 COMMON TERMS USED IN ANIMAL HUSBANDRY AND POULTRY

1. **Adaptation** : Adjustment of an individual's or group of individuals' genotypes to the changed environmental situation.
2. **Albinism** : Absence of pigments in the hair and skin.
3. **Animal**: The word includes the various organisms belonging to the kingdom Animalia
4. **Animal Husbandry**: It is an art of management including scientific feeding, breeding, housing and health care of domestic animals.
5. **Anterior** : Front or forward part of the body.
6. **Breed** : Animals which have a common origin and so the common characteristics which are distinguished from other group of animals within the same species and the characters are inherited in the progeny.
7. **Breeding** : It is the manipulation of hereditary material in accordance to the terms of demand dictates.
8. **Broiler** : The hybrid chicks having rapid growth and attaining 1.50 kg weight during the period of 6 weeks of age and sold for table purpose up to 8 weeks.
9. **Calf** : Young one of cattle or buffalo below the age of six months.
10. **Calving Interval** : The period between two successive calvings.
11. **Castration** : Act of crushing the spermatic cord by Burdizzo's castrator.
12. **Chick** : A young male or female fowl below 6 weeks of age.
13. **Conception** : The successful union of male and female gametes to form a zygote and implantation of zygote is known as conception. It is an act of becoming pregnant.
14. **Digestion** : The term digestion refers to all the changes a food undergoes in the alimentary canal and makes the nutrients absorbable for the use by the body.
15. **Domestic animal** : The animals which are reared on farm and farm premises.
16. **Dorsal** : It refers to the back or back portion of an animal.
17. **Dry matter** : It refers to that fraction of food which doesn't contain moisture



- higher than 10 per cent and is composed of the nutrients.
18. **Dry period** : The period after lactation during which the animal does not produce milk.
  19. **Fertility** : It refers to the ability to reproduce.
  20. **Flock** : It is the group of sheep, goat or poultry birds.
  21. **Foetus** : Developing individual in intra-uterine life when the body parts are formed before birth.
  22. **Gait** : The forward posture and motion or style of a animal.
  23. **Gene** : It is the unit of inheritance, which is transmitted in gametes or reproductive cells. It is the physical basis of heredity.
  24. **Genotype** : The actual genetic make-up of an individual as determined by the genes it carries.
  25. **Germplasm** : The material on the basis of heredity taken collectively. The sum of gene constitution of an individual.
  26. **Gestation** : The period of pregnancy.
  27. **Heifer** : The younger female of cattle above six months of age to first calving.
  28. **Herd** : It is a group of cattle or buffalo.
  29. **Heredity** : The occurrence of genetic factors derived from each of its parent in an Individual.
  30. **Heritability** : The percentage of variation in individual characteristics between related individuals which is due to true genetic difference.
  31. **Hybrid** : The progeny of parents that are genetically different from two pure lines.
  32. **Inheritance** : Transmission of genetic factors from parents to offspring's.
  33. **In-utero** : Within the uterus.
  34. **In-vivo** : Within the living body.
  35. **In-vitro** : Within an artificial environment.
  36. **Lactation period** : The period from parturition to the day of drying in which the animal produces milk.
  37. **Layer** : An egg laying female chicken upto one year.
  38. **Libido** : Sexual desire or sexual drive.
  39. **Livestock** : The term livestock in broad sense can be defined as all the animals, birds and other living creatures used for producing products for the use of man.  
Livestock in narrow sense is loosely used to include the (mammal) farm animals.
  40. **Offspring** : Youngone of both the sexes produced by the parents.
  41. **Oogenesis** : Formation of ova.
  42. **Ovulation** : A process of release of ova or egg from matured Graffian follicle.
  43. **Pedigree** : It is record or history of ancestors of an individual.
  44. **Phenotype** : The external appearance or performance of an individual which are determined by genes and are observable by eye.
  45. **Poultry** : The term poultry includes a number of avian species such as chicken, duck, turkey, geese, guinea fowl and quails domesticated for economic purpose.
  46. **Progeny** : The young offspring of the parents.
  47. **Prolificacy** : Ability of giving birth to many or few offsprings from a given mating.
  48. **Puberty** : It is the stage in the life of animal indicating first sexual activity.
  49. **Service** : The process in which mature male covers the female in heat with the aim to deposit the spermatozoa in the female genitalia.
  50. **Sire** : The male parent of an individual.

51. **Species** : A group of individuals which have certain common characteristics that distinguish them from other group of individuals within a genera of genus.
52. **Sterility** : Inability to produce any offspring.
53. **Succulent feeds** : Greens/forages harvested in full bloom stage which are soft, and contain large amount of moisture. They carry easily digestible nutrients and are rich in vitamins, mineral and digestible carbohydrates and proteins.
54. **Teaser** : A vasectomized (castrated) bull used to detect the heat or estrus of female (cow).
55. **Trait** : It means a specific character.
56. **Zygote** : It is a fertilized ovum.

**EXERCISES**

**Q.1 Fill in the blanks.**

- Livestock contributes ..... % to the country's total Gross Domestic Products.
- India has ..... million poultry population.
- The act of crushing the spermatic cord by Burdizzo's castrator is known as .....
- Egg of poultry contains almost all the vitamins with the exception of Vit. ....
- Buffalo population of Maharashtra in 2012 was ..... millions.
- ICMR recommended per capita availability of meat per year is ..... Kg.

**Q.2 Match the pairs.**

Group A		Group B	
1)	Heifer	a)	Cow
2)	Milk	b)	Male parent
3)	Eggs	c)	Young female
4)	Sire	d)	Female parent
5)	Chicken	e)	Layer poultry
		f)	Broiler poultry

**Q.3 Identify the odd one out.**

- Milk, Meat, Poultry, Egg
- Cattle, Buffalo, Sheep, Pig.
- Dung, Meat, Milk, Egg.

**Q.4 Answer the following questions in brief.**

- What is integrated livestock farming?
- Write the nutritive value of milk.
- Write limitations of poultry farming.
- Give the meaning of livestock.
- What is mean by Animal husbandry?

**Q.5 Answer the following in detail.**

- Describe the importance of livestock in India.
- Explain present status and scope of livestock.

## 2. CATTLE BREEDS

### Can you recall ?



1. Terms - breed and species.
2. Different cattle breeds of India.
3. Indigeneous cattle breeds used for draft, dual and milk purpose.
4. Exotic cattle breeds used for crossbreeding purpose.

### Remember...



Cattle belongs to family Bovidae, genus *Bos* (ruminant, quadrupeds) and species *Bos indicus* (humped) and *Bos taurus* (without hump)

India is gifted with large number of cattle breeds particularly draft purpose breeds. In all there are 43 well recognized cattle breeds in India. In addition, large cattle population comes under the 'non-descript' category. Majority of the Indian breeds are low milk producers and are reared primarily for the production of bullocks which are used for draft purpose.

### 2.1 CLASSIFICATION OF CATTLE BREEDS

Cattle breeds are broadly classified into three major types according to their utility.

- A) **Milch purpose breeds** - Sahiwal, Red Sindhi, Gir and Tharparkar.
- B) **Dual purpose breeds** - Deoni, Ongole, Kankrej, Hariana and Rathi.
- C) **Draft purpose breeds** - Amritmahal, Bachaur, Badri, Bargur, Belahi, Binjharpuri, Dangi, Gangatiri, Gaolao, Ghumusari, Hallikar, Kangayam, Kenkatha, Khariar, Kherigarh, Khillar, Konkan Kapila, Kosali, Krishna Valley, Ladakhi, Lakhimi, Malnad Gidda, Malvi, Mewati, Motu, Nagori, Nimari, Ponwar, Pulikulam, Punganur, Red Kandhari, Siri, Umblachery and Vechur.

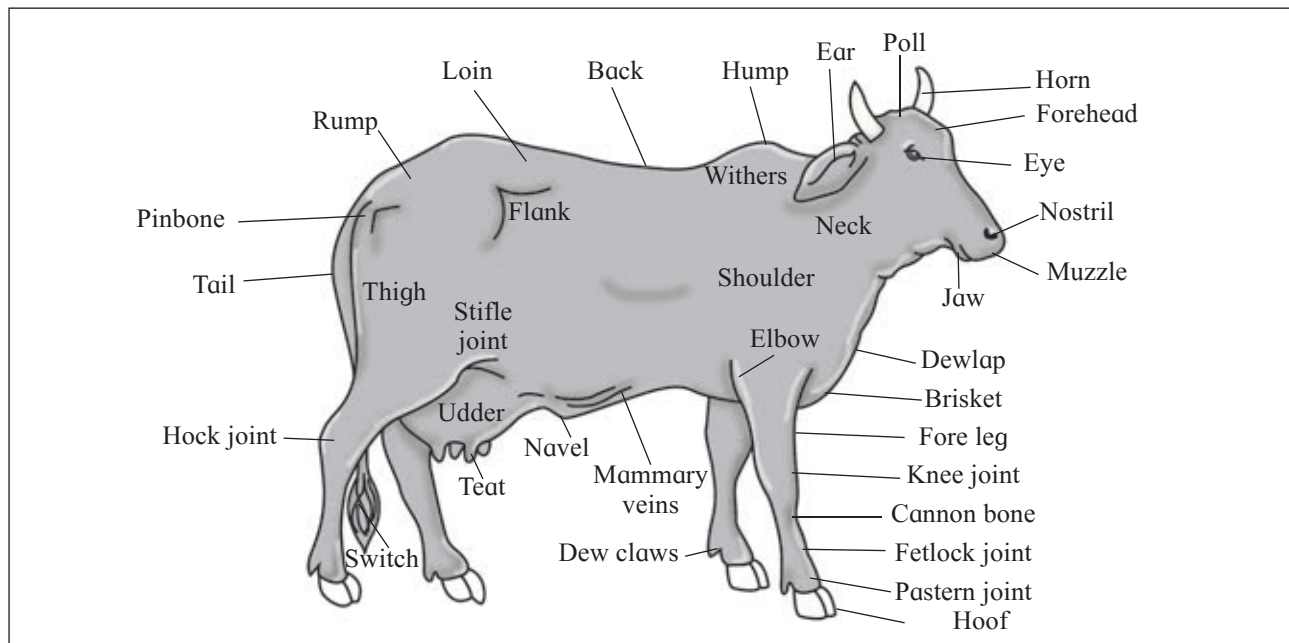


Fig. 2.1 External body parts of cow

Can you tell ?

Cattle breeds of Maharashtra.



## 2.2 MILCH PURPOSE

### 2.2.1 Sahiwal

**Synonyms :** *Lola, Montgomery, Lambi-Bar, Multani.*



Fig. 2.2 a Sahiwal : Male

**Origin and Habitat :** The Sahiwal breed was originated in the dry areas of the Punjab which lies along the India – Pakistan border and its breeding tract is Montgomery districts now named as Sahiwal district. Good animals are also seen in Punjab, Delhi, Uttar Pradesh, Bihar, Chattisgarh and Madhya Pradesh.

Do you know ?

Sahiwal is the best milk breed of Indian subcontinent and the highest milker of all the Zebu breeds.



#### Prominent characteristics

1. Deep body, loose skin (hence the Lola), short legs, stumpy horns, broad and lethargic posture are the typical characters of the breed.
2. Colour of Sahiwal is reddish brown to dun sometimes with white patches on the neck and the underline.

3. Horns are short and thick, not exceeding 3 inches in length. Loose horns are common in females.



Fig. 2.2 b Sahiwal : Female

4. Massive hump (in male), voluminous dewlap and pendulous sheath is prominent.
5. Tail is long whip like, almost reaching to the ground, tapering to a good black switch is observed.
6. Naval flap is prominent in female.
7. Average body weight : Male - 522 kg, Female - 340 kg.

#### Economic importance

1. Average lactational milk yield is 2200 kg.
2. Age at first calving is 40 months.
3. Inter calving period is 450 days.
4. The bullocks are generally docile and lethargic, making them more useful for slow work.

Do you know ?

The highest milk producer cattle breed in India.



### 2.2.2 Red Sindhi

**Synonyms :** *Scindh, Scindhi, Red Karachi, Sindhi, Malir (Baluchistan).*

**Origin and Habitat :** The native tract of Red Sindhi breed is Karachi and Hyderabad districts of Pakistan. The portion of Sind called “Kohistan” is the real breeding tract of this breed.



**Fig. 2.3 a Red Sindhi : Male**

#### **Prominent characteristics**

1. Body is medium sized and compact
2. Animals have well proportionate body and are of extremely docile in nature.
3. Horns are thick, emerging laterally and end in blunt points.
4. Colour is red with the shades varying from dark red to light. Males are darker than females, when matured, may be almost black on hump, head, feet and tail.



**Fig 2.3 b Red Sindhi : Female**

5. Heavy hump, dewlap and sheath are characteristics of the males.
6. Cows have capacious udder with a tendency to become pendulous in heavy milkers.
7. Average body weight : Male - 450 kg, Female - 295 kg.

#### **Economic importance**

1. Red Sindhi cows have good production potential and the average lactational milk yield is 1800 kg.
2. The average age at first calving is 46 months.
3. The inter calving period is 500 days.
4. Bullocks of this breed are suited for road and field work. They are hardy and resistant to various diseases.
5. Red Sindhi cattle have capacity to adopt to different climatic conditions, hence the bulls are being used to grade up the local stock.

In Australia, Red Sindhi have been successfully used in crossing with British breeds to produce tropical beef types.

#### **Can you tell ?**

**Average lactational milk yield of Red Sindhi cow**



#### **2.3.3 Gir**

**Synonyms :** *Kahtiwari, Surti, Decan.*

**Origin and Habitat :** Gir is originated in South-West region of Gujarat State and have spread to neighbouring Maharashtra and Rajasthan. The native tract of breed is Gir forest and hilly mounds of Kathiawar

#### **Prominent characteristics**

1. The body is robust and well proportionate.
2. Colour varies from shades of red and white to almost black and white or entirely red.
3. Forehead is prominent, convexly bulged out and broad like a bony shield. This overhangs eyes in such a way that they appear to be partially closed and it gives sleepy appearance to animal.
4. Ears are long, pendulous, drooping resembling like a curling leaf with a notch at the tip.



Fig. 2.4 a Gir : Male



Fig. 2.4 b Gir : Female

5. Horns are curved, turning back at the tip.
6. Animals have moderately developed dewlap.
7. Males have large and pendulous sheath.
8. The tail is long and whip like.
9. The udder is well developed, round in shape and teat tips are round.
10. Average body weight : Male - 544 kg, Female - 386 kg.

#### Economic importance

1. Gir cows are good milkers and average lactational milk yield is 1750 kg.
2. Average age at first calving is 50 months.
3. The inter calving period is 500 days.
4. Bullocks are heavy and powerful. They are efficient for farm operations for all types of soils.

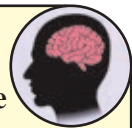
5. The Gir animals are famous for their tolerance to stress conditions. They are resistant to various tropical diseases.

#### Remember..



- The Gir derives its name from the Gir Forest, which is the natural habitat of the breed.
- Gir females have been found as good female parent in crossbreeding programme with elite exotic breeds.

#### Can you recall ?



The powerful draft breed of cattle

#### 2.2.4 Tharparkar

**Synonyms :** *Thari, White Sindhi, Grey Sindhi, Cutchi.*

**Origin and Habitat :** Thari cattle are found in the vicinity of Umarkot, Naukot, Dhoro, Naro, Chhor, Mithi, Islamkot and Khari Ghulam Shah of Rajasthan. Though the origin of Thari is from arid region but the breed is spread in tropical regions too.

#### Prominent characteristics

1. Tharparkar breed is deep, strongly built, medium sized, with straight limbs and well set feet, and with an alert and springy carriage.
2. Body colour is white or gray. In males, the gray color may deepen, particularly on the fore and hind quarters.
3. The head is of medium size, the forehead is broad and flat or slightly convex above the eyes.
4. The poll is broad, the front of the horns and face are practically on one plane.

5. The skin between the eyes is often wrinkled, the wrinkles running perpendicularly.
6. The eyes are full and bright. The eyelashes are black and there is a small ring of black skin on the eyelids.
7. The ears are somewhat long, broad and semi-pendulous and face forward.



Fig. 2.5 a Tharparkar : Male



Fig. 2.5 b Tharparkar : Female

8. Horns are set well apart curving gradually upwards and outwards in the same line as that of the poll with blunt points inclined inwards.
9. The hump in males is moderately well developed, firm and placed in front of the withers.
10. The dewlap is of medium size and the skin is fine and mellow.
11. The sheath in the males is of moderate length and is semi-pendulous.

12. The navel flap in the females is prominent.
13. The hooves are hard and black, of moderate size and have no tendency to turn out.
14. Udder is moderately developed with three to four inches long teats, with symmetrical placement.
15. Average body weight : Male - 550 kg, Female - 408 kg.

### Economic importance

1. The average lactational milk yield is 1600 kg.
2. The average age at first calving is 42 months.
3. The inter calving period is 550 days.
4. Bullocks are suited for carting and ploughing.
5. They are efficient, sturdy, with a medium speed.

## 2.3 DUAL PURPOSE

### 2.3.1 Deoni

**Synonyms :** *Dongarpatti, Dongari*

**Origin and Habitat :** The origin of Deoni cattle is by way of breeding of local animals with Gir. The home tract of Deoni is Latur district of Maharashtra and adjoining area of Andhra Pradesh and Karnataka. The breeding tract of Deoni cattle lies in Balaghat range of the Sahyadri hills.

### Prominent characteristics

1. Deoni is a medium heavy animal.
2. Body colour is clear white in *Wannera* and *Balankya* strain, whereas irregular black spots are seen all over the white body in *Shevera*.
3. Body is moderately developed symmetrical with clearly defined muscles.

4. Head is masculine, alert, broad, slightly convex and held high on the apex of the neck with a majestic look.
5. Fore head is prominent, broad and slightly bulging.
6. Ears are long, drooping with slightly curved tips.



Fig. 2.6 a Deoni : Male



Fig. 2.6 b Deoni : Female

7. Horns are medium, thick, apart, emerging from the sides of the poll behind and above the eyes in outward and again curving upward direction.
8. Eyes are prominent, bright and alert.
9. Hump is massive and well developed in males.
10. Chest is deep and wide, with well sprung ribs.
11. Skin is thick and loosely attached with the body.

12. Dewlap and sheath are medium and pendulous.
13. Tail is long whip like, reaching below the hock joint with black and white mixed coloured switch.
14. Udder is well attached and medium in size.
15. Average body weight : Male - 600 kg, Female - 400 kg.

#### Do you know ?

- Deoni is an admixture of Gir, Dangi and local cattle.
- *Wannera* (Black face with white body), *Balankya* (Complete White) and *Shevera* are the three strains of Deoni cattle according to their colour pattern
- Superior draft capacity, tolerant to diseases, adapted to tropical climate and tolerant to drought conditions are excellent qualities of Deoni breed.

#### Economic importance

1. The average lactational milk yield is 860 kg.
2. The average age at first calving is 43 months.
3. The inter calving period is 447 days.

#### Remember..

Deoni animals are used for cross breeding with Holstein Friesian breed to develop Holdeo crossbreds.

#### 2.3.2 Ongole

**Synonym :** *Nellore*.

**Origin and habitat :** This breed is found in Ongole taluka of Nellore, Guntur and Prakasam districts of Andhra Pradesh.



### Prominent characteristics

1. The Ongole cattle are large sized animals
2. Animals have long body and short neck.
3. They have glossy white coat colour called *padakateeru*. The male has dark gray markings on the head, neck and hump.



Fig. 2.7 a Ongole : Male



Fig. 2.7 b Ongole : Female

4. Face is short with greater breadth of forehead and muzzle.
5. Eyes are large, prominent and heavy looking, elliptical in shape.
6. Ears are moderately long and slightly in drooping position.
7. Horns are short and stumpy, growing outwards and backwards.
8. The hump in the males is well developed and erect.
9. Tail is long with black switch and touching to the ground.

10. Average body weight: Male - 600 kg, Female - 375 kg.

### Economic importance

1. Cows are medium milkers and average lactational milk yield is 700 kg.
2. The average age at first calving is 50 months.
3. The intercalving period is 550 days.
4. Bullocks are heavy and medium workers.

### 2.3.3 Kankrej

**Synonym :** *Nandibail*

**Origin and habitat :** Kankrej breed is originated in Mehsana, Kutch, Ahmedabad, Kheda, Sabarkantha, Banaskantha districts of Gujarat and Rajasthan states. Good herds of Kankrej animals are also seen in areas of sugar factories in Maharashtra.

### Prominent characteristics

1. Kankrej is one of the heaviest Indian breeds with broad chest.



Fig. 2.8 a Kankrej : Male

2. Body colour varies from silver grey to iron grey with thick skin.
3. Hump is large and dewlap is moderate.
4. Face is short with large ears and lyre-shaped horns.
5. The gait is particular to the breed known as  $1\frac{1}{4}$  spaces (*Sawaichal*) with smooth movement of the body keeping the head noticeably high.



**Fig.2.8 b Kankrej Female**

6. Average body weight : Male - 530kg, Female - 375kg.

**Economic importance**

1. Cows are fairly good milkers and average lactational milk yield is 1000 kg.
2. The average age at first calving is 50 months.
3. The inter calving period is 550 days.
4. Bullocks are heavy to medium workers.

**Do you know !**

Kankrej breed is famous for particular walking type of gait known as *Sawaichal*.



**2.3.4 Hariana**

**Synonym :** Nil.

**Origin and habitat :** The breed is originated in east Punjab and is now extensively found in Rohtak, Hissar, Gurgaon, Karnal and Delhi regions.

**Prominent characteristics**

1. Proportionate body with compact graceful appearance.
2. Popular colour is white or light grey.
3. Head is carried high, horns are stumpy and short, curving upward and inward.
4. Face is long and narrow, flat forehead and a bony prominence in the centre of the poll. Ears are small and sharp.

5. Sheath is short and navel flap is rudimentary.
6. Legs are moderately long and lean. Pin bones are prominent and far apart in females but close in males.



**Fig. 2.9 a Hariana : Male**



**Fig. 2.9 b Hariana : Female**

7. Tail is short, thin and tapering with a black switch reaching just below the hocks.
8. The average body weight: Male - 430kg, Female - 310kg.

**Economic importance**

1. Average lactational milk yield is 800 kg.
2. Age at first calving is 47 months.
3. The inter calving period is 425 days.
4. The bullocks are good working animals for fast ploughing and road transport.

## 2.4 DRAFT PURPOSE

### 2.4.1 Khillar

**Synonyms :** *Hanam, Khillari.*

**Origin and habitat :** The breed originates from Solapur, Satara and Sangli districts of Maharashtra. The good animals are also seen in adjoining part of Karnataka.

#### Remember...

The variety Hanam Khillar or sometimes known as 'Atpadi Mahal' is prevalent in the southern Maharashtra. In Solapur and Satara districts and their adjoining areas the breed is known as 'Mhaswad Khillar' in the Khandesh, as Tapi Khillar or Thillari. A type of more recent origin is known as Nakali Khillar.



#### Prominent characteristics

1. The typical Khillar animal has compact body, tight skin, with clean cut features and the gait.
2. There is a slight rise in the level of the back towards the pelvis.
3. The ribs are well sprung and give the trunk a barrel shape.
4. The gait of the Khillar is quick and spirited.
5. Khillar of the Deccan plateau, the Mhaswad and the Atpadi Mahal types are greyish white in colour.
6. The colour in the males is deeper over the forequarters and hindquarters, with peculiar gray and white mottle marking on the face.
7. The Tapi Khillar is white with carrot nose and carrot hooves.
8. The *Nakali* Khillar is gray with tawny or brickdust colour over the forequarters.



Fig. 2.10 a Khillar : Male



Fig. 2.10 b Khillar : Female

9. Newly born calves have rust-red coloured polls, but this colour disappears within a couple of month.
10. Average body weight : Male - 362kg, Female - 294kg.

#### Economic importance

1. Average lactational milk yield is 400 kg.
2. Age at first calving is 1500 days.
3. The breed is highly valued as fast paced, powerful draft animals.
4. Khillar animals have hard red hooves and are extremely fit for draft purpose hence always fetch very good price.

#### Try this...

Get information about different cattle breeds reared in your area



5. They are mostly used for agricultural operations and transport of goods.
6. Males of Khillar often become furious and develop revenge taking attitude if ill-treated.

#### 2.4.2 Dangi

**Synonyms :** *Kalkheri, Sonkheri.*

**Origin and habitat :** Dangi have taken their name from the home tract of its origin in the Dang in then Bombay State; it is a hilly tract with heavy rainfall. Best individuals are found in Ahmednagar and Nashik districts of Maharashtra and adjacent area of Gujarat State.

#### Prominent characteristics

1. The Dangi animals are broken red and white or black and white coloured.



Fig. 2.11 a Dangi : Male



Fig. 2.11 b Dangi : Female

2. The animals are of medium in size, with deep body and generally of ponderous built.
3. The head is usually small with a slightly protruding forehead. The muzzle is large.
4. The horns are generally short and thick. The ears are small.
5. The legs are short and stout. The hooves are exceptionally hardy, being black and flint-like.
6. The dewlap is slightly pendulous. The sheath, though loose, is not excessively pendulous.
7. The hump is of medium size and firm.
8. The skin is oily and of medium thickness and the coat is shiny. It facilitates fast movements of water from body surface during rainy-days.
9. Average body weight : Male - 550kg, Female - 375kg.

#### Economic importance

1. The cows are poor milkers. Average lactational milk yield is 700 kg.
2. Age at first calving is 1600 days.
3. Dangi bullocks are primarily medium-slow draft animals.
4. The breed is known for its excellence in working qualities under heavy rain and marshy fields in Konkan region of Maharashtra states and adjoining parts of Gujarat and also on the hilly tracts.
5. The cattle are extremely hardy and thrive well in hilly and heavy rainfall tract.

#### Remember...

Dangi animals exude an oily secretion which protects the skin and body from heavy rain.



### 2.4.3 Red Kandhari

**Synonym :** *Lal Kandhari*.

**Origin and habitat :** The Red Kandhari cattle are found in the purest form in Kandhar, Mukhed, Nanded, Biloli and Naigaon Tahsils of Nanded district and adjoining pockets of Ahmedpur, Chakur, Shirur Anantpal, Ausa and Udgir tahsils of Latur district, Parli tahsil of Beed and Hingoli tahsil of Hingoli district in Marathwada region.

#### Prominent characteristics

1. Red Kandhari is a medium sized, strong and robust animal.
2. The body is compact squarely built with well proportionate limbs
3. The bull has a majestic gait.
4. The colour of the breed is uniform deep dark-red, but variations from a dull red to almost dark brown are also found.



Fig. 2.12 a Red Kandhari : Male



Fig. 2.12 b Red Kandhari : Female

5. The head is moderate in size, well proportionate with clear cut outlines.
6. Forehead is broad between eyes and is slightly bulging.
7. Ears are long, slightly drooping sideways and have rounded tips.
8. Eyes are shining with a black colour around the eye. Muzzle is black.
9. Horns are evenly curved and are of medium size.
10. Coronet is black.
11. Dewlap is of medium size with few folds. Hump is tightly formed and large in males.
12. Tail is fairly broad, tapering and is moderately long with a good black switch which extends well below the hocks and reaching coronet.
13. Udder is small and tucked up above the belly line, teats are small but squarely placed.
14. Average body weight : Male - 430kg, Female - 350kg.

#### Do you know ?

Being highly efficient in farm operations and carting, Red Kandhari animals are sold at considerably high price in the cattle markets.



#### Economic importance

1. The cows are poor milkers. Average lactational milk yield is 600 kg.
2. Age at first calving is 1200 days.
3. The bullocks are used mainly for draft purpose. Different agricultural operations like ploughing and carting are efficiently done.

#### 2.4.4 Gaolao

**Synonym :** *Gawali*

**Origin and habitat :** Good Gaolao animals are seen in Southern Madhya Pradesh and Vidarbha region of Maharashtra. The Gaolao is predominantly located in Arvi and Karanja tahsils and the adjoining villages of Wardha and Nagpur districts of Maharashtra and Chhindwara in Chhattisgarh.

#### Prominent characteristics

1. Gaolao animals are medium in height, lightly built and tend to be narrow and long.
2. Females are usually white and males are gray over the neck, hump and quarters.



**Fig. 2.13 a Gaolao : Male**



**Fig. 2.13 b Gaolao : Female**

3. The head is markedly long narrow with a straight profile.
4. Adult individuals show roman nose like appearance of the forehead. The forehead is usually flat, though it appears rigid at the top, giving a slightly convex appearance.
5. The eyes are almond-shaped and placed slightly at angles.
6. The ears are of medium size and are carried high.
7. The horns are short and stumpy, blunt at each points and commonly slope slightly backwards.
8. The neck is short, with a moderately well-developed hump, which is usually loose and hangs on one side.
9. Hooves are of medium size, hard and durable, and suited to hard road and hillside work.
10. The dewlap is large and voluminous but the sheath is moderately developed.
11. The skin is thin but loose.
12. The tail is comparatively short, reaching only a little below the hocks.
13. Average body weight: Male - 431kg, Female - 340kg.

#### Economic importance

1. Average lactational milk yield is 700 kg.
2. Age at first calving is 1300 days.
3. Bullocks are good for fast-trotting type draft work suitable for quick transport in the hilly areas.
4. The Gaolao are excellent for transportation and agriculture operations under hot and dry conditions of Vidarbha region.
5. It is a small and compact breed having good disease resistance capacity.

### 2.4.5 Konkan Kapila

**Synonym:** *Kali Kapila*

**Origin and habitat :** The breed is originated from Sindhudurg, Ratnagiri, Raigad, Thane and Palghar districts of Konkan region of Maharashtra and adjoining area of Goa state.

#### Prominent characteristics

1. Colour is generally black or reddish however, brown, white and mixed coloured animals are observed.



Fig. 2.14 a Konkan Kapila : Male



Fig. 2.14 b Konkan Kapila : Female

2. Body is small in size and compact.
3. Head is small and straight. Forehead is sometimes slightly concave.
4. Horns are grey in colour, cylindrical, straight, outward and backward.

5. Hump and dewlap is small and medium size.
6. Ears are short, erect and horizontal in orientation.
7. Udder is small in size and teats are cylindrical with pointed and rounded tips.
8. Tail is broad at base and tapering towards the end with large tuft of black hairs.

#### Economic importance

1. Average lactational milk yield is 500 kg.
2. Age at first calving is 1450 days.
3. The Konkan Kapila individuals are hardy and well survive in hot and humid conditions of coastal area of Maharashtra and Goa.

## 2.5 EXOTIC BREEDS

### 2.5.1 Holstein Friesian

**Origin and habitat :** Friesland, Holland, spread all over the world in different countries.

#### Remember...

Holstein Friesian is an excellent dairy breed.



#### Prominent characteristics

1. Animals of this breed are ruggedly built and possess large and capacious barrel.
2. Colour is black and white with irregular patches not blended.



Fig. 2.15 a Holstein Friesian : Male

3. The head is long narrow and straight.
4. Body is wedge shaped and voluminous.
5. Chest is big, wither is rounded and navel is loose.
6. Thighs are straight.
7. Udder is capacious and voluminous with prominent milk veins.



Fig. 2.15 b Holstein Friesian : Female

**Remember...**

Holdeo is cross between Holstein Friesian and Deoni cattle.



8. Tail is long with white switch.
9. Average body weight : Male -1000kg, Female - 675kg.

**Economic importance**

1. Average lactational milk yield is 6000 kg.
2. Age at first calving is 780 days.
3. They are excellent grazers.

**2.5.2 Jersey**

**Origin and habitat:** Island Jersey in English Channel.

**Prominent characteristics**

1. Body is compact with medium size.
2. The colour is fawn with or without white markings. The muzzle is black with light coloured encircling rings.
3. The wedges are having straight top line.



Fig. 2.16 a Jersey : Male



Fig. 2.16 b Jersey : Female

4. Head is comparatively tight. Forehead is double dished.
5. The back is straight and runs in level with sharp withers.
6. Animals are hardy and fine skinned.
7. The udder is large capacious with well placed teats.
8. The horns are small and tapering toward the tip and grow forward and curved inside at the tips.
9. The ears are small and the eyes are protruding.
10. Average body weight : Male - 675kg, Female - 450kg.

**Do you know ?**

Jersey is the small sized dairy breed.





### Economic importance

1. Milk of this breed is in large demand in butter industries because milk is yellow in colour with fat globules large in size.
2. Average lactational milk yield is 4000 kg.
3. Age at first calving is 690 days.
4. The breed can withstand tropical humid climate more than other exotic breeds. Jersey survives on medium quality pasture.



Fig. 2.17 a Brown Swiss : Male

#### Remember...

Phule Triveni is a three breed cross developed from Holstein Friesian, Jersey and Gir breeds at Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar.



### 2.5.3 Brown Swiss

Origin and habitat : Switzerland

#### Remember...

Brown Swiss is a docile breed and tolerant to more heat.



#### Prominent characteristics

1. Body is large, wedge shaped. The head is broad and dished.
2. The skin is thick but loose.
3. The colour varies from silver to dark brown.
4. The horns are whitish in colour with black tips and medium in length. They grow forward, upward and outward.
5. The udder is large and capacious.
6. Average body weight : Male - 900kg, Female - 625kg.



Fig. 2.17 b Brown Swiss : Female

#### Economic importance

1. Average lactational milk yield is 5000 kg.
2. Age at first calving is 900 days.
3. Cattle are hardy and long living.
4. They are also used for beef production.

#### Internet my friend

- Collect information about NBAGR
- Collect information about newly recognized cattle breeds
- How many cattle breeds are recognised now in India?



**EXERCISES**

**Q.1 Fill in the blanks.**

1. The best breed of cattle in Indian subcontinent is .....
2. The area of Sind called ..... is the real breeding tract of Red Sindhi.
3. .... is the cattle breed originated in South West region of Gujarat State.
4. The Kankrej breed is famous for particular walking type of gait known as .....
5. .... is the small sized exotic dairy breed of cattle .
6. .... breed of cattle is typical for quick draft quality and spirited.
7. ...., .... and .... are the three strains of deoni cattle.
8. .... is an excellent exotic dairy breed
9. .... breed of cattle is found in Konkan region of Maharashtra.
10. .... is synonym of Sahiwal cattle.

**Q.2. Identify the odd one out**

1. Dangi, Khillar, Gaolao, Deoni
2. Holdeo, Jersey, HF, Brown Swiss
3. Tharparkar, Sahiwal, Gir, Khillar
4. Jerdeo, Karanswiss, Holdeo, Sahiwal
5. Gir, Sahiwal, Red Sindhi, Red Kandhari

**Q.3. Match the pairs**

Group A		Group B	
1.	Milch Purpose	a.	305 days
2.	Dual Purpose	b.	Sahiwal
3.	Draft Purpose	c.	Jersey
4.	Exotic Breed	d.	Deoni
5.	Lactation Period	e.	Khillar
6.	Dry Period	f.	Holdeo
		g.	60 days
		h.	420 days

**Q.4 Answer the following questions in brief.**

1. Name crossbreds of Maharashtra.
2. Write colour strains of Deoni.
3. Give origin of Haryana.
4. Name milch breeds of cattle.
5. Give name of exotic cattle famous for high fat per cent with yellow colour of milk.
6. Write origin and habitat of Khillar.
7. Write prominent characteristics of Red Kandhari.
8. Give economic importance of Gaolao.
9. Write origin and habitat of Dangi.
10. Write origin and habitat of Jersey.

**Q.5 Answer the following in detail.**

1. Describe origin, prominent characteristics and economic importance of Deoni cattle.
2. Write in detail origin, prominent characteristics and economic importance of Sahiwal cattle.
3. Describe in detail Holstein Friesian breed of cattle.

### 3. BUFFALO BREEDS

#### Can you recall ?



1. Different types of buffalo breeds in India.
2. Famous buffalo breed in India.
3. Black gold of Indian economy.

The buffaloes were domesticated about 5000 years ago from the wild buffaloes still found in India in the Assam forests (*Bubalus arni*). There are two types of buffaloes, namely, riverine and swamp. The riverine buffaloes (2n=50) have been primarily developed for milk and secondarily for meat and draft whereas the swamp buffaloes (2n=48) have been primarily developed for draft and secondarily for meat and milk. Water buffalo (*Bubalus bubalis*) is being raised as an economic animal in about 50 countries of the world. Thus buffalo species is spread in tropical as well as temperate regions of the world. In recent years, the buffalo

commonly known as an 'Asian animal' has attracted global attention. The buffalo is the dairy, draft and meat animal of Asia. The Indian sub-continent is the home tract of the world's best dairy buffaloes. Today the water buffalo (*Bubalus bubalis*) is recognized as the 'milking machine' of India. It accounts for nearly half of India's total milk production (49.2 percent).

#### 3.1 CLASSIFICATION OF BREEDS

There are 16 recognized breeds of buffaloes in India. There are few well defined breeds with standard qualities and with specific physical characteristics that differentiate them unmistakably from other types as may be found in various states of the country. These are all milch breeds, but number of animals belonging to these breeds is in small fraction of the total buffalo population of the country. On the basis of regions the well defined buffalo breeds are as follows :

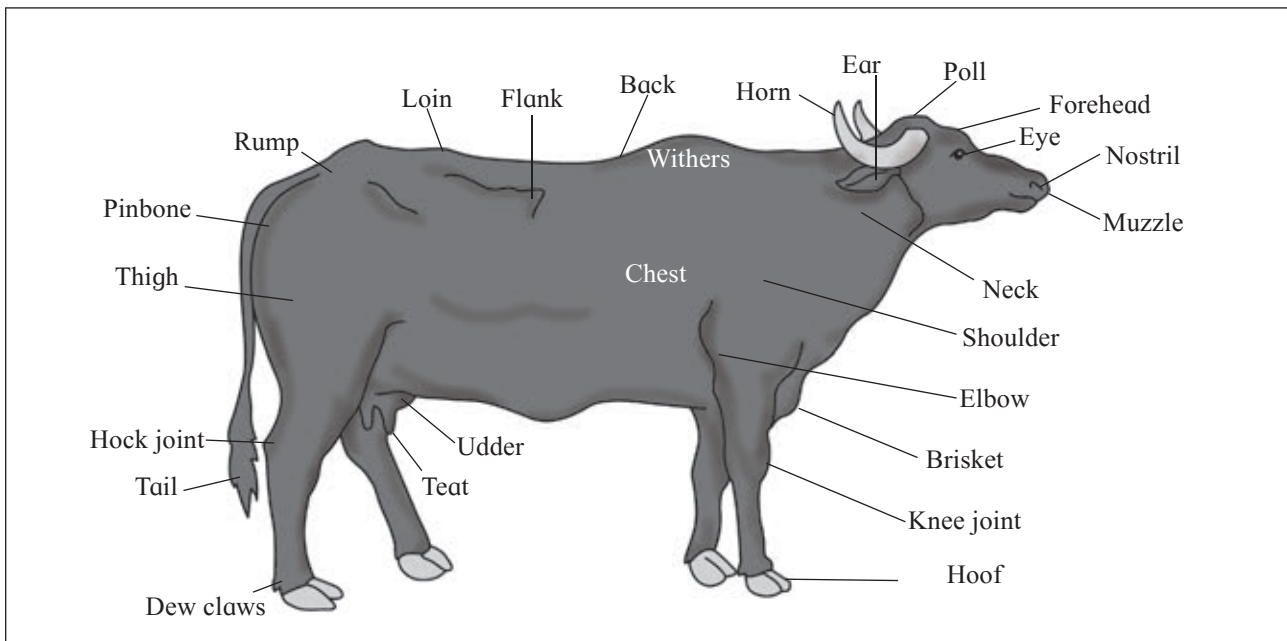


Fig. 3.1 External body parts of buffalo

**Table 3.1 : Classification of buffalo breeds**

North and North-Western	Central Indian	South Indian	Western Indian
1. Bhadawari	1. Chhattisgarhi	1. Bargur	1. Banni
2. Murrah	2. Kalahandi	2. Chilika	2. Jaffarabadi
3. Nili-Ravi	3. Luit (Swamp)	3. Toda	3. Mehsana
	4. Marathwadi		4. Surti
	5. Nagpuri		
	6. Pandharpuri		

**Internet my friend**

- Total number of recognized breeds in India.



**Can you tell ?**

- Buffalo breeds of Maharashtra
- Black Gold of Maharashtra



**3.2 BUFFALO BREEDS**

**3.2.1 Murrah**

**Synonym :** *Delhi*

**Origin and habitat:** The home tract of Murrah is Rohtak in Haryana state. Rohtak, Hissar and Gurgaon districts of Haryana and Delhi have a large population of Murrah animals. High yielding Murrah animals are also found in the adjoining areas of Uttar Pradesh and Punjab. It has now been spread in almost all the milk producing states.

**Prominent characteristics**

1. The colour is jet black and large in size with long and deep body.



**Fig. 3.2 a Murrah : Male**



**Fig. 3.2 b Murrah : Female**

2. The front portion of body in females is light and narrow, and the rear portion is heavy presenting a wedge shaped appearance. Females have short, fine and clear cut head.
3. Horns are short turning backward and upward and finally tightly curled inward in the spiral form.
4. Bulls are heavy and broad with prominent cushion of short and dense hair.
5. The forehead is broad and prominent.
6. The nostrils are wide apart. Eyes are bright, active and prominent in females but slightly shrunken in males.
7. Ears are short, thin and alert.

8. The udder is well developed, capacious with prominent milk veins and squarely placed large teats. Teats are long and placed uniformly wide apart. Rear teats are generally longer than fore teats.
9. The hocks are nearly straight in males but somewhat bent in females. Hips are broad.
10. The tail is generally long and flexible reaching up to the fetlocks. Tail switch is white.
11. Average body weight is 552 Kg.

#### Economic importance

1. The average age at first calving is 46 months.
2. Average lactational milk yield is 1914 kg.
3. Average milk fat per cent is 7.66.
4. The average inter calving period is 454 days.

#### Remember...

Murrah is among the elite dairy breeds of buffaloes and is used for grading up of local non-descript buffaloes.



#### 3.2.2 Surti

**Synonyms** :*Decani, Deshi, Gujarat, Nadiad and Talabda*

**Origin and habitat** :The home tract is in the South-Western parts of Gujarat. Best animals are found in Anand, Nadiad, Khaira and Baroda districts covering a vast area between Mahai and Sabarmati rivers.

#### Prominent characteristics

1. Surti animals are of medium size with straight back and low legs. The buffaloes are brown (*bhurra*) or rarely black in appearance.
2. The hair in several specimens appears greyish brown.

3. A characteristic feature is the presence of two white collars (chevrons); one around jaw from ear to ear and the other on brisket. There may be a streak of white hair above the eyes. The region below the knees and hocks has a whitish or grey tuft of hair.



Fig. 3.3 a Surti : Male



Fig. 3.3 b Surti : Female

4. The horns are sickle shaped, curling downward and backward and then inward in terminal portion. The tip of the horn forms a characteristic hook.
5. Tail is fairly long, thin and flexible ending in a white tuft.
6. The hips of Surti females are broad and flat.
7. The udder is well developed; it is pinkish in appearance, finely shaped and squarely placed between the hind legs.
8. The average body weight is 462 Kg.

**Economic importance**

1. Age at first calving is 53 months.
2. Average lactational milk yield is 1547 kg.
3. The average milk fat is 8.10%.
4. The average inter calving period is 510 days.
5. Animals consume less feed.

**Do you know ?**

The Surti buffalo is a economic feeder and thrives well on both limited and without green and produces milk with higher fat and SNF content.



4. The horns are generally sickle-shaped with the curve more upward than the Surti and less curved than in Murrah.
5. The Mehsana animals are longer than local Murrah with lighter limbs but slightly longer and heavier head.



**Fig. 3.4 b Mehsana : Female**

**3.2.3 Mehsana**

**Origin and habitat :**The home tract is in areas around Mehsana and Ahmedabad districts of Gujarat. The rural areas of Patan, Sidhpur, Kadi Radhanpur, Banaskantha and Sabarkantha have large herds of Mehsana buffaloes.

**Prominent characteristics**

1. Mehsana animals are intermediate between Murrah and Surti.



**Fig. 3.4 a Mehsana : Male**

2. The body colour is mostly black. A few animals are black-brown or brown.
3. The forehead is wide with slight depression in the middle, sloping towards root of horns.

6. The muzzle is wide with widely open nostrils.
7. The eyes appear prominent, bulging from the sockets with folds of skin on upper eyelid.
8. The udder is attached high in the back and carried well. Milk veins are prominent.
9. The average body weight is 595 kg.

**Remember..**

- It is believed that Mehsana breed arose from interbreeding between Murrah and Surti breeds.
- Mehsana breed is reputed for regular breeding and persistent milking



**Economic importance**

1. Age at first calving is 42 months.
2. Average lactational milk yield is 1988 kg.
3. The average milk fat is 7.60 percent.
4. The average inter calving period is 490 days.

### 3.2.4 Jaffarabadi

**Synonyms :** *Jaffari, Gir, Bhavnagari*

**Do you know ?**

**Jaffarabadi breed is the heaviest among buffalo breeds of India.**



**Origin and habitat :** This breed is originated from Gir forests of Kathiawar. The breed is found mainly in Saurashtra region of Gujrat spread over Junagarh, Bhavnagar, Amreli and Rajkot districts. It derives its name from the town of Jaffarabad.

**Prominent characteristics**

1. The animals are characterized by relatively long body, a loose frame and have a large built.
2. The head and neck are massive and dewlap is prominent.



**Fig. 3.5 a Jaffarabadi : Male**



**Fig. 3.5 b Jaffarabadi : Female**

3. The bone of forehead widens and covers the eyes to give ‘sleepy eye appearance’ especially in males.
4. The horns are heavy and broad inclined to drop on each side of the neck and slightly adjacent close to tip. Horns form an incomplete curl which is not so tight like Murrah.
5. A typical Jaffarabadi specimen is black in colour, but animals of grey and copper are also available.
6. The average body weight is 545 kg.

**Economic importance**

1. Age at first calving is 65 months.
2. Average lactational milk yield is 2031 kg.
3. The average milk fat is 7 to 8.50%.
4. The average inter calving period is 509 days.

### 3.2.5 Nagpuri

**Synonyms :** *Purnathadi, Berari, Ellichpuri and Gaulani.*

**Do you know ?**

**Nagpuri buffalo breed has four distinct strains, viz. Purnathadi (Akola district), Ellichpuri (Amravati District), Gaulani and Nagpuri (Nagpur District)**



**Origin and habitat :** The home tract of Nagpuri breed lies in Vidarbha Region of Maharashtra extending from Nagpur to Western parts of Amravati district. Akola, Chandrapur, Bhandara, Buldhana, Wardha and Yavatmal district have sizeable population of Nagpuri buffaloes.

**Prominent characteristics**

1. Nagpuri buffaloes are of light built with a long narrow head and neck.
2. A characteristic features of Nagpuri buffalo is long flat curved horns which extend on the either side of neck reaching up to the shoulders



**Fig. 3.6 a Nagpuri : Male**



**Fig. 3.6 b Nagpuri : Female**

3. The face is long and thin, cone shaped with straight nasal bone.
4. The ears are medium in size with pointed tips.
5. The colour is usually black with white patches on face, legs and tips of the tail. Purnathadi strain is slightly brownish with a predominant white patch on forehead.
6. The limbs are somewhat long, light and slender. Tail reaches a little below hocks and has white switch.
7. The average body weight is 450 kg.

**Economic importance**

1. Age at first calving is 55 months.
2. Average lactational milk yield is 1036 kg.
3. The average milk fat is 7.90%.
4. The average inter calving period is 510 days.

**Remember...**



**Nagpuri buffaloes are used for heavy draft purpose in paddy fields of Bhandara, Chandrapur and Gadchiroli districts.**

**3.1.6 Pandharpuri**

**Origin and habitat :** Pandharpuri buffaloes are found in Solapur, Kolhapur, Satara and Sangli districts of Western Maharashtra.

**Prominent characteristics**

1. The animals are medium sized and having long and compact body.
2. The animals have long and narrow face with prominent nasal bone.
3. The neck is comparatively longer and thin.
4. The body colour varies from light black to dark black.
5. The horns are very long, sword shaped almost up to the back and twisted outwards.
7. The udder is medium sized, compact and somewhat hidden in between hind quarters with well placed teats.
8. The average body weight is 420 kg.

**Economic importance**

1. Age at first calving is 43 months.
2. Average lactational milk yield is 1475 kg.
3. The average milk fat is 7.80%.
4. The average inter calving period is 452 days.





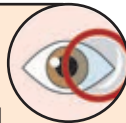
Fig. 3.7 a Pandharpuri : Male



Fig. 3.7 b Pandharpuri : Female

**Observe that...**

- The Pandharpuri buffaloes are mild in temperament and hardy.
- The Pandharpuri buffaloes are consumer friendly by way of allowing door to door milking for milk quality satisfaction of consumers.



### 3.1.7 Marathwadi

**Origin and habitat :** Marathwadi buffalo breed is located in the districts of Beed, Parbhani, Jalna and parts of Nanded and Latur districts of Marathwada region.

#### Prominent characteristics

1. The animal is light medium sized with compact stature.

2. Skin and coat colour varies from greyish black to jet black. White markings on the face, legs and switch are also sometimes found (*Chandri*).
3. The horns are medium long, parallel to neck, reaching up to the shoulder but never beyond shoulder blade and usually not flat.
4. The forehead is moderately broad and eyes are generally red tinged.
5. The ears are drooping. Neck is longer with heavy brisket.
6. Limbs are long and light. Tail is moderately long running below the hock with white switch.
7. The average body weight is 350 kg.



Fig. 3.8 a Marathwadi : Male



Fig. 3.8 b Marathwadi: Female

**Economic importance**

1. Age at first calving is 52 months.
2. Average lactational milk yield is 1100 kg.
3. The average milk fat is 7.60 percent.
4. The average inter calving period is 530 days.

**Do you know !**

- Marathwadi buffaloes are of short stature and can tolerate drought.
- Males are used for draft and transportation in hilly tract.



**Observe and identify following breed ?**



**EXERCISES**

**Q.1 Fill in the blanks.**

1. .... is the heaviest breed of buffalo.
2. The home tract of .....buffalo breed is Haryana state of India.
3. .... buffalo breed is developed through the cross between Murrah and Surti.
4. In the Vidarbha region ..... breed is used for heavy draft purpose in paddy fields.
5. The horns of .....buffalo breed are parallel to neck and reaching upto the shoulder point.

2. In Bhandara, Chandrapur and Gadchiroli districts, Nagpuri buffaloes are used in paddy fields
3. Mehsana breed is developed from interbreeding between Murrah and Surti breed
4. Delhi buffalo is also known as Murrah buffalo

**Q.2 True or False.**

1. Marathwadi male used for transportation in hilly region

**Q.3 Make the Pairs.**

Group A		Group B	
1.	Mehsana	a)	Deccani
2.	Murrah	b)	Crossbred buffalo
3.	Surti	c)	Tightly curled horns
4.	Jaffarabadi	d)	Ellichpuri
5.	Nagpuri	e)	Bhavnagari
		f)	Marathwada
		g)	Sword shaped horns

**Q.4 Answer the following questions in brief.**

1. Mention the shape of horns in Nagpuri buffalo.
2. Name the buffalo breeds of Maharashtra.
3. Give age at first calving in Murrah breed.
4. Write the lactational milk yield of Mehsana buffaloes.
5. Mention the shape of horn of Pandharpuri buffaloes.
6. Write origin and habitat of Mehsana buffaloes.
7. Give economic importance of Marathwadi buffaloes.
8. Write the typical characteristics of Nagpuri.
9. Give prominent characteristics of Surti.
10. Write origin and habitat of Jaffarabadi.

**Q.5 Complete the following table.**

North and North-Western	Central Indian	South Indian	Western Indian
	Nagpuri		
Murrah			Mehsana
		Toda	

**Q.6 Answer the following in detail.**

1. Explain prominent characteristics and economic importance of Jaffarabadi buffaloes.
2. Enlist breeds of buffalo. Explain prominent characteristics and economic importance of Murrah buffaloes.
3. Describe origin, prominent characteristics and economic importance of Pandharpuri buffaloes.

## 4. SHEEP AND GOAT BREEDS

### Can you recall ?

- Important small livestock species
- Importance of Sheep and Goat in Indian economy
- Importance of Goat and Sheep Milk, Skin, Wool, Meat etc



### 4.1 CLASSIFICATION OF SHEEP BREEDS

All the sheep have several characteristics in common. Sheep belongs to family *Bovidae* (ruminants), genus *Ovis* and species *aries*. Within this species many different breeds exist.

### Internet my friend

Difference between Sheep and Goats.



### Classification of Indigenous sheep breeds on the basis of agro-ecological regions in India

North Temperate	North-Western Arid and Semi Arid	Southern Peninsular	Eastern
1. Bhakarwal (CW)	1. Chokla (CW)	1. Bellary (MCW)	1. Balangir (MCW)
2. Changthangi (CW)	2. Hissardale (AW)	2. Coimbatore (MCW)	2. Bonpala (MCW)
3. Gaddi (CW)	3. Jaisalmeri (MCW)	3. Deccani (M)	3. Chottanagpuri (MCW)
4. Gurez (CW)	4. Jalauni (MCW)	4. Hassan (M)	4. Ganjam (MCW)
5. Karnah (AW)	5. Kheri (MCW)	5. Kanguri (M)	5. Garole (M)
6. Kashmir Merino (AW)	6. Magra (CW)	6. Kilakarsal (M)	6. Tibetan (CW)
7. Poonchi (CW)	7. Malpura (MCW)	7. Madras Red (M)	7. Kendrapada (MCW)
8. Rampur\Bushair(CW)	8. Marwari (MCW)	8. Mandya (M)	
	9. Muzaffarnagari (MCW)	9. Mecheri (M)	
	10. Nali (CW)	10. Nellore (M)	
	11. Patanwadi (CW)	11. Nilgiri (AW)	
	12. Pugal (MCW)	12. Rammand White (M)	
	13. Sonadi (MCW)	13. Tiruchy Black (M)	
	14. Munjal(M)	14. Vembur (M)	
	15. Panchali (M)		

Within parenthesis is the major product of the breed.

- AW: Apparel wool;
- CW: Carpet wool;
- MCW: Mutton and Carpet wool;
- M: Mutton.

**Internet my friend**



- Total number of recognized sheep breeds in India.

**4.2 SHEEP BREEDS**

**4.2.1 Indian Sheep Breeds**

**1. Deccani**

**Observe and Discuss**



- Observe the sheep breed found in your locality.
- Discuss with the farmers about routine management of their sheep.

**Habitat:** This breed is mostly found in the South-Eastern part of Maharashtra and in the neighbouring areas of Telangana and Karnataka. The breed is widely distributed in several districts which includes Nashik, Pune, Ahmadnagar, Kolhapur, Solapur and Aurangabad districts of Maharashtra state.

**Prominent characteristics**

1. The sheep are strong and hardy.
2. The colour is dominantly black, with some grey and roan strain.
3. The breed has thin neck, a narrow chest, prominent spinal processes, raised withers, flat ribs, drooping croup and poor leg of mutton.



**Fig. 4.1 a Deccani : Male**



**Fig. 4.1 b Deccani : Female**

4. The rams are usually horned and the ewes are polled.
5. The animals have roman nose, lop ears and short tail.
6. The average live weight of ram and ewes is 38 and 28 kg, respectively.

**Do you know !**

According to colour Deccani is classified as **Black Deccani** and **White Deccani**.



**Economic importance**

1. This breed is mostly reared for mutton production.
2. The fleece is coarse and consists of a mixture of wool fibers and hairs in varying proportions.
3. The average annual wool yield is 700g.
4. The wool is usually black, white and grey in colour. Wool is of inferior quality and used for making rough blankets and carpets.

**Do you know ?**

“Madgyal” is one of the unexplored sheep breed of Maharashtra found in and around Madgyal village in Sangli district from which the breed name is derived.





Fig. 4.2 Madgyal



Fig. 4.3 b Merino : Female

#### 4.2.2 Exotic sheep breeds

##### Can you tell ?

Which is the most popular fine wool breed of the World?



##### 1. Merino

**Habitat:** The breed is a native of Spain and is spread all over the world.

##### Prominent characteristics

1. Colour of wool is white and skin is pink.
2. Wrinkles or folds in the skin are the qualities of Merino breed.
3. The head is medium sized and fairly well covered with wool.



Fig. 4.3 a Merino : Male

4. Females are polled.
5. Rams have rather large, heavy, spirally turned horns.
6. The breed is small in size, somewhat upstanding angular.
7. Merino rams and ewes weigh about 75 kg and 65 kg, respectively at the time of maturity.
8. Merinos are extremely hardy, being able to survive under adverse weather and poor grazing conditions.

##### Economic importance

1. It is the most popular fine wool breed of the world.
2. Average fine quality wool yield varies from 4 to 7 kg in rams and 3 to 4 kg in ewes.
3. Wool fiber diameter is 17 to 24 microns and length is 5 to 10 cm

##### Remember...

Merino rams of Australian and German origins have been used in large numbers to produce new breeds of superior quality.



## 2. Rambouillet

**Habitat:** The breed is originated from France and is a descendant of old Spanish Merino.

### Prominent characteristics

1. The colour is white and skin is pink in colour.
2. The breed is hardy and excellent grazer on poor pasture.
3. The breed is the largest one among the fine wool breeds.



Fig. 4.4 a Rambouillet : Male



Fig. 4.4 b Rambouillet : Female

4. Body is heavy , head is carried high and ears are small.
5. Rams have large head and are horned, whereas the ewes are polled.
6. Heavy dense wool extends over the face below eyes and over entire body of the animals.

7. Average body weight of matured ram and ewe is 110 kg and 80 kg, respectively.

### Economic importance

1. The breed is reared for wool and mutton purpose.
2. The breed has the best mutton conformation among all fine wool breeds.
3. Annual wool yield per animal is 4.5 - 5.5 kg.
4. The wool has long staple (5.5 – 7.5 cm), fair density, uniformity and moderate shrinkage.

### Do you know ?



#### Sheep crossbreeds developed in India

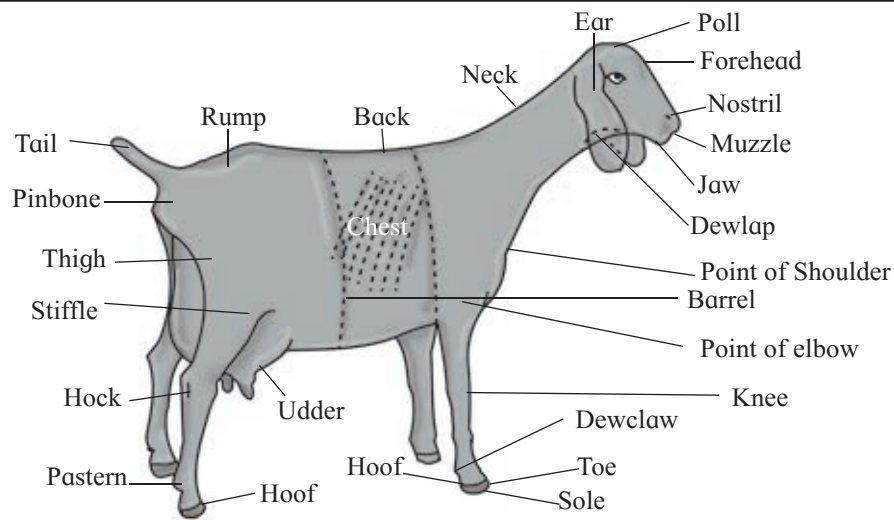
1. Avikalin = Rambouillet × Malpura (Carpet Wool)
2. Avivastra = Rambouillet × Chokla (Fine Wool)
3. Bharat = Chokla / Nali × Merino / merino Rambouillet (Fine Wool)
4. NARI Suwarna = Garole × Deccani (Twinning)

## 4.3 CLASSIFICATION OF GOAT BREEDS

The goat is the earliest ruminant domesticated around 9000-7000 B.C. The goat belongs to the family *Bovidae* (hollow horned ruminants) and sub family *Caprini*, the member of genus *Capra* and species *hircus*. It is estimated that there are about 102 descript breeds of goats in the World. Today, India ranks first for its genetic resources and numerical superiority of goat in the World.

**CLASSIFICATION OF INDIGENOUS GOAT BREEDS  
ON THE BASIS OF REGION**

<b>Temperate Himalayan region</b>	<b>Dry Northern Region</b>	<b>Central region</b>	<b>Southern region</b>	<b>Eastern region</b>
1. Changthangi / Pushmina/ Kashmiri	1. Jamunapari	1. Marwari	1. Surti	1. Ganjam
2. Gaddi (Chamba)	2. Barbari	2. Sirohi	2. Osmanabadi	2. Assam hill
3. Chegu	3. Beetal	3. Mehsana	3. Malbari	3. Black Bengal
4. Bhakarwali	4. Pantaja	4. Zalawadi	4. Kanni Adu	4. Sumi - Ne
	5. Rohilkhandi	5. Kathiwari (Kutchi)	5. Sangamneri	
		6. Jakhrana	6. Kokan kanyal	
		7. Gohilwadi	7. Berari	
		8. Kahmi	8. Attapadi	
			9. Teressa	
			10. Kodi Adu	
			11. Salem Black	
			12. Bidri	
			13. Nandi durga	



**Fig. 4.5 External body parts of the goat**

**Can you tell ?**

- Goat is known as ‘Poor man’s cow.’
- The Goat is ATM for 21<sup>st</sup> century.



**Try this...**

- Study the goat breeds found in your locality and collect their photographs.
- Name the goat breeds of Maharashtra.





## 4.4 GOAT BREEDS

### Internet my friend

- Total number of recognized breeds of goats in India.



### 4.4.1 Indian breeds

#### 1. Osmanabadi

**Habitat:** This breed is originated in Tuljapur and Udgir Taluka of old Osmanabad district of Maharashtra state. The breed is distributed in Latur, Beed, Nanded, Parbhani, Aurangabad, Ahmednagar and Solapur districts of Maharashtra.

#### Prominent characteristics

1. The breed is medium in size and prominently black in colour. Sometimes white and brown colour spotted goats are also found.



Fig 4.6 a Osmanabadi : Male



Fig 4.6 b Osmanabadi : Female

2. Males are generally horned, but females may be horned or polled.
3. Long and pendulous ears with or without spots.
4. Average body weight of adult buck and doe is 34 and 32 kg respectively.
5. Age at first kidding is 19 – 20 months.
6. The average birth weight of kid is 2.4 kg.

#### Economic importance

1. The breed is considered useful both for meat and milk.
2. The breed is mostly used for meat and quality of meat is good with a dressing percentage of 45-50.
3. Milk yield ranges from 0.5 to 1.5 kg per day.
4. The average lactation period is 120 days.
5. Under good management practices kidding is thrice in a two years and twining is common.

#### 2. Sangamneri

**Habitat:** The breed is commonly found in Ahmednagar, Pune and Nashik districts of Maharashtra.

#### Prominent characteristics

1. Sangamneri is medium sized goat breed with long hair.
2. Coat colour of the breed is highly variable i.e. white, black or brown. Some goats with mixed patches are also found.
3. Ears are medium sized and drooping.
4. Horns are medium sized and directed backward and upward in both sexes. .
5. Average live weight of buck and doe are 38 and 29 kg, respectively.



Fig 4.7 a Sangamneri : Male



Fig 4.7 b Sangamneri : Female

2. Ears are black with white margin, flat open, long drooping.
3. Horns are backward, straight and pointed.
4. Forehead is flat and broad, black in colour.



Fig 4.8 a Kokan Kanyal : Male



Fig 4.8 b Kokan Kanyal : Female

6. The average birth weight of kid is 1.9 kg.
7. Average age at first kidding is 18 months

#### Economic importance

1. Sangamneri is useful for both meat and milk.
2. Quality of meat is good with a dressing percentage of 41-46.
3. The breed produces 165 kg of milk in a lactation period of 150 days.
4. Kidding occurs thrice in two year. Doe produces single or twins

#### 3. Konkan Kanyal

**Habitat:** The breed is predominantly found in Sindhudurg district of Maharashtra.

#### Prominent characteristics

1. Colour is black, with white markings on collar and lower jaw, ventral surface white.

#### Economic importance:

1. Birth weight ranges from 1.5 to 2.5 Kg.
2. Adult body weight ranges from 32 to 35 Kg in male while 25 to 30 Kg in female.
3. Goats are regular breeders and breed round the year.
4. Twinning percentage is 66.00.

#### 4. Berari

**Habitat:** Originated from Berar region of Central Province which is recently known as Vidarbha region of Maharashtra state. Goats are found in Vidarbha region particularly in Nagpur, Wardha, Amravati and Akola districts.

### Prominent characteristics

1. Coat colour varies from dark tan to light tan, Light to dark strip on lateral sides from base of horn to nostrils, black colour ring around neck in adult male.
2. Black hair line along with the vertebral column extending up to tail in both sexes was observed as unique characteristic in Berari goat.



Fig 4.9 a Berari : Male



Fig 4.9 b Berari : Female

3. Forehead is convex.
4. Ears are pendulous (drooping), flat and leafy

### Economic importance

1. Adult body weight is 34 kg in male and adult female weighed around 28 kg.
2. Age at first kidding is 14 to 15 months.
3. Twinning is around 35 percent.

4. Daily milk production is 530 g and milk yield per lactation is 78 kg with lactation length of 130 days.

### 5. Jamunapari

**Do you know ?**

**Jamunapari is know as milk Queen of India**



**Habitat:** The breed is originated in between the region of Jamuna, Ganges and Chambal rivers. The breed is mostly found in Etawah, Agra, Mathura, Chakar nagar and Batpura districts of Uttar Pradesh.

### Prominent characteristics

1. Jamunapari is the biggest and majestic goat breed of India.
2. The colour of the breed is generally white or light yellowish tan with light brown spots on the neck and face. Sometimes black or tan coloured spots are found on body.



Fig 4.10 a Jamunapari : Male



Fig 4.10 b Jamunapari : Female

3. The typical character of the breed is highly convex nose with a tuft of hair known as “*Roman nose*” or “*Parrot mouth*” appearance.
4. Ears are too long (20 to 25 cm), pendulous and tubular.
5. Horns are present in both sexes and are short and flat.
6. Tail is short and thin.
7. Thick hairy portion is found on buttocks as like feathers, hence known as ‘*Pari*’.
8. Udder is well developed with conical teats.
9. Average live weight of buck and does are 75 and 55 kg, respectively.
10. The average birth weight of kid is up to 4kg.

#### Economic importance

1. The breed is most famous dual purpose breed of India.
2. The breed produces 1.5-2.0 kg of milk per day and the average milk fat is 4-5 percent.
3. Average lactational milk yield is 200 kg.
4. Dressing percentage is 45-48.
5. Usually kidding is once in year. Does give birth to 57 percent single and 43 percent twins.

#### Remember...

Jamunapari breed is extensively used to upgrade indigenous breeds for milk and meat purpose.



#### 6. Black Bengal

**Habitat:** The breed is originated from South Bengal and found in West Bengal, Assam and its adjoining areas.

#### Prominent characteristics

1. The colour of breed is predominantly black, sometimes brown and white strains also noticed.
2. The breed is dwarf in size. Legs are short and straight back.
3. Both sexes are beard.
4. Breed is having soft, glossy and short hairs.
5. Ears are short and neatly upright.



Fig 4.11 a Black Bengal : Male



Fig 4.11 b Black Bengal : Female

6. Horns are 5 – 8 cm long in both sexes and slightly tilted upward or straight.
7. Udder is well set and nicely developed.
8. Average live weight of buck and doe is 15 and 12 kg, respectively.
9. The average age at first kidding is 13 – 15 months.

**Remember...**

**Black Bengal is famous for fine skin (shoe leather), quality meat and prolificacy**



**Economic importance**

1. Breed is reared for meat. Meat of this breed is excellent and palatable.
2. Average lactational yield is 53 kg with 4 – 5 percent fat.
3. Average lactation length is 90 – 120 days.
4. The breed is most prolific and kidding twice in a year.
5. The leather is very fine used to prepare shoes.

**7. Barbari**

**Habitat:** The breed is originated in the city of Barbera of East Africa. In India Barberi is distributed at Etawah, Agra, Mathura, Aligarh district of UP and Bharatpur district of Rajasthan.

**Remember...**

**Barbari is a dwarf breed, highly suited for stall feeding and hence generally found in cities.**



**Fig 4.12 a Barbari : Male**



**Fig 4.12 b Barbari : Female**

**Prominent characteristics**

1. The colour of the breed varies but white with red or tan spots is most common.
2. Barbari is small size goat, legs short, bones fine and wedge shaped body.
3. Ears are small-tubular, erect, cricked, upward and outwards.
4. Horns are medium, slightly twisted, directed upward and backward.
5. Average body weight of buck and doe is 38 and 23 kg respectively.
6. The average birth weight of kid is 1.0 kg
7. The average age of first kidding is 15 - 16 months.

**Economic importance**

1. Barbari is a good milker and highly prolific.
2. Average lactational yield is 112 kg with percent milk fat and average lactation length is 152 days.
3. Barbari is a prolific breeder .Kidding occurs twice in 12 – 15 months with 65 percent twins and 10 percent triplets.
4. Meat quality is very good.

## 8. Changthangi

**Synonyms :** *Pashmina or Kashmiri*

**Habitat:** The breed is predominantly found in Ladakh, Lahul and Spiti valleys and neighbouring area of Himachal Pradesh.

### Prominent characteristics

1. Changthangi breed is also known as Pashmina due to its ability to produce longer and finer hairs i.e. 'pashmina' on the sides and shoulders.
2. Pashmina is a medium sized goat breed predominantly white in colour (50%) and sometimes brown, grey or black.
3. Ears are small, pricked and pointed outwards.



Fig 4.13 a Changthangi : Male



Fig 4.13 b Changthangi : Female

4. Both sexes have large horns, turning outward, upward and inward to form a semicircle but wide variation exists in both shape and size.

5. The breed looks pretty with long coarse hair. Body of the breed is strong with powerful legs.
6. Average body weight of buck and doe is 20 kg.
7. Average age at first kidding is 20 months.
8. The average birth weight of kid is 2.1 kg.

### Economic importance

1. The breed is highly valued for its warm fine delicate fiber (hair) called Pashmina. Pashmina is harvested once in a year in the month of June or July.
2. Average production of Pashmina is 215 gm with a range of 70-500 gm per animal.
3. Kidding occurs once in a year and does generally produce single kid.
4. Does produce enough milk for kid.
5. Meat of the breed is of good quality.

#### Do you know ?

- Pashmina is used for making high quality Kashmiri 'Rug or Shawl', known as Ring Shawl.



## 9. Sirohi

**Habitat:** Sirohi goat is found in Sirohi, Bhilwara, Tonk and Jaipur districts of Rajasthan and Palampur district of Gujarat.

#### Remember...

Sirohi is used for upgradation of goats for meat purpose.



### Prominent characteristics

1. Sirohi goats have a predominantly brown coat, with light or dark brown patches.
2. The coat colour of some goats is completely white, which are found in Ajmer region, hence known as Ajmeri.

3. Some goats are wattled and have medium-sized flat leaf-like drooping ears.
4. Both sexes have small horns, curved upward and backward



Fig 4.14 a Sirohi Male



Fig 4.14 b Sirohi Female

#### Economic importance

1. Sirohi is mainly reared for meat production.
2. Twinning is around 10 percent.
3. Birth weight is 2.5 to 3 Kg
4. Average lactational milk yield is 65 Kg
5. Average lactation length is 120 days

#### Can you tell ?

Which is the best milch purpose goat breed of the World?



#### 4.4.2 Exotic goat breeds

##### 1. Saanen

**Habitat:** The breed is originated in West and North-West Switzerland.

##### Prominent characteristics

1. The breed is white to biscuit coloured with black spots on the nose, ears and udder.
2. The goats are large in size with straight nose and erect ears pointed forward and upward.
3. Bucks are horned whereas does are hornless (Polled).

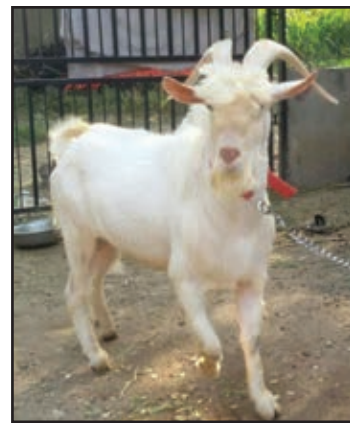


Fig 4.15 a Saanen Male



Fig 4.15 b Saanen Female

#### Remember...

The breed is sensitive to strong sunlight and therefore indoor management is necessary.



4. The body has good dairy conformation and the udder is well developed.
5. Body weight varies from 55-70 kg.

### Economic importance

1. The breed is persistent in milking hence known as 'Milk Queen' of the goat World.
2. Daily milk production is 1.0 – 3.0 kg with 3.5 per cent milk fat.

### 2. Boer

**Habitat:** The Boer goat was developed in South Africa in the early 1900s for meat production. Their name is derived from the Afrikaans (Dutch) word *boer*, meaning farmer. The breed is brought in India in year 1993 by Maharashtra *Sheli Va Mendhi Sanshodhan va Vikas Sanstha* Phaltan, Dist. Satara in the form of embryo and frozen semen.

### Prominent characteristics

1. Boer goats commonly have white bodies and distinctive brown heads.
2. Some Boer goats can be completely brown or white or paint, which means large spots of a different color are on their bodies.
3. Both the sexes have long and pendulous ears.
4. Horns are curved and backward.



Fig 4.16 a Boer Male



Fig 4.16 b Boer Female

### Economic importance

1. This breed is popular for meat.
2. The adult body weight ranges from 80 to 120 Kg, hence the breed is mostly reared for *quorbani* (Sacrifice) *Eid* purpose.
3. Kidding is possible every eight months.
4. Milk production during the first 12 week of lactation ranged from 1.8 to 2.5 kg/day.
5. Dressing percentage is 45.

### Do you know ?

- Central Institute for Research on Goat is located at Makhdoom, District Mathura, Uttar Pradesh.
- Central Sheep and Wool Research Institute is located at Avikanagar, District Tonk, Rajasthan.



**EXERCISES**

**Q.1 Fill in the blanks**

1. The sheep belongs to .....
2. The goat breed of Vidarbha region of Maharashtra is.....
3. The unexplored sheep breed found in Sangli district is .....
4. ....breed of goat found in Ahmednagar district is white in colour
5. .... goat breed is famous for shoe leather.
6. ....breed is known as 'Pari'.
7. ....breed is recognized as 'milk queen' of goat world.

**Q.2 Make the pair**

A		B	
1	Osmanabadi	1	Carpet wool
2	Pashmina	2	Black Coloured
3	Garole	3	NARI Suwarna
4	Deccani	4	Shawl/Fine wool
5	Jamunapari	5	Gujarat
		6	Majestic goat
		7	Fine leather

**Q.3 State true or false**

- 1) Changthangi breed is found in Ladakh.
- 2) The habitat of Sangamneri goat is located in Sangameshwar district.
- 3) Sirohi is good milker and highly prolific.
- 4) Jamunapari is dwarf breed suited for stall feeding.
- 5) Merino is known as milk queen of the Goat world.

**Q.4 Answer in brief.**

1. Write short note on Osmanabadi goat.
2. Give the prominent characteristics of Konkan Kanyal goat.
3. Why Jamunapari is known as 'Pari'?
4. Enlist the crossbreds of sheep developed in India.
5. Give economic importance of Sangamneri goat.

**Q.5 Answer the following questions**

1. Explain the characteristics of Konkan kanyal breed .
2. Write in brief characteristics of Deccani breed of sheep.
3. Complete the following chart.

Sr. No	Name of Breed	Habitat/ Origin	Characteristics
1.	Sangamneri	Sangamner	
2.	.....	.....	Shoe leather
3.	Osmanabadi		
4.	Merino		Fine wool

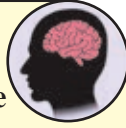
4. Give the typical characteristics of Changthangi Goat.
5. Which exotic breeds are used for cross breeding in sheep, give two typical characteristics.

**Q.6 Answer the following questions in detail**

1. Give agro-ecological classification of Indian Goat/Sheep breeds.
2. Describe in detail the habitat prominent characteristics and economic importance of Deccani/ Merino sheep/Osmanabadi goat/ Jamunapari goat.

## 5. POULTRY BREEDS

### Can you recall ?



1. The types of Indian Pure breeds
2. The importance of backyard poultry and poultry industry in India
3. The meaning of poultry

- The term poultry is used as synonymous to chicken, includes a number of avian species such as chicken, quail, duck, turkey, geese and guinea fowl domesticated for economic purposes.
- There are four species of wild or jungle fowl
  1. *Gallus gallus* (Red jungle fowl)
  2. *Gallus iafayettii* (Ceylon jungle fowl)
  3. *Gallus sonnerattii* (Grey jungle fowl)
  4. *Gallus various* (Javan jungle fowl).
- The relative contribution of these few species to the formation of modern domestic breeds still remains controversial. While some believe that all the present day domestic breeds of poultry are originated from red jungle fowl (*Gallus gallus*). Others are of the opinion that two or more of the four existing wild species of fowl are responsible for the same.

### Remember...



- The term 'class' is used to designate groups of breeds, which have been developed in certain regions.

- A breed refers to a group of domestic fowls with a common ancestry, and having similarity in shape, conformation, growth, temperament and shell colour of egg.
- Variety is a subdivision of breed distinguished either by colour pattern or shape of comb or type of feather pattern.
- Strain is a group of birds within variety that has been bred by one person or firm for some time and has more or less uniform characteristics and capabilities.

### Do you know ?



- Within a breed there may be several varieties.
- A breed or a variety may have several strains or lines identified by a given name and produced by a breeder through at least five generations of closed flock breeding.

### 5.1 CLASSIFICATION OF POULTRY BREEDS

#### Internet my friend



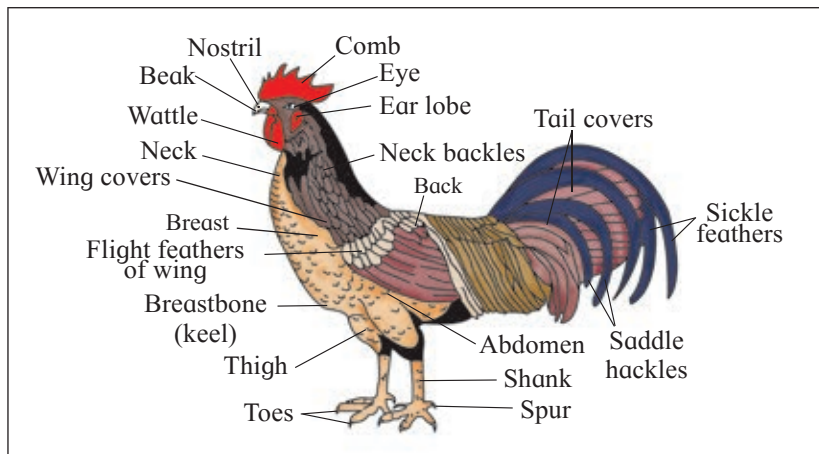
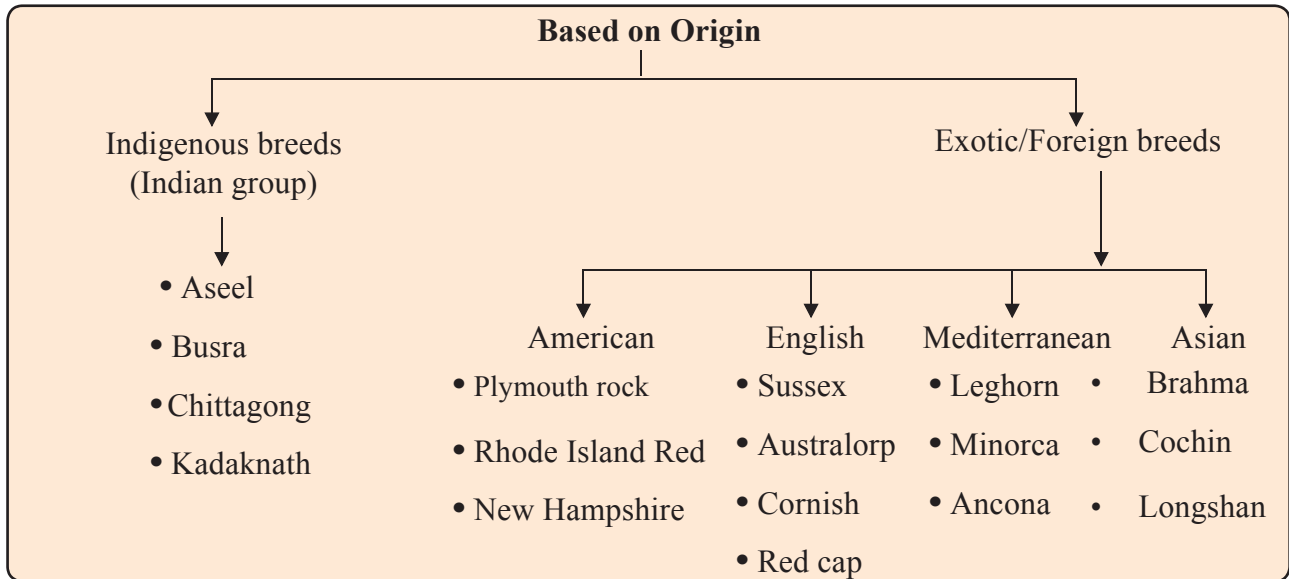
Breeds used for egg production and broiler farming.

**A. On the basis of origin :** Poultry breeds are classified as American, Asiatic, English and Mediterranean on the basis of origin.

### Do you know ?



- English origin breeds are known for their excellent fleshing properties.


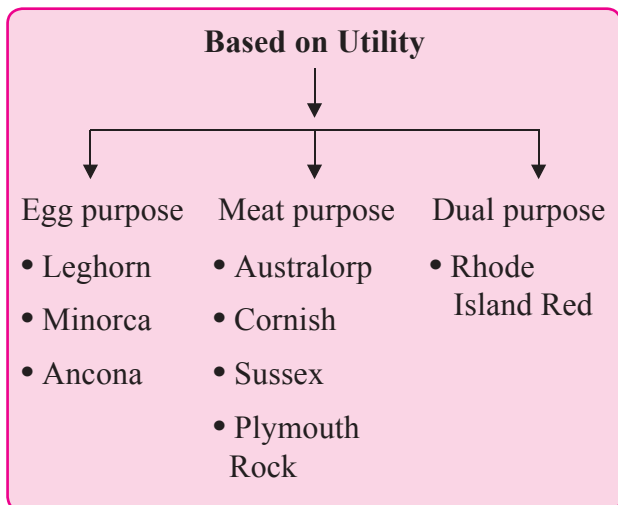


**Fig. 5.1 External body parts of Fowl**

**B) On the basis of Utility / Purpose :** Fowls are often classified based on the purpose for which they are developed such as egg type, meat type and dual purpose (for both egg and meat).

**Observe**

- Observe the features of commercial strain maintained in your locally.

## 5.2. INDIAN BREEDS

A large number of fowls of different sizes, shapes and colours, resembling the jungle fowls, are found all over India. Aseel, Chittagong, Busra and Kadaknath are only four pure breeds of fowls in India.

### 5.2.1 Aseel

Aseel, which means real or true, is the name given to an indigenous breed of fowl known for its noble qualities of fighting.

**Habitat:** The best specimens of the breed although rare, are encountered in parts of Andhra Pradesh, Uttar Pradesh and Rajasthan.

**Prominent characteristics**

1. The most popular varieties are Brown (Teekar), Red (Peela), White (Nurie), Black (Java), Black and Red (Yakub).



**Fig. 5.2 Aseel**

2. Aseel is well known for its pugnacity, high stamina, majestic gait and dogged fighting qualities.
3. They possess small and firmly set Pea comb. In both the sexes comb and wattles are bright red.
4. Head is short but broad and deep. The beak is stout and strong.
5. The face is long and slender and not covered with feathers.
6. The eyes are compact, well set and present bold looks.
7. The neck is long, uniformly thick but not fleshy.
8. The body is round and short with a broad breast, straight back and close set strong tail root.
9. Wings are small in size carried close to the body.
10. The legs are strong, straight and well apart.
11. Egg shell colour is light brown.
12. Standard weights ( Kg.) : Cock 4 to 5, Hen 3 to 4, Cockerels 3.5 to 4.5, and pullets 2.5 to 3.5.

**Economic importance**

1. The breed is well known for its quality meat.
2. Hen is a good sitter and efficient mother
3. The annual egg production is 80-90.

**5.2.2 Kadaknath**

Kadaknath is also known as “Kalamasi”, meaning the fowl is having black flesh

- **The common country hen, the desi is the best mother for hatching, a good forager but a poor layer.**

**Habitat:**Kadaknath is a native bird of Jhabua and Dhar districts of Western Madhya Pradesh reared by the tribal people.

**Prominent Characteristics**

1. The commonly available varieties of Kadaknath are Jet-black, penciled and golden
2. The adult plumage varies from silver and gold spangled to bluish black without any spangling.
3. The skin, beak, shank, toes and soles of feet are slate like.
4. The comb, wattles and tongue are purple.
5. Intense black coloration is also seen in most of the internal organs, skeleton, muscle, tendons, nerves and blood.
6. Standard weights (Kg):- Cock : 1.5 kg, Hen : 1.0 kg



**Fig. 5.3 Kadaknath**

**Do you know ?**

Flesh of Kadaknath is black in colour due to deposition of black pigment, melanin.



**Economic importance**

1. This fowl is useful as backyard poultry.
2. The overall production potential of Kadaknath is much higher than any other native birds of the country.
3. Flesh is having distinct delicious taste and also medicinal value.
4. The annual egg production is 90-100.

**Remember...**

Meat of Kadaknath is known for its high protein (25 %) and low fat (0.73 – 1.03%) content.



**5.3 EXOTIC BREEDS**

**5.3.1 Egg purpose – White leghorn**

**Origin and Habitat :** The breed is originated in Italy. Today, white leghorn is one of the most popular breed throughout the plains of India.

**Prominent characteristics**

1. Out of 12 varieties, only three are popular- Single comb white, Single comb buff and Single comb light brown.
2. Leghorn is characterized by active, compact and light body, long back, prominent breast in force blending pretty carriage, long shanks and small head with wheel set comb and wattles.
3. The shape of comb is quite important. The single comb of the male should be of medium size and should stand erect, with five uniform, deeply serrated points. The front point of the female should stand erect, but the remainder of the comb should gradually slope to one side.



**Fig. 5.4 White leghorn**

4. All the varieties have yellow beaks, skin, shanks and toes.
5. Standard weights (kg) - Cock 2.6, Hen 2.0, Cockerel 2.0, Pullet 1.8.

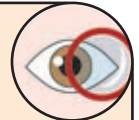
**Economic importance**

1. The egg production is 280 - 300 eggs per year.
2. The breed is the most popular and World's number one egg producer.

**5.3.2 Dual purpose – Rhode Island Red**

**Observe...**

- **Characteristics of Mediterranean class are white ear lobes, relatively large combs, clean shanks, yellow or white skin, tight feathering, non-broodiness, early maturity and white shelled eggs.**



**Origin and Habitat :** Rhode Island Red is developed in Rhode Island in America after crossing with the Red Malay game, Brown Leghorn, Shanghasis and Wyandotte.

**Prominent characteristics**

1. The bird has some what long, rectangular body, which is also broad and deep.
2. The back is flat and the breast is carried well forward.

3. The plumage is rich dark or brownish red in covers, evenly distributed over the entire surface, and is well glossed.



**Fig. 5.5 Rhode Island Red**

4. The wing when spread shows black both in primaries and secondary. The tail coverts, sickle feathers, and main tail feathers are also black. In lower neck feathers of the female, there is also slight black marking at the base.
5. The colour of the breed is, brownish red, but buff, white and brown are not uncommon.
6. Colour of egg shells is brown to dark brown.
7. There are two varieties of RIR namely Single and Rose comb. In both varieties skin and shanks are yellow and the ear lobes are red. The single comb is more popular.
8. Standard weights (kg) - Cock 3.8, Hen 2.9, Cockerel 3.4, Pullet 2.5.

#### **Economic importance**

1. It is a good layer and also meat yielding breed.
2. The annual egg production is 200.

#### **5.4 COMMERCIAL VARIETIES**

The majority of present day chickens used as egg layers and broilers are crossbreds. The hybrid broilers and layers developed for backyard farming are as given below

#### **5.4.1 Giriraja**

1. It is dual purpose variety resembles to desi breed developed by KVAFSU, Bidar.
2. It is suitable for all weather conditions.
3. These birds can be reared similar to that of commercial broiler in a large scale.
4. Egg colour is brown similar to desi chicken with 55-60 grams weight.
5. They are good for free range and can be fed with locally available materials.
6. Weight (kg) : Adult male (40 weeks) : 4.0 – 5.0 kg, Adult female : 3.0 – 3.5 kg.
7. The annual egg production is 140 - 150.



**Fig. 5.6 Giriraja**

#### **5.4.2 Grampriya**

1. This is multicoloured variety developed at Director of Poultry Research, Hyderabad.
2. There are two varieties, white is very good for egg production and the coloured considered as a dual purpose.
3. This variety is good for free range farming.
4. They have lower predator threat.
5. They are moderate in body weight with longer shanks.

6. They are hardy and their livability is very good.
7. They start laying at an age of 175 days.
8. Egg colour is brown with 55-60 gm weight.
9. The annual egg production is about 230-240 eggs in intensive and 150-160 egg under backyard condition.



Fig. 5.7 Grampriya

**Just Do it**

Compare production performance of improved backyard poultry breeds namely Giriraja, Grampriya and Swarnadhara.



**5.4.3 Swarnadhara**

1. This is new hybrid dual purpose variety developed for all weather conditions by KVAFSU.
2. These birds resemble to desi chicken.
3. They escape easily from predators, because of lesser body weight.
4. They mature by 160 – 170 days and lay 180 – 200 eggs in 280 days.
5. Egg colour is brown similar to deshi chicken with 55 - 60 gram weight.
6. Adult male (40 weeks) weight is 3.5 to 4.0kg, and adult female weight is 2.5 - 3.0 kg.



Fig. 5.8 Swarnadhara

**Table No. 5.1 Comparative Production Performance of Improved Backyard Poultry Breeds**

Sr. No.	Characters	Giriraja	Grampriya	Swarnadhara	Local
1	Weight at 8 weeks (kg)	1.6 - 1.9	1.1 - 1.2	1.1 - 1.2	0.7 - 1.0
2	Survival rate (%)	95 - 97	-	95 - 97	87 - 92
3	Age at first egg production (days)	170	175	170	270
4	Egg production per annum (Nos.)	140 - 150	230 - 240 in intensive 150 - 160 in backyard	180 - 200	60 - 70
5	Average weight of each egg (gm)	55 - 60	55 - 60	55 - 60	35 - 40
6	Live weight of adult birds (Kg)	3.5 - 4.5	2.5 - 3.0	3 - 3.5	2-2.5

**EXERCISES**

**Q.1 Fill in the blanks**

1. .... breed is most popular and World's number one egg producer.
2. Giriraja is a commercial variety developed for ..... purpose.
3. Meat of ..... breed is known for its high protein and low fat content.
4. .... is the best example of dual purpose foreign breed of poultry.
5. .... is the best table and game purpose Indian breed.

**Q.2 Match the pairs.**

Group A		Group B	
1)	American	a)	Brahma
2)	English	b)	Ancona
3)	Mediterranean	c)	Plymouth Rock
4)	Asian	d)	Basra
5)	Indian Breed	e)	Cornish

**Q.3 Identify the odd one out.**

1. Meat purpose breed - Australorp: Sussex : Minorca : Plymouth Rock : Cornish
2. English origin breed - Cornish : New Hampshire : Red Cap : Australorp : Sussex
3. Indian pure breed - Aseel : Basra : Chittagong : Giriraja : Kadaknath
4. CARI BREED - Sonali : Priya : Dhanraja : Grampriya : Debendera

**Q.4 State True or False.**

1. Flesh of Aseel is black in colour.
2. Grampriya is the popular variety in backyard condition.
3. Italy is the origin of White leghorn.

4. Swarnadhara variety developed by Director of Poultry Research, Hyderabad.
5. Average egg production of White leghorn is 280-300 eggs per year.

**Q.5 Answer the following questions in brief.**

1. Write economic importance of Kadaknath Breed.
2. Give characteristic of Rhode Island Red.
3. Enlist the meat purpose poultry breeds.
4. Write the characteristics of White leghorn.
5. Which are the most popular eggs purpose varieties in backyard condition?

**Q.6 Answer the following questions in details.**

1. Enlist egg purpose breeds of poultry and write in detail origin, habitat, morphological characteristics and importance of White leghorn.
2. Discuss in detail origin, habitat, prominent characteristics and importance of Aseel.
3. Classify poultry breeds on the basis of origin and utility. Write in detail origin, habitat, prominent characteristics and importance of Rhode Island Red.



## 6. FEEDS AND FEEDING

### Can you recall ?



1. Which nutrients are present in our food ?
2. Role of proteins, carbohydrates, lipids, vitamins and minerals in animal body.
3. What are the common sources of water for farm animals?

### 6.1 FEED NUTRIENTS

The animal body derives all its required nutrients for various physiological functions of the body from the food it eats. In order to understand the science of livestock feeding, it is necessary to know certain facts about these feed nutrients, their contents in the feed-stuff and requirements, functions and symptoms of deficiencies in the animals. This topic deals with the basic study of the nutrients like water, proteins, carbohydrates, lipids, vitamins and minerals present in the animal feed.

**Feed nutrient is a substance or any food constituent that nourishes the body and helps in maintenance, growth, production and reproduction of an animal.**

#### 6.1.1 Water

### Can you tell ?

**Why animals drink water?**



Water plays vital role in almost all life processes. It is the simplest, readily available and cheapest feed nutrient. In cattle, water is approximately 75 to 80 per cent at birth, 68 to 72 per cent at 5 months and 50 to 60 per cent of body weight in the mature animals.

Though not acting as a source of energy, water ranks far above all other nutrients in the body as regards the rate of turnover and is the most important single nutrient for the regulation of life and required in highest amount. Its shortage adversely affects the productive capacity of the animals, particularly in milk producing animals. In summer cool water has beneficial effect.

### Remember...

- In the absence of water an animal would die comparatively in a short time compared to any other nutrients.



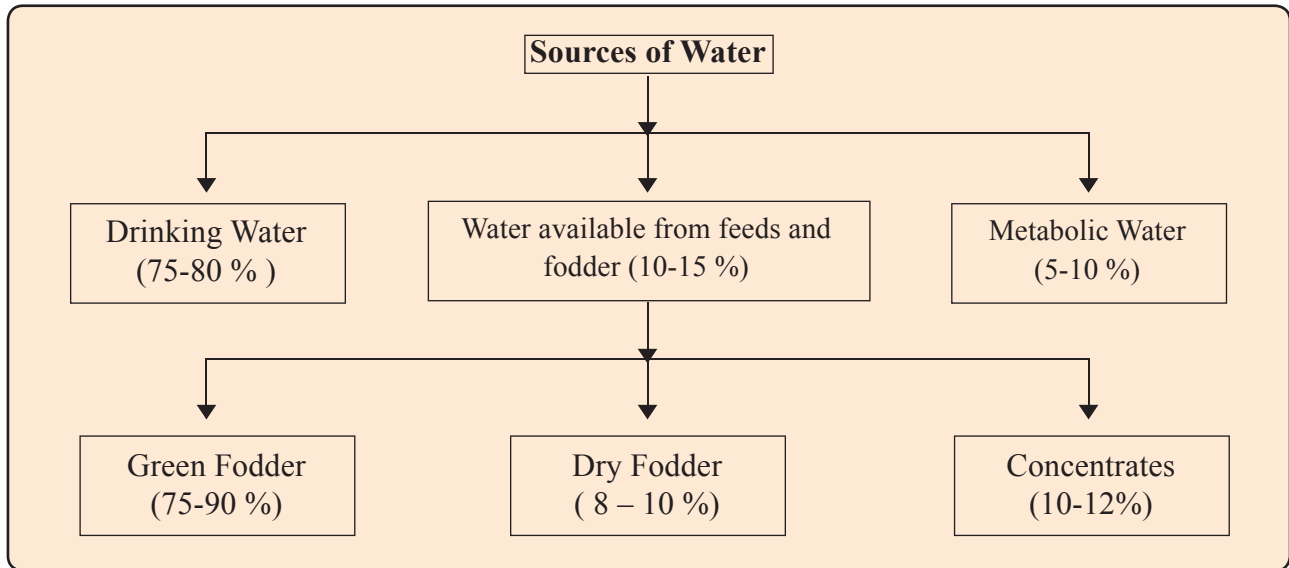
#### Sources of water for animals

1. *Drinking water* : This is a major source of water and contributes about 75-80 per cent of the total water requirement.
2. *Water available from feeds and fodders* : The water content in various feeds of plant origin is taken by the animals through their feeding. Green fodders supply 75 – 90 per cent water, while dry fodders and cereal grains and their by-products provide 8-10 percent, and oil cakes 10-12 per cent water. It contributes about 10-15 per cent of the total water requirement of the animal.
3. *Metabolic water* : Animals also obtain water resulting from the oxidation of food is called metabolic water. It contributes about 5 – 10 per cent of the total water requirement.

### Remember...

**Each gram of carbohydrates, protein and fat yields about 0.6, 0.4 and 1.1ml of metabolic water respectively.**





**Fig 6.1 Sources of Water**

**Functions of water**

1. It is a major component of various body fluids like blood, urine, saliva, lymph and tears.
2. It is an important constituent of every living tissue.
3. It is an ideal solvent for nutrients.
4. It plays important role in thermoregulation of the body.
5. It makes the acid-base equilibrium in the body.
6. It is required in the metabolism by way of oxidation of nutrients.
7. It helps in the transportation of nutrients and hormones through blood to all the tissues.
8. It helps in the excretion of metabolic waste and toxic products from the kidney.
9. It also keeps the gastro-intestinal, reproductive and uro-genital tracts moist.

10. It helps in the transmission of sight and sound due to its refractive characteristics.
11. It acts as a cushion for the joints in the form of synovial fluid and for the nerves as a cerebrospinal fluid

**6.1.2. Proteins**

**Can you recall ?**

1. Who coined the term “Protein”?
2. Deficiency symptoms of proteins in our body.



**Proteins are defined as complex organic nitrogenous compounds consisting of various amino acids joined together by peptide linkage.** Chemically, all the proteins contain C, H, O, N and generally sulfur and occasionally phosphorous, iron, zinc and copper.

**Classification of Proteins**

On the basis of chemical composition, solubility and shape, proteins are classified as:

1. **Fibrous Proteins:** These insoluble animal proteins are resistant to animal digestive systems and are composed of elongated,

**Do you know ?**

- Why you drink water?



filamentous chains joined up by cross linkages. They are Collagens, Elastins and Keratins.

2. **Globular Proteins:** This group includes all the enzymes, antigens and hormones having proteins. They are Albumins, Globulins, Lacto globulins, Histones and Protamines.
3. **Complex Proteins:** These are composed of simple proteins combined with non-proteins substances called 'prosthetic' group. They are Phosphoproteins, Glycoproteins, Lipoproteins, Chromoproteins, Nucleoproteins and Metalloproteins

### Functions of Proteins

#### Can you recall ?

**The sources of protein required for your body**



1. They are structural and functional unit of animal cell.
2. Being constituent of enzymes, they act as catalytic agents in different kinds of chemical reactions.
3. Proteins stored as amino acids act as food nutrient for growing embryo, e.g. ovalbumin of egg white.
4. They are constituent of **haemoglobin and myoglobin** which help in transport of  $O_2$  in blood and muscle cells, respectively.
5. Blood plasma proteins viz. **thrombin and fibrinogen** help in clotting of the blood.
6. They are component of antibodies, e.g. lacto-globulin in colostrum.
7. *Keratin* (Structural protein) is responsible for giving structure to skin, hooves, feathers.
8. They are important constituents of milk (Caesin) and egg (Albumin).

9. They are the components of hormones like **insulin** and **thyroxine**.
10. They act as energy source.

#### Remember...

**One gram of protein yields about 4.08 Kcal of energy.**



#### Internet my friend

- **Functions of essential amino acids.**



### Amino Acids

Amino acids are the building blocks of protein structure and determine many of the properties of protein. They are produced when proteins are hydrolysed by enzymes, acids or alkalis.

Plants, ruminants and many micro-organisms are able to synthesize the amino acids and consequently the proteins from simple non-protein nitrogenous compounds (NPN) such as nitrates but monogastric animals cannot synthesize the amino acids in sufficient amounts required to build their body proteins, therefore it must be provided through a dietary source referred as essential amino acids. While some are synthesized in their body and hence need not to be supplied through the diet are referred as non-essential amino acids.

In ruminants all the amino acids required are synthesized in required amounts and proportion by the rumen-micro-organisms, thus making this class of animal independent of a dietary source.

The essential amino acids for the poultry birds are: Threonine, Valine, Leucine, Lysine, Histidine, Arginine, Phenylalanine, Tryptophan, Iso-leucine, Methionine and Glycine.

Table 6.1 Difference between essential and nonessential Amino acids

Essential Amino acids	Nonessential Amino acids
<ol style="list-style-type: none"> <li>1. They are not synthesized in the body in adequate amount.</li> <li>2. They are to be essentially supplied through diet.</li> <li>3. These are also called indispensable amino acids.</li> <li>4. Examples are: Arginine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan and Valine.</li> </ol>	<ol style="list-style-type: none"> <li>1. They are synthesized in the body in adequate quantity.</li> <li>2. They are not essentially required to be supplied through diet.</li> <li>3. These are also called dispensable amino acids.</li> <li>4. Examples are: Alanine, Asparatic acid, Cystine, Glutamicacid, Citrulline, Glycine, Hydroxyproline, Proline, Serine and Tyrosine</li> </ol>

### 6.1.3 Carbohydrates

Carbohydrates are defined as polyhydroxy aldehydes or ketones. Chemically they contain carbon, hydrogen and oxygen.

#### Can you recall ?

- Who discovered carbohydrates?
- What is the another name for carbohydrates?



#### Classification of Carbohydrates

The carbohydrates, based on their chemical structures, are usually classified in two major groups as:

1. Sugars
2. Non-sugars

1. **Sugars:** All the sugars are either monosaccharides or oligosaccharides. Depending upon the number of carbon atoms present in their molecule, the mono saccharides are divided into trioses, tetroses, pentoses, hexoses and heptoses containing 3, 4, 5, 6 and 7 carbon atoms, respectively. The oligosaccharides include all the sugars other than monosaccharides and have disaccharides, trisaccharides and

tetrasaccharides depending on the number of mono saccharides from 2 – 10.

2. **Non- Sugars:** This group includes those carbohydrates which have high molecular weight and are tasteless, insoluble and amorphous and have more than 10 mono saccharides. They are further divided into two sub-groups, namely
  - a) **Polysaccharides or Glycans :** These are the polymers of large number of mono saccharides units. e.g. Starch, Cellulose
  - b) **Complex carbohydrates :** These are the compounds containing carbohydrates and non-carbohydrates molecules. e.g. Glycolipids and Glycoproteins.

#### Functions of Carbohydrates

1. They are major source of energy to the animals.

#### Remember...

One gram of carbohydrate yields 4.18 kcal energy.



**Table 6.2 Difference between monosaccharides and oligosaccharides**

Mono saccharides	Oligosaccharides
1. They consist of single polyhydroxy aldehyde. 2. Examples a. Trioses → Glyceraldehyde b. Tetroses → Erythrose c. Pentoses → Arabinose, Xylose, Xylulose, Ribose and Ribulose d. Hexoses → Glucose, Fructose, Mannose and Galactose e. Heptoses → Sedoheptulose	1. They consist of more than one and less than 10 monosaccharide units. 2. Examples a. Disaccharides → Sucrose, Lactose, Maltose, Cellobiose and Trehalose b. Trisaccharides → Raffinose c. Tetrasaccharides → Stchyose

- They are the components of amino acids and glycoproteins, glycolipids and fatty acids.
- They are constituent of RNA and DNA.
- They are present in milk as lactose.
- They play role in the synthesis of milk fat.
- They form the bulk in the rumen and satisfy the hunger.

## 5. Lipids

**Can you recall ?**

**Who coined the term “Lipid”?**

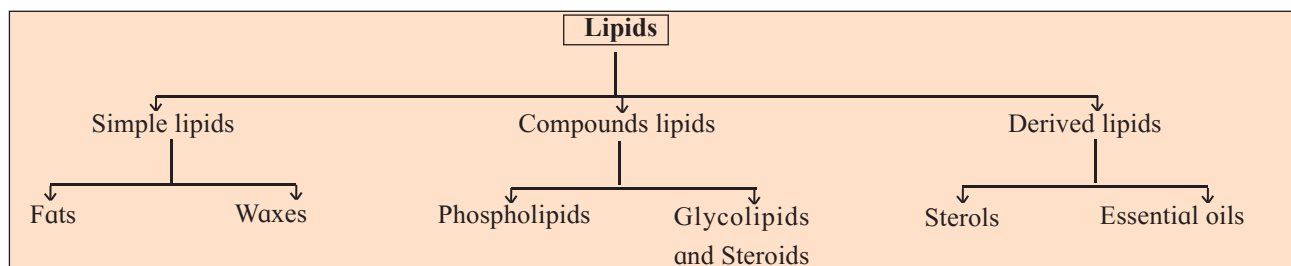


**Lipids are water insoluble organic bio molecules found in plant and animal tissues.** Unlike polysaccharides and proteins, lipids are not polymers and contain carbon, hydrogen and oxygen but relatively much richer in first two. Lipid is a collective term used for wide variety of substances that vary from simple short chain fatty acids to large very complex molecules.

## Classification of lipids

Based on chemical structure, lipids are classified into following three groups

- Simple lipids:** These are the esters of fatty acids with various alcohols. Fats and oils are constituents of both plants and animals, both have same chemical structure and chemical properties but differ in their physical properties i.e. oils are liquid and fats are solid at room temperature. Waxes are the esters of fatty acids with alcohol other than glycerol. Free fatty acids play important role in animal physiology.
- Compound lipids:** These are the esters of fatty acids containing other non-fatty prosthetic groups in addition to an alcohol and fatty acids. The best examples of phospholipids are fats containing phosphoric acids and N (e.g. Lecithin, Cephalin and Plasmogens) and Glycolipids



**Fig. 6.2 Classification of Lipids**

are fats containing carbohydrate and often N (e.g. Glycolipids and Galactolipids). Compound lipids consists of simple lipids combined with non-lipids.

3. **Derived lipids:** They are derived from compound lipids. The best examples are sterols, essential oils, fatty acids and alcohols.

### Remember...

One gram of fat produces about 9.3 kilo calories of energy.



### Functions of Lipids

1. They are rich source of energy and supply about 2.25 times more energy than carbohydrates and proteins.
2. They carry fat soluble vitamins i.e Vitamin A,D,E, and K.
3. They provide insulation to the vital organs and lubrication to the gastro-intestinal tract.
4. They improve the taste and palatability of the food and delay the sensation of hunger.
5. They regulate the heat as they are deposited in subcutaneous tissue and being a poor conductor of heat
6. They act as reserve food material; on account of their insolubility in aqueous solutions.
7. They supply all the fatty acids which are physiologically important as
  - i) Phospholipids play an important role in absorption and transportation of fatty acids and fat soluble vitamins.
  - ii) The synthesis of hormones like adrenocorticoids, sex hormones and steroids and bile.
  - iii) Cholesterol is an important constituent of brain.

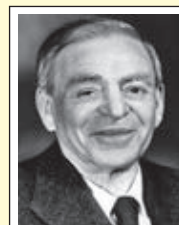
### 6.1.5 Vitamins

#### Can you tell ?

What do vitamins do for our body?



#### Introduction to scientist



**Casimir Funk (1884-1967):** He was a Polish biochemist first to formulate the concept of vitamin, Which he called “Vital amines” or “Vitamines” in the year 1912

**Vitamins (vital + amine) are the organic substances needed in minute quantities but are essential for various metabolic processes in the animal body.** There are at least 15 vitamins which have been accepted as essential food factors. The system of naming the vitamins by alphabet is still widely used. However, now-a-days, their chemical names are accepted worldwide. Vitamins have no chemical resemblance to each other, but they have similar general functions in the metabolism. Most of the vitamins have been artificially synthesized. Some of the vitamins are synthesized in the body of some animals.

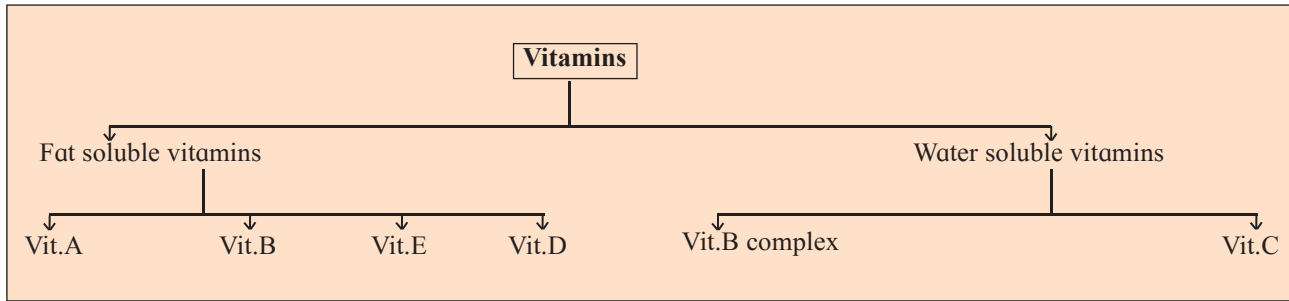
### Remember...

In ruminants, the rumen microbes are capable of producing B vitamins required to support the tissue needs.



#### Classification of vitamins

Vitamins are generally divided into fat soluble (Vit. A, D, E and K) and water soluble (Vit. B groups and C) groups depending on their solubility and associations with fat or water.



**Fig. 6.3 Classification of Vitamins**

**Remember...**

**Rumen synthesizes all the water soluble vitamins, (Vit. B complex and Vit. C) hence they are not dietary essential vitamins.**



**Importance of vitamins**

1. They are required for proper metabolism of proteins, carbohydrates, fats and minerals.
2. They are helpful in digestion.
3. They are essential for normal growth, health and maintenance.
4. They provide immunity against diseases.
5. They are constituents of some co-enzymes.

**Table 6.3 Differences between Fat-soluble and Water-soluble Vitamins**

Fat soluble Vitamins	Water soluble Vitamins
1. Structurally they contain C, H, and O	1. Their chemical structure contain C,H, O and N, S, or Co.
2. They are soluble in fats.	2. They are water soluble.
3. They are stored in good quantity wherever fat is stored.	3. They are not stored anywhere in the body
4. They are absorbed from the GI tract in presence of fat.	4. They are absorbed along with water from GI tract.
5. They are required for the regulation of metabolism of the structural units. Each vitamin has one or more independent and specific role.	5. They are collectively concerned mainly with the transfer of energy in every cell.
6. Following metabolic use, they are excreted through faeces.	6. Following metabolic use, they are excreted through urine.
7. e.g. Vitamin A,D,E & K	7. e. g. Vit. B Complex and C

Table 6.4 Sources, functions and symptoms of deficiencies of vitamins in livestock

Vitamin	Sources	Biological functions	Symptoms of deficiencies
<b>Vitamin A</b> ( Retinol ) <i>Anti-xerophthalmic factor</i>	<ul style="list-style-type: none"> <li>• Green forage,</li> <li>• Yellow maize,</li> <li>• Green pastures.</li> </ul>	<ol style="list-style-type: none"> <li>1. Required for normal vision as it synthesizes rhodopsin.</li> <li>2. Maintains integrity and activity of epithelial cells and bony tissues.</li> <li>3. Helps in keeping the fertility normal.</li> <li>4. Protects the body from infections by maintaining the normal epithelial lining.</li> </ol>	<ol style="list-style-type: none"> <li>1. Deficiency symptoms occur in animals on high cereals and dry roughages.</li> <li>2. Mild deficiency results in ‘night blindness’</li> <li>3. Xerophthalmia i.e. excessive watering, softening and cloudiness of cornea resulting in absence of vision</li> <li>4. Blindness in calves.</li> <li>5. Dry, rough and scaly skin.</li> <li>6. Infertility and abortions.</li> </ol>
<b>Vitamin D</b> <i>Anti-rachitic factor</i>	<ul style="list-style-type: none"> <li>• Sun dried roughages,</li> <li>• Egg yolk,</li> <li>• Fish</li> <li>• Colostrum</li> </ul>	<ol style="list-style-type: none"> <li>1. Helps in the absorption of calcium and phosphorous from the gastrointestinal tract.</li> <li>2. Enhances re-absorption of Ca and P from kidney.</li> <li>3. Required for deposition of Ca and P in bones.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Rickets</b> in young animals characterized by bending of legs, enlarged and painful joints.</li> <li>2. <b>Osteomalacia</b> in adults characterized by lameness, bone deformities and weakness of bones.</li> </ol>
<b>Vitamin E</b> (Tocopherol) <i>Anti-sterility factor</i>	<ul style="list-style-type: none"> <li>• Vegetable oils</li> <li>• Green fodders</li> <li>• Germinated</li> <li>• Cereal grains</li> <li>• Fish meal.</li> </ul>	<ol style="list-style-type: none"> <li>1. Acts as antioxidant of cell membranes.</li> <li>2. Prevents the formation of peroxides(harmful products)</li> <li>3. Essential for the normal function of muscles.</li> </ol>	<ol style="list-style-type: none"> <li>1. Muscular dystrophy or White muscle disease in calves, resulting in degeneration and necrosis of the muscles.</li> <li>2. Stiff lamb disease in lambs.</li> <li>3. Infertility in males and females</li> </ol>



<p><b>Vitamin K</b> <i>Coagulation factor</i></p>	<ul style="list-style-type: none"> <li>• Green leafy materials</li> <li>• Egg yolk</li> <li>• Liver and fish meal.</li> </ul>	<ol style="list-style-type: none"> <li>1. Required for blood coagulation</li> </ol>	<ol style="list-style-type: none"> <li>1. Deficiency results to increased coagulation time</li> </ol>
<p><b>Thiamin</b> (Vitamin B<sub>1</sub>)</p>	<ul style="list-style-type: none"> <li>• Brewers' yeast,</li> <li>• Green pastures/ fodders,</li> <li>• Milk</li> <li>• Cereal grains,</li> <li>• Egg yolk.</li> </ul>	<ol style="list-style-type: none"> <li>1. Thiamine helps in enzyme system for the synthesis of fats from proteins.</li> <li>2. It has potential role in oxidation of sugar in tissues including brain.</li> </ol>	<ol style="list-style-type: none"> <li>1. Loss of appetite</li> <li>2. Retarded growth</li> <li>3. Weakness typical neuritis</li> <li>4. Diarrhoea in pigs and calves</li> </ol>
<p><b>Riboflavin</b> (Vitamin B<sub>2</sub>)</p>	<ul style="list-style-type: none"> <li>• Brewers' yeast,</li> <li>• Green pastures/ fodders</li> <li>• Milk and milk products especially whey.</li> </ul>	<ol style="list-style-type: none"> <li>1. Helps to oxidize substrate to generate ATP within the mitochondria.</li> <li>2. Mediates the first oxidative step in the oxidation of fatty acids.</li> </ol>	<ol style="list-style-type: none"> <li>1. Alopecia (hair loss),</li> <li>2. Dry and scaly skin,</li> <li>3. Poor appetite,</li> <li>4. Retarded growth,</li> <li>5. Diarrhoea</li> </ol>
<p><b>Niacin</b> (Vitamin B<sub>3</sub>)</p>	<ul style="list-style-type: none"> <li>• Green Lucerne</li> <li>• Leafy vegetables</li> <li>• Yeast</li> <li>• Poultry-products.</li> </ul>	<ol style="list-style-type: none"> <li>1. Two niacin containing coenzymes are required for the metabolism of carbohydrates, proteins and fats.</li> </ol>	<ol style="list-style-type: none"> <li>1. Black tongue in dogs</li> <li>2. Poor growth,</li> <li>3. Skin lesions,</li> <li>4. Diarrhoea in pigs</li> </ol>
<p><b>Pantothenic acid</b> (Vitamin B<sub>5</sub>)</p>	<ul style="list-style-type: none"> <li>• Molasses</li> <li>• Wheat bran</li> <li>• Peas</li> <li>• Egg yolk</li> <li>• Yeast</li> <li>• Milk</li> </ul>	<ol style="list-style-type: none"> <li>1. It has stimulating effect on central nervous system.</li> <li>2. Being precursor of cholesterol, Coenzyme A is involved in the synthesis of steroid hormones</li> </ol>	<ol style="list-style-type: none"> <li>1. Slow growth,</li> <li>2. Dermatitis,</li> <li>3. Loss of hair</li> <li>4. Diarrhoea.</li> <li>5. Goose stepping in pigs</li> <li>6. Premature graying of hair in dog</li> </ol>

<p><b>Pyridoxine</b> (Vitamin B<sub>6</sub>)</p>	<ul style="list-style-type: none"> <li>• Cereal grains and by-products</li> <li>• Brewer's yeast</li> <li>• Rice bran</li> <li>• Pulses</li> <li>• Milk</li> </ul>	<ol style="list-style-type: none"> <li>1. Required for protein metabolism.</li> <li>2. Required in the absorption of amino acids from the intestine.</li> <li>3. It helps in the synthesis of fats from proteins and carbohydrates.</li> </ol>	<ol style="list-style-type: none"> <li>1. Dermatitis</li> <li>2. Retarded growth</li> <li>3. Anemia</li> <li>4. Incoordination of movements and convulsions.</li> <li>5. Diarrhoea</li> </ol>
<p><b>Folic acid</b> (Vitamin B<sub>9</sub>)</p>	<ul style="list-style-type: none"> <li>• Green leafy vegetables</li> <li>• Cauliflower</li> <li>• Cereals</li> <li>• Extracted oil-seed meals</li> <li>• Animal protein meals</li> </ul>	<ol style="list-style-type: none"> <li>1. Essential for the synthesis of DNA in the cells</li> <li>2. It takes part in the formation and maturation of the RBC.</li> <li>3. Along with the vitamin B<sub>12</sub>, it helps in the synthesis and metabolism of nucleic acid.</li> </ol>	<ol style="list-style-type: none"> <li>1. Poor growth and reproductive failure</li> <li>2. Reduced appetite and anaemia</li> </ol>
<p><b>Cyanocobalamin</b> (Vitamin B<sub>12</sub>) APF(Animal Protein Factor)</p>	<ul style="list-style-type: none"> <li>• Chiefly foods of animal origin i.e. milk, fish, fish meal</li> <li>• Brewer's yeast, kidney, beef extract</li> <li>• Fungus <i>Streptomyces griseus</i></li> </ul>	<ol style="list-style-type: none"> <li>1. It has major enzymatic role in the one-carbon metabolism and synthesis.</li> <li>2. The coenzyme form of vitamin B<sub>12</sub> function in several important enzyme systems.</li> <li>3. Vitamin B<sub>12</sub> alone is necessary for the synthesis of RNA.</li> </ol>	<ol style="list-style-type: none"> <li>1. Poor appetite and growth in young calves</li> <li>2. Reproductive failure</li> <li>3. Anaemia.</li> </ol>
<p><b>Vitamin C</b> (Ascorbic acid )</p>	<p>All citrus fruits</p>	<ol style="list-style-type: none"> <li>1. Ascorbic acid is a strong reducing agent;</li> <li>2. It is essential for collagen formation.</li> <li>3. It is an important antioxidant.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Dental carries:</b> Spongy haemorrhagic friable gums, loose teeth.</li> <li>2. Poor healing of wounds</li> <li>3. Reproductive failure in both males and females.</li> </ol>

**6.1.6 Minerals :****Can you tell ?****Why do you need minerals ?**

Minerals represent the inorganic component of the animal body which contains about 3 per cent. Although required in small quantities, they play a vital role in animal nutrition.

**Remember...**

**Minerals are the inorganic substances required for physiological functions of the body.**

**Classification of essential minerals**

Essential elements/minerals are classified into i) major elements/macro minerals and ii) trace elements/micro minerals depending upon the concentration in the animal body. The concentrations of macro-elements in diet are expressed in percentage of the diet or in Kg of diet but micro-elements are expressed as ppm or mg/kg of diet.

**Table 6.5 Classification of minerals.**

Major elements/ (Macro-minerals)	Trace elements/ (Micro-minerals)
1. Calcium (Ca)	1. Iron (Fe)
2. Phosphorous (P)	2. Zinc (Zn)
3. Potassium (K)	3. Copper (Cu)
4. Sodium (Na)	4. Molybdenum (Mb)
5. Chlorine (Cl)	5. Selenium (Se)
6. Sulphur (S)	6. Iodine (I)
7. Magnesium (Mg)	7. Manganese (Mn)
	8. Cobalt (Co)

**General functions of minerals**

1. Macro-elements are important structural components of bones and other tissues and body fluids.
2. They play vital role in the maintenance of acid-base balance, osmotic pressure, membrane electrical potential and transmission of nerve impulses.
3. Micro-elements serve as components of enzymes and enzyme-cofactors and as components of hormones of the endocrine system.
4. They are required in tissue growth and repair for bone and teeth formation, hair, hoofs and horns, soft tissues and in blood cells.
5. Many elements are required for the synthesis of milk and egg shell formation.
6. They help in the digestion and absorption of nutrients in production of erythrocytes.
7. They are responsible for permeability of cell membrane
8. They help in production of erythrocytes and transportation of oxygen.
9. Some elements are now-a-days are used as isotopes for recording advanced metabolisms.
10. The isotopes of the following elements are used in animal experiments:

Ca<sup>45</sup> of Calcium, P<sup>32</sup> of Phosphorus, S<sup>35</sup> of sulphur, Zn<sup>65</sup> of Zinc, I<sup>131</sup> of Iodine and Se<sup>35</sup> of selenium

**Table 6.6 Sources, biological functions and symptoms of deficiencies of minerals in livestock**

Mineral	Sources	Biological functions	Symptoms of deficiencies
Calcium (Ca)	<ul style="list-style-type: none"> <li>• Di-calcium phosphate</li> <li>• Bone meal</li> <li>• Milk</li> <li>• Green vegetables</li> <li>• Oil cakes</li> </ul>	<ol style="list-style-type: none"> <li>1. Formation of bones and teeth.</li> <li>2. Helps in clotting of the blood.</li> <li>3. Synthesis of milk.</li> <li>4. Maintains the acid-base balance of the body fluid.</li> <li>5. Regulation of heart beats and muscle tone</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Rickets</b> in young and <b>Osteomalacia</b> in adult animals.</li> <li>2. <b>Milk fever</b> in high yielding cows.</li> <li>3. Reduction in milk yield</li> <li>4. Poor growth rate</li> </ol>
Phosphorous (P)	<ul style="list-style-type: none"> <li>• Milk</li> <li>• Cereal grains</li> <li>• Cereal by-products</li> <li>• Bone meal</li> <li>• Oil cakes</li> <li>• Sodium phosphate</li> <li>• Di-calcium phosphate.</li> </ul>	<ol style="list-style-type: none"> <li>1. Essential component of the acid-base buffer system.</li> <li>2 Oxidation of carbohydrates leading to the formation of ATP</li> <li>3. Formation of bones.</li> <li>4. Maintenance of normal appetite</li> <li>5. Regularity of estrous cycle and maintenance of fertility.</li> <li>6. Constituents of bone &amp; teeth</li> </ol>	<ol style="list-style-type: none"> <li>1. Poor growth rate</li> <li>2. Infertility</li> <li>3. <b>Pica/depraved appetite</b> i.e. eating of wood, cloths, soil, paper, stone plastic, bones</li> <li>4. Recumbency</li> <li>5. <b>Rickets</b> in young and <b>Osteomalacia</b> in adult animals</li> </ol>
Sodium (Na), Potassium (K) and Chlorine (Cl)	<ul style="list-style-type: none"> <li>• Common salt</li> <li>• Animal and Marine by-products</li> </ul>	<p><b>These minerals are closely associated with each other.</b></p> <ol style="list-style-type: none"> <li>1. Sodium and potassium maintain osmotic pressure of body fluids and the acid-base balance.</li> <li>2. Potassium helps in the contraction and relaxation of the heart and activates certain enzymes.</li> <li>3. Chlorine helps in cell nutrition.</li> </ol>	<ol style="list-style-type: none"> <li>1. Reduced appetite, growth and body weight</li> <li>2. Low milk production.</li> <li>3. Muscular weakness</li> <li>4. Increased thirst.</li> <li>5. Intense craving for salt, leading to pica.</li> <li>6. Dehydration</li> </ol> <p><b>Potassium deficiency usually does not occur</b></p>
Magnesium (Mg)	<ul style="list-style-type: none"> <li>• Leguminous fodders</li> <li>• Brans</li> <li>• Oil cakes</li> <li>• Dried yeast,</li> <li>• MgO</li> <li>• MgSO<sub>4</sub></li> </ul>	<ol style="list-style-type: none"> <li>1. Activates phosphatase transferases, decarboxylases and acyl transferases.</li> <li>2. Growth and development of bones and tooth.</li> <li>3. Role in muscle contraction</li> </ol>	<ol style="list-style-type: none"> <li>1. Grass tetany / lactation tetany in cows and ewes.</li> <li>2. Hyper-excitability and muscular twitching in calves.</li> </ol>

Sulphur (S)	<ul style="list-style-type: none"> <li>S-containing amino acids, proteins (mucin, cartilage proteins) and vitamins.</li> </ul>	<ol style="list-style-type: none"> <li>Essential component of some amino acids and vitamins.</li> <li>It is important in the enzyme system.</li> <li>In association with the iron, it is used for the formation of haemoglobin in RBCs.</li> </ol>	As diets invariably contain S-containing compounds like proteins and ruminants can synthesize all S-containing amino acids and vitamins from the dietary S-sources, no sulphur deficiency, in real sense, occurs.
Iron (Fe)	<ul style="list-style-type: none"> <li>Green forages,</li> <li>Legumes and seed coats,</li> <li>Feeds of animal origin</li> <li>Ferrous sulphate</li> </ul>	<ol style="list-style-type: none"> <li>It synthesizes haemoglobin and red blood cells.</li> <li>It helps in the utilization of oxygen by the blood.</li> <li>It is concerned in the formation of melanin.</li> </ol>	<ol style="list-style-type: none"> <li>Iron deficiency results in to anaemia characterised by the paleness of mucosae and weakness.</li> <li>Depigmentation of hair.</li> <li>Greater morbidity and mortality are associated with depressed immune responses.</li> <li>Decreased growth rate.</li> </ol>
Copper (Cu)	<ul style="list-style-type: none"> <li>Copper sulphate</li> <li>Concentrates</li> </ul>	<ol style="list-style-type: none"> <li>It is a component of cytochrome oxidase and tyrosinase</li> <li>It is necessary for the formation of haemoglobin.</li> <li>It plays important role in the production of 'crimp' wool.</li> <li>It is required for the normal pigmentation of wool and hair.</li> </ol>	<ol style="list-style-type: none"> <li>Anaemia</li> <li>Depigmentation of coloured hair and black wool.</li> <li>'<b>Sway back disease</b>' in new born lambs.</li> <li><b>Falling disease</b> in cattle</li> <li>Steely wool</li> </ol>
Cobalt (Co)	<ul style="list-style-type: none"> <li>Legumes</li> <li>Pastures</li> <li>Liver meal</li> <li>Cobalt sulphate</li> <li>Cobalt chloride</li> </ul>	<ol style="list-style-type: none"> <li>It plays important role in the synthesis of Vit. B<sub>12</sub> in ruminants.</li> <li>It is necessary for the growth and development of body.</li> <li>It is also involved in the synthesis of DNA and the metabolism of amino acids.</li> </ol>	<ol style="list-style-type: none"> <li><b>Wasting disease</b> in ruminants characterized by loss of appetite, emaciation, rough coat and scaly skin,</li> <li>Severe anemia, weakness and reduced resistance to infection leading to death.</li> </ol>

Iodine (I)	<ul style="list-style-type: none"> <li>• Fish meal,</li> <li>• Cod liver oil Iodized salts (Na-and-K iodide, or Na iodate).</li> <li>• Molasses</li> </ul>	<ol style="list-style-type: none"> <li>1. Iodine is essential for the synthesis of thyroxine and triiodothyro.</li> <li>2. It influences physical and mental growth and maturation of tissues.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Goiter</b> in newly born animals. Animals may be born hairless, weak or even dead.</li> <li>2. Fetal death or abortion can occur at any stage of gestation.</li> <li>3. Retarded growth,</li> <li>4. Poor mental and sexual development.</li> <li>5. Infertility</li> </ol>
Zinc (Zn)	<ul style="list-style-type: none"> <li>• Yeast</li> <li>• Bran</li> <li>• Molasses</li> <li>• Germ of cereal grains. (Animal proteins are richer sources than plant protein)</li> </ul>	<ol style="list-style-type: none"> <li>1. Several enzymes contain the zinc which affects the metabolism of carbohydrates, proteins, lipids and nucleic acid.</li> <li>2. Being a part of insulin hormone, it plays important role in carbohydrate metabolism.</li> </ol>	<ol style="list-style-type: none"> <li>1. Reduced feed intake</li> <li>2. Reduced growth rate.</li> <li>3. Alopecia ,rough coat</li> <li>4. <b>Parakeratosis</b> in pigs</li> <li>5. Infertility</li> <li>6. Bone disorders</li> <li>7. Disorders of feathers and hair coat</li> <li>8. Skin diseases</li> </ol>
Manganese (Mn)	<ul style="list-style-type: none"> <li>• Whole rice</li> <li>• Green fodders</li> <li>• Bran</li> </ul>	<ol style="list-style-type: none"> <li>1. Manganese is important as an enzyme activator in number of phosphate transferases and decarboxylases.</li> <li>2. It is believed to be involved in amino acid metabolism</li> </ol>	<ol style="list-style-type: none"> <li>1. In calves, weak legs and pasterns, enlarged joints, stiffness and twisted legs.</li> <li>2. In heifers and cows, silent heat and low conception rate.</li> </ol>
Selenium (Se)	<ul style="list-style-type: none"> <li>• Fish meal,</li> <li>• Sodium selenite</li> <li>• Sodium selenate</li> </ul>	<ol style="list-style-type: none"> <li>1. It has non-specific antioxidant property.</li> <li>2. It has a role in absorption and retention of Vitamin E.</li> </ol>	<ol style="list-style-type: none"> <li>1. Infertility and poor growth in most of the species.</li> <li>2. <b>White muscle disease</b> in calves</li> </ol>
Molybdenum (Mo)	<ul style="list-style-type: none"> <li>• Cabbage</li> <li>• Soybean</li> <li>• Peas</li> <li>• Cereals</li> </ul>	<ol style="list-style-type: none"> <li>1. It stimulates action of rumen micro-organisms</li> </ol>	<ol style="list-style-type: none"> <li>1. No deficiency symptoms are recorded.</li> </ol>

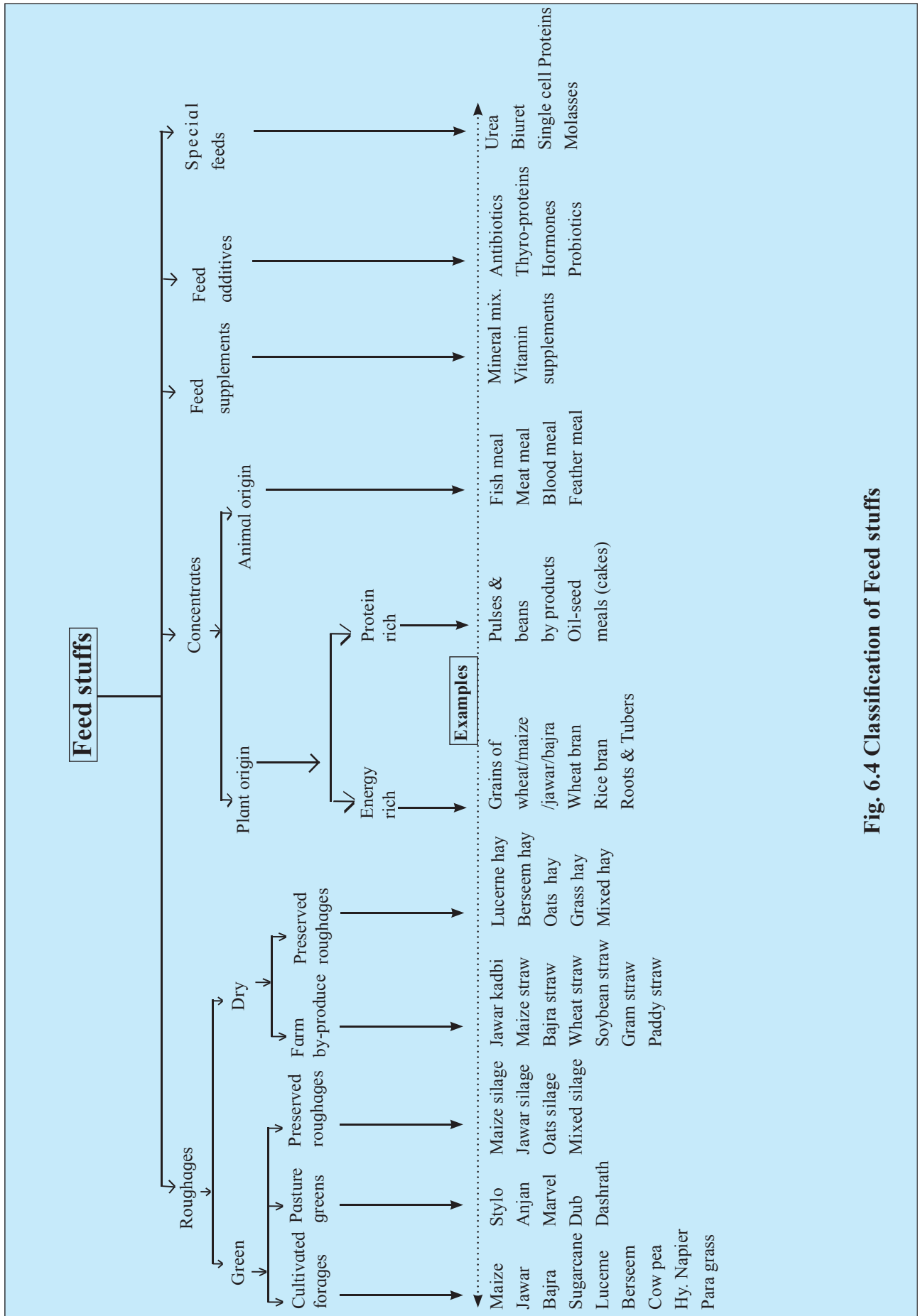


Fig. 6.4 Classification of Feed stuffs

## 6.2 CLASSIFICATION OF FEED STUFFS

Feedstuff is any material fed to animal for providing nourishment. The diet of farm animal primarily consists of plants and plant-products; however, feeds of animal origin are also used in limited proportion.

The various feedstuffs used in livestock feeding are broadly classified into following groups:

1. Roughages
2. Concentrates
3. Feed supplements
4. Feed additives
5. Special feeds

### 6.2.1 Roughages

#### Remember...

- **Roughages are the feedstuffs which contains more than 18% crude fibre and less than 60% TDN.**
- **In absence of roughages, ruminants can not synthesize required proteins, vitamins and enzymes.**



Roughages are voluminous feedstuffs and are poor in nutrient quality. They are edible herbage eaten by the animals. The term forage is also used for roughage. They are bulky due to their light weight or due to high moisture content and loose structure. All roughages are fed mainly to fulfill the voluminous stomach of the ruminants and are utilized either for maintenance or production purpose depending upon the contents of digestible proteins. Fortunately, all these roughages are available on the farm either as crop residues, pasture grasses or can be cultivated on the farm and can be fed either as greens, hay, silage or straws to

the dairy animals. Thus, the farm animals do not compete with the man for foods.

The roughages are further classified as-

1. **Green roughages:** They contain 80-90% moisture. e.g. Pastures, cultivated fodder, silage, tree leaves
2. **Dry roughages:** They contain about 10-15% moisture. e.g Paddy, Wheat straw , Jawar kadbi, hay, dry grasses.

#### Importance of feeding green roughages to the ruminants

1. Green roughages are bulky (voluminous) and, therefore, act as filler and satisfy the appetite of multi-stomach ruminants and mono-gastric animals as well.
2. Green roughages have cooling effect on the body of the animal.
3. They contain 'unidentified' growth factors that favour the normal growth of the animals.
5. They provide nutrients at a cheaper cost than concentrates.
6. Feeding leguminous green fodders like berseem alone can sustain about 10 litres of milk production per day, thus saving feeding cost up to 20 percent.
7. Green roughages are rich in carotene i.e. precursor of vitamin A which maintains the normal vision, skin luster and also build body resistance.
8. Greens supply soluble sugars like glucose, fructose and sucrose, amino acids, vitamins, proteins and minerals in required amounts to all types of livestock.
9. All roughages can be obtained from a cultivated, non-cultivated or pasture land which provide variety of roughages.



**Table 6.7 Differences between roughages and concentrates**

Roughages	Concentrates
1. Roughages contain more than 18 % crude fibre.	1. Concentrates contain less than 18 % crude fibre.
2. They contain less than 60 % TDN.	2. They contain more than 60 % TDN.
3. They are more bulky and lighter per unit weight.	3. They are less bulky and heavier per unit weight.
4. They have comparatively low nutrient digestibility.	4. They have comparatively high nutrient digestibility.
5. They have less nutritive value per unit weight.	5. They have more nutritive value per unit weight.
6. They have low nutrient density.	6. They have high nutrient density.
7. They have wider to medium nutritive ratio(NR).	7. They have narrow to medium nutritive ratio(NR).
8. They are cheaper than the concentrates per unit weight.	8. They are costlier than the roughages per unit weight.
9. Examples: jawar kadbi, wheat straw, lucerne hay	9. Examples: wheat bran, rice bran, oil seed cakes



**Paddy Straw      Jawar Straw      Wheat Straw**

**Fig. 6.5 Dry roughages**



**Ground nut cake      Cotton seed cake      Fish meal**

**Fig. 6.6 Concentrates**

### 6.2.2 Concentrates

Concentrates are high in nutritive value, and physically require less space and more digestible than roughages. They are rich either in energy or in proteins depending upon their source. Generally concentrates of legume origin are rich in digestible proteins and those from non-legume origin show high contents of energy and low proteins. Further, concentrates from agro-industry are having both proteins

and energy in medium range. Animal origin concentrates are rich in proteins. Generally animal origin concentrates are fed to the poultry birds.

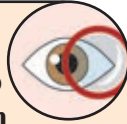
#### Remember...

**Concentrates are the feedstuffs which contain less than 18% crude fibre and more than 60% TDN.**



**Observe and Record...**

**Dry and green roughages fed to cattle, buffalo, sheep & goats in your locality.**



The concentrates are classified as-

1. **Energy rich concentrates:** They are rich in energy. e.g. Cereal grains and their by products.
2. **Protein rich concentrates:** They may be of plant or animal origin.
  - a. Plant origin - e.g.oil cakes, pulses, soybean.
  - b. Animal origin - e.g.Fish/Bone/Meat meal.

**6.2.3 Feed Supplements**

Feed supplements are the compounds supplemented to improve the nutritional value of the basal diet so as to take care of any deficiency. Following are some commonly used feed supplements:

**A. Mineral supplements**

Mineral contents of various feedstuffs vary depending upon the soil profile and individual genetic variation of the plants from which the feedstuffs are prepared.

**Do you know ?**

**The benefits of mineral supplements.**

**Can vitamin and mineral supplements be harmful ?**



Further, the mineral requirement of animals varies with age, sex, type and stage of production. The diet meant for an animal may not supply the required minerals in appropriate quantity which may result in its deficiency. Therefore, mineral supplements do take care of the deficiency of one or more deficit minerals for the effective animal production. These

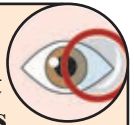
mineral supplements are prepared from the sources like common salt, calcium carbonate, rock phosphate, bone meal etc.

**B. Vitamin Supplements**

Like mineral supplements, vitamin supplements do play a vital role in livestock feeding particularly in commercial farms. Usually different feedstuffs used for livestock feeding are deficit in one or more dietary vitamins and to take care of these vitamin deficiencies, use of specific vitamin(s), vitamin mixture is advised for feeding.

**Observe and Record...**

**Collect the information about mineral and vitamin supplements fed to livestock in your locality.**



**6.2.4 Feed Additives**

**Can you tell ?**

**Which feed additives are available in market for livestock?**



Feed additives are non-nutritive substances, added to the basal diet in small amount in order to improve the feed efficiency and production performance of the livestock. They neither provide any nutrients nor used as a drug for the treatment of any disease.

Feed additives give protection against undesirable environmental influences. By changing the nutritional behavior, they prevent the composition of the diet from undergoing harmful biochemical reactions. Further, they enhance the feed efficiency and improve the performance of the animal directly or indirectly. e.g. thyroproteins, probiotics, antibiotics, etc.

**Remember...**

**Feed additives do not provide any nutrient nor energy to the animals.**



Following are some feed additives used in livestock feeding :

1. **Antibiotics:** These are the anti-bacterial chemicals used in calf feeding.
2. **Antioxidants:** They are used to prevent oxidation of feed-fats and thereby rancidity.
3. **Enzymes:** They are used to improve digestion and feed efficiency.
4. **Thyroproteins** (Iodinated caseins): They are used to increase wool and milk production.
5. **Hormones :** They are used to improve the performance in growth and reproduction, but they should not be used for increasing the milk production.

**Remember...**

Like thyro-proteins, hormones are not used for increasing milk yield



6. **Probiotics :** These preparations are based on live micro-organisms that are consumed as food and feed additives which have beneficial effect on the health status of livestock. They help to prevent imbalances and enhance the growth of healthy microflora.

**Remember...**

The bacteria most commonly used as animal feed probiotics are *Lactobacillus*, *Bacillus*, *Streptococcus*, *Pediococcus*, *Enterococcus* and *Bifidobacterium*.



7. **Prebiotics :** These are defined as non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth / activity of one or limited number of bacteria in colon. The most commonly used prebiotics to yield

health benefits are carbohydrate substrates such as oligosaccharides or dietary fibre with low digestibility.

**Do you know ?**

Use of probiotics and prebiotics in animal feed has shown to benefit digestion, animal performance and improvement in the immunity.



**Functions of Prebiotics and Probiotics**

1. They inhibit growth or reduce the activity of harmful bacteria in intestine.

**Internet my friend**

Search the various prebiotics and probiotics available in the market for livestock.



2. They help in increasing immunity
3. They improve the secretion of digestive enzymes and help in proper digestion.
4. They increase the production of lactic acid and regulate pH of tract.
5. They promote acidic pH for the absorption of protein and minerals like calcium, copper, magnesium, iron and manganese.
8. **Coccidiostats :** They are used to prevent coccidiosis.
9. **Flavouring agents:** They are used to improve palatability and feed appeal.
10. **Pigments:** They improve the quality of animal products e.g. egg yolk colour in poultry.
11. **Pellet binders:** They improve pellet quality and lessen dustiness in the mill.
12. **Feed sweeteners:** They increase palatability and feed conversion.

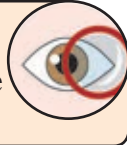
### 6.2.5 Special Feeds

**Definition :** Special Feeds are the substances which are added in the roughage component of the diet to enrich its nutritive value.

Low quality dry roughages like wheat straw, paddy straw, jawar kadbi, maize straw, bajra straw and even crop residues etc are poor in their nutritive value and palatability. However, all these fodders form the major proportion of staple diets of the ruminants.

#### Observe and Record...

**Low quality dry forages available for cattle feeding in your locality.**



Hence, the process of enrichment of these fodders with suitable low-cost energy and protein sources makes them not only palatable but they can be efficiently and completely utilized by the ruminants. Ruminants can efficiently digest fertilizer-grade urea with the help of micro-organisms in to quality proteins, hence urea is used to enrich such low-quality roughages. Feed urea provides 2900 g crude protein/kg. When urea is heated, biuret is obtained. Both are equally useful in ruminants' feeding. Biuret provides 2550 g crude protein/kg.

Use of urea-molasses for increasing the nutritive value and palatability of wheat straw, jawar kadbi, etc is now-a-days practised for their efficient utilization on the livestock farms. The treatment increases digestibility and intake of the treated straw, rate of rumen degradation by more than 50 %. The process is relatively inexpensive, easy to adopt and makes the treated straw pliable and palatable.

### 6.2.6 Unconventional Feedstuffs

Maize, jawar, bajra, hybrid napier, para grass, etc are routinely fed to the livestock hence they are conventional types of feedstuffs. Besides such conventional feeds, the man has lot of choice in the nature to select and feed such

feedstuffs which are not commonly used for livestock feeding. For example, we generally neglect to feed mung or wheat straw and either leave it in the field or burn in the field itself. But if one thinks to utilize such feedstuffs for livestock feeding then all such feeds become unconventional feedstuffs. Considering their palatability and nutritive value, they are to be 'prepared' and then fed to the livestock. Such practice of feeding is most popular during the periods of scarcity or fodder shortage.

Unconventional feedstuffs are, therefore, those which are not commonly/conventionally used for feeding of livestock but fed during the period of fodder scarcity. However, it is to note that these unconventional feedstuffs (i) have poor nutritive value, (ii) their inclusion in the basal diet is limited and (iii) they can efficiently be used only after some or other physical, chemical or biological treatment.

#### Classification of unconventional feedstuffs

Like conventional feed stuffs, there are two types of unconventional feedstuffs :

1. Roughages
2. Concentrates

**1. Unconventional roughages:** They include crop residues and straws and tree leaves from pasture lands. Their contents of DCP range between 0.00 to 9.00 percent and TDN between 40.0 to 50.0 percent depending upon whether they are leguminous or non-leguminous. On the other hand, they have high insoluble ash and lignin; some have such anti-nutritional factors as phytic acid, alkaloids, tannins which reduce palatability and the intake if fed without any treatment.

Some unconventional fodders such as wheat straw, mung straw, maize straw, soybean straw, sugarcane tops, gram straw; others are leaves of banana, glyricedia, babul, sanhemp, tapioca, peepal, banian also form a component of unconventional roughages.

**Observe and Record...**

The various unconventional roughages available in your locality.



**2. Unconventional concentrates:** This group includes variety of plant as well as animal origin materials that can be prepared and used for feeding the livestock. They are:

**A. Plant origin :** Tapioca waste, mango seeds, babul seeds, sugarcane bagasse, tomato pomace, sugarbeet pulp, groundnut kernel, niger cake, neem seed cake, sunflower and safflower meal, etc.

**B. Animal origin :** dried poultry droppings, hydrolysed poultry feather meal, crab meal, cow dung meal, etc.

### 6.3 Antinutritional factors in feedstuffs

Antinutritional factors/ substances are defined as “those substances which are generated in the natural feedstuffs by normal metabolism of the species from which the material originates and by different mechanisms exerting effects abnormal to optimum nutrition.

Intake of such substances through feed causes reduced growth, poor feed conversion, hormonal changes and sometimes histopathological alterations in important organs, ultimately causing economic loss in livestock production. Therefore, care must be taken that they are not present in the animal’s diet.

Antinutritional factors are classified on the basis of their origin and the biological response produced by the animals.

#### 1. Depressing digestion and metabolic utilization of proteins

a. **Protease inhibitors** have the ability to inhibit proteolytic activity of some digestive enzymes. e.g. Inhibiting trypsin present in soybean and kidney beans

seeds.

b. **Saponins**, present in lucerne, produce gases in the rumen digesta—leading to ‘bloat’ when green lucerne is fed in excess

#### 2. Reducing solubility or interfering mineral utilization

a. **Phytic acid** is present in linseed, castor beans, soybean, cotton seed, rice, maize and wheat. It has 6-phosphoric acid radicals and it forms salts with minerals. Though its salts with Na and K are soluble, those with Ca, Mg, Fe and Zn are insoluble. However, addition of enzyme *phytase* to plant feeds increases phosphorous availability. Phytic acid depresses the utilization of minerals like Ca, Mg, Fe and Zn by forming insoluble compounds which get eliminated through faeces.

b. **Oxalic acid** is present in grasses, hybrid napier and paddy straw. In ruminants, excess oxalates combine with feed calcium and thus calcium becomes unavailable for absorption. The calcium oxalate crystallizes in various tissues especially kidney and rumen wall causing oxalate poisoning characterised by rapid and laboured respiration, depression, weakness, coma and finally death.

c. **Gossypol** present in cotton seed cake. It is highly poisonous particularly to poultry birds. It reduces the appetite and body weight.

**Remember...**

Saponins in lucerne, oxalic acid in hybrid napier, nitrates in oats and dhurin in young jawar plant are the antinutritional factors.



d. **Glucosinolates** present in crops of *Brassica* family; are responsible for pungent odour. They depress the synthesis

of thyroxine hormone and cause depressed iodine uptake.

### 3. Inactivating certain vitamins/ hormones

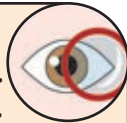
- a. **Mimosine** is present in subabul. When fresh leaves of subabul are fed to ruminant, mimosine is converted to a toxic component which shows alopecia, excessive salivation, poor appetite, weight loss and death. Subabul is toxic to poultry.
- b. Rancid fats inactivate biotin and destroy Vitamin A, D and E.

### 4. Others

- a. **Cynogens** are a) Dhurin—present in premature jowar plants. When hydrolysed by the enzyme present in rumen yields hydrocyanic acid(HCN) which causes death and b) Linamarin – occur in linseed, pulses, cassava.
- b. **Nitrates** ( $\text{NO}_3$ ) present in oats are not poisonous but when oats are fed to the cattle, this  $\text{NO}_3$  are reduced to  $\text{NO}_2$  which is poisonous.
- c. **Mycotoxins:** Under favourable conditions, various fungal species secrete their metabolites called mycotoxins which are harmful to the animals. Aflatoxins are

#### Observe and record...

**Storage conditions favourable for fungal growth in feeds and fodder.**



produced in cottonseed and groundnut cake and cereal grains. Toxicity affects numerous liver functions and cumulative impact can be fatal to animal. Dairy animals, sheep, goats, pigs and poultry are affected by aflatoxins.

#### Internet my friend

Search which mycotoxins are harmful to livestock.



## 6.4 RATION

### Remember...

**Ration is defined as amount of food given to the animal for a period of 24 hours.**



### Types of rations

1. **Maintenance ration:** It is the amount of feed required just to maintain various body processes at optimum rate without any gain or loss in body weight or any change in body composition.

### Remember...

**Production ration is offered over and above the Maintenance ration.**



2. **Production ration:** This is the additional allowance of the daily diet i.e. over and above the maintenance ration to meet demands of production either of milk, meat, wool, egg, etc, as per the type of the livestock. For milking cow, for example, 1 kg of concentrate mixture is offered for every 2.5 litres of milk production. This is production ration.
3. **Balanced ration:** This is the 'total' diet which furnishes all the nutrient demands of the animal in such a proportion and amount that are required for proper nourishment of an animal without any loss or change in body weight.
4. **Pregnancy ration:** It is an extra allowance of ration given to a pregnant animal during the last term of gestation to meet the nutrient requirements of fast growing foetus and also to keep the mother for optimum milk production after calving.

### Remember...

**The pregnancy quota of the ration is given during the last trimester of gestation.**




**Desirable characteristics of ration**

1. Ration should be palatable and should contain digestible feedstuffs so as to ensure optimum feed intake and nutrient availability.
2. It should include sufficient green forages, preferably legumes.
3. It should be free from toxic compounds and foreign substances like metals, moulds, dust, etc which may have undesirable odour.
4. It should be fairly bulky and laxative to satisfy the hunger and to expel the undigested material out.
5. It should include variety of feedstuffs providing all ‘dietary’ essential minerals, vitamins and their precursors.
6. It should be economical

**Do you know ?**

**Feeding cost contributes 60-70 per cent of the total cost of production.**




7. It should be properly processed to ensure a desirable effect.

8. Irrespective of any type of ration, a ration should fulfill the dry matter needs (and thus the appetite) of the animal. Generally, dry matter requirement depends on the live weight of the animal and with the nature of its production. The DM need and intake is calculated at the rate of 2.5 to 3.0 % of live weight.

**Remember...**


**Indigenous cattle, require dry matter (DM) @ 2.5 percent whereas, crossbred cow and buffalo require @ 3.0 percent of their live weight.**



**6.5 THUMB RULE IN CATTLE FEEDING**

**Observe and record ...**

**Different Feeds and fodders required for adult cow/buffalo per day.**



The conventional method of feeding livestock is thumb rule feeding. This method is simple and easily adoptable by common farmer.

**Principles of Thumb Rule:**

1. Dry matter requirement is 2.0 percent of live weight of a dry cow, 2.5 percent of live weight of indigenous lactating cow and 3.0 percent of live weight of milch cross-bred cow or buffalo.

**Table 6.8 : Concentrate requirement for maintenance**

Type of requirement	Concentrate requirement
Maintenance	<b>Indigenous :</b> 1.0 kg, <b>Crossbred cow/buffalo :</b> 1.5 to 2.0 kg
Milk production	<b>Indigenous :</b> i) 1 kg / 2.5 lit milk, if dry roughages are 2/3 <sup>rd</sup> ii) 1 kg / 3.0 lit. milk if dry roughages are 1/2 <b>Crossbred cow/buffalo :</b> i) 1 kg/2.5 lit milk if dry roughages are 1/2
Pregnancy	i) For <i>cow</i> , 1 kg extra allowance during 6 <sup>th</sup> month of pregnancy and 2 kg during 7/8/9 <sup>th</sup> months ii) For <i>buffalo</i> , 1 kg extra allowance during 7 <sup>th</sup> month of pregnancy and 2 kg during 8/9/10 <sup>th</sup> months.
Breeding	<b>Bull :</b> 1 kg extra allowance during the breeding period

2. Roughage requirement should be fulfilled as 2/3<sup>rd</sup> of total DM through dry roughages and 1/3<sup>rd</sup> through green.
3. The requirement of concentrate mixture for maintenance, milk production and pregnancy is as below:
4. Daily feeding of common salt @ 25-50 gram / animal be practised.
5. Minerals are required when good quality greens are not available or when only straws are fed. Commercial mineral mixtures are available and may be used at 1-2 % level.
6. Vitamin mixtures are also available in suitable packs; their use at 20 – 30 grams / 100 kg concentrate mixtures is sufficient.
7. When straw is used as sole roughage, addition of 1 – 2 % lime stone powder(150 mesh) is beneficial.
8. In areas where greens are available for stock feeding, the DCP content of the concentrate mixtures be reduced from 18 to 15 % in line with the quantity of green or hay legume and to 17 % when mixed legumes and grasses are fed.

**Remember...**

**Roughly for every 10 kg of quality greens, 1 kg concentrate mixture can be cut from the concentrate quota with the additional advantage of dry matter, TDN, minerals and vitamins in favour of greens.**



**Limitations of Thumb Rule**

1. If low quality feed ingredients are fed, this method fails to meet the nutrient requirements.
2. It is unsatisfactory method for milch buffaloes because of their high milk fat per cent content.

**Remember...**

**Requirements of a cross-bred cow producing more than 15 litres milk may not be met by thumb rule feeding with straw alone.**



**Try this...**

1. Calculate DM, green, dry roughages and concentrate requirement for indigeneous cow weighing 300 kg and yielding 2.5 liter of milk per day.
2. Calculate DM, green, dry roughages and concentrate requirement for buffalo weighing 400 kg and yielding 5.0 liter of milk per day.



**6.7 WATERING OF ANIMALS**

**Importance of watering the animals**

Water is required essentially for all body functions. It is vital to the life of the animal that water level in the body be maintained. Under normal conditions, excess water is not harmful to the live animals; they normally drink what they require. On the other hand, an animal will die more rapidly if deprived of water than if deprived of food.

**Remember...**

**Reduced water intake adversely affects digestion, assimilation and excretion of waste products in urine and faeces.**





Water is taken by the animal generally when feed is taken and the type of feed in a given set of environment reflects the amount of water the animal requires. Hence the water requirements are highly related to the amount of 'dry matter' the animal consumed. Increased consumption of dry matter increases the water requirement and consumption. Generally, water requirement of adult cattle is 3-5 kg per kg of dry matter intake and for suckling calves it is 6-7 kg for every kg of dry matter. Consumption increases during late pregnancy. Milking cows and buffaloes require additional amount of water to the tune of 4-5 kg for each kg of milk produced. Birds require less water compared to mammals per unit of body size.

toxic substances, micro organisms and unnatural smell make the animal to refuse to drink the water irrespective of thirst. On the contrary, clean, free flowing and abundant fresh water is preferred by all the animals.

**Do you know ?**

**Intake of drinking water is generally 2.5 times that of dry matter or 10-15 percent of body weight.**



**Factors affecting water intake**

Following factors do affect the intake of drinking water by the animal-

1. **Quality of feed:** The high protein diet, pentosans, salt, fats and fibre in the diet increase the water requirements. Silage and laxative feeds increase the water needs.
2. **Time of watering:** More water is consumed during night than day-time. Further, season also affects the water requirement and consumption by the animals.

**Remember...**

**Water should be available to the animals at all times.**



3. **Quality of water:** Water may carry many toxic materials because of its property as a solvent. Presence of excess of mineral salts, in the water, contamination with

**Remember...**

**Animal drinks more water when it is cool, clean and fresh.**



**Try this...**

**Record how much water does a cow drink in summer**



**Drinking water requirement (per day)**

**a. For maintenance:**

Cattle	30 - 40 lit.
Sheep and goat	4 - 5 lit.
Poultry	0.5 lit.
Pig	6 - 8 lit.

**b. For lactation 3 - 4 lit. / kg milk**

**Remember...**

**Ratio of dry matter intake to water intake is 1:4**



**EXERCISES**

**Q.1 Fill in the blanks**

1. Milk casein is an example of..... .
2. Roughages are the feed stuffs which contain more than.....per cent fibre.
3. Urea is an example of .....
4. Vitamin ..... is also called as coagulation factor.
5. Calcium is an example of ..... essential mineral.

**Q.2 Make the pairs.**

A Group		B Group	
i.	Vitamin A	a.	Rickets
ii.	Vitamin D	b.	White muscle disease
iii.	Vitamin E	c.	Night blindness
iv.	Vitamin K	d.	Friable gums
v.	Vitamin C	e.	Increased coagulation time
		f.	Alopecia
		g.	Dermatitis

**Q.3 Identify the odd one out**

1. Arginine / Histidine / Alanine / Valine / Lysine
2. Pastures / Wheat straw / Jawar Kadbi / Hay / Dry grasses
3. Calcium / Phosphorus / Potassium / Copper / Sulphur
4. Trioses / Tetroses / Pentoses / Disaccharides / Hexoses
5. Iron / Zinc / Iodine / Sodium / Cobalt

**Q.4 State True or False**

1. Concentrates are voluminous feed stuffs and are poor in nutrient quality.
2. Dry roughages contain about 10 - 15 per cent moisture.
3. Antioxidants are the anti bacterial chemicals used in calf feeding.

4. Thyroproteins are used to increase wool and milk production.
5. Enzymes are used to improve digestion and feed efficiency.

**Q.5 Give examples**

1. Feed additives used in livestock feeding.
2. Unconventional concentrates.
3. Vitamin supplements in livestock feeding.
4. Essential amino acids.
5. Protein rich concentrates

**Q.6 Answer in brief**

1. Write Importance of feeding green roughages to the ruminants.
2. Give the importance of livestock in Vitamin supplements
3. Write a short note on feed additives.
4. Give classification of unconventional feed stuffs.
5. Give importance of watering in livestock.
6. Write the qualities of drinking water for livestock.
7. Write the principles of thumb rule.
8. Write the limitations of thumb rule.
9. Write the factors affecting the intake of drinking water by the animals.

**Q.7 Differentiate between**

1. Essential and non essential amino acids.
2. Monosaccharides and oligosaccharides.
3. Fat soluble and water soluble vitamins.
4. Roughages and concentrates.
5. Micro and macro minerals.

**Q.8 Give scientific reasons.**

1. Amino acid are also called as buildings blocks of protein.
2. Roughages are called as voluminous feed stuffs.

3. Feed additives are added to the basal diet of livestock.
4. Unconventional feed stuffs are not commonly fed to livestock.

**Q.9 Answer the following questions.**

1. Complete the table.

Vitamin	Source	Functions	Deficiency
Vitamin A			
Vitamin D			

2. Explain with the help of examples.
  - i. Major essential elements or minerals in animal body.
  - ii. Trace elements or minerals in animal body.
3. Calculations.
  - i. Calculate the DM required for 400 kg weighing indigenous lactating cow by thumb rule method.
  - ii. Calculate the DM required for 500 kg weighing buffalo by thumb rule.

**Q.10 Answer in detail.**

1. Give classification of feed stuffs of livestock with suitable examples.
2. Write the functions of water in animal body.
3. Write the functions of minerals in livestock

**Q.11 Complete the following table**

Sr. no.	Mineral	Source	Functions	Deficiency
1	Calcium			Milk fever
2	Phosphorus	oil cakes		
3	Cobalt		Synthesis of VitB <sub>12</sub>	
4	Iron		Role in muscle contraction	Anaemia
5	Vit A			

**Q.12 Read the given following paragraph and answer the questions based on it.**

**Special feeds**

Special feeds are the substances which are added in the roughage component of the diet to enrich its nutritive value. Low quality dry roughages like wheat straw, paddy straw, jawar kadbi and even crop residues are poor in their nutritive value and palatability. However, all these fodders form the major proportion of staple diets of the ruminants. Hence the process of enrichment of these fodders with suitable low – cost energy and protein sources make them not only palatable but they can be efficiently and completely utilized by the ruminants. Ruminants can efficiently digest fertilizer – grade urea with the help of micro organisms in to quality proteins, hence urea is used to enrich such low quality roughages. Feed urea provides 2900 g crude protein / kg. When urea is heated, biuret is obtained. Both are useful in ruminants feeding. Biuret provides 2550g crude protein / kg. Use of urea – molasses for increasing nutritive value and palatability of wheat straw, jawar kadbi, etc. is now a day’s practiced for their efficient utilization on the livestock farms.

**Questions**

1. How the nutritive value of wheat straw is increased for feeding livestock?
2. How much quantity of crude protein is provided by feeding urea to livestock?
3. How ruminants can digest fertilizer – grade urea?
4. What happens when urea is heated?
5. Write the names of dry roughages you know having low quality nutritive value.

## 7. FORAGE PRODUCTION

### Can you recall ?



- 1 Why milk production is low in Indian cattle ?
- 2 Land preparation for fodder crops
- 3 Various seasons for growing different forage crops.
- 4 Different types of forages.

India stands first in milk production in the world but, the livestock productivity is low as

compared to developed countries. Deficiency in feed and fodder is identified as one of the major reason for low productivity of dairy animals in India. The shortages in dry and green fodder by 2020 will be 24.81 and 64.21 per cent compared with the requirements of 630 and 1134 million tons for the current livestock population, respectively. Therefore there is need to increase fodder production to meet nutritional requirement of livestock and for improving their productivity.

**Table 7.1: Projected demand, supply and fodder deficits in the country (Million tons)**

Year	Demand		Supply		Deficit		Deficit as %	
	Green	Dry	Green	Dry	Green	Dry	Green	
2010	589	1061	451	395.2	138	666	23.46	62.76
2015	609	1097	466	400.6	143	686	23.56	63.50
2020	630	1134	473	405.9	157	728	24.81	64.21
2025*	650	1170	488	411.3	162	759	24.92	64.87
2050*	631.0	1012.7	547.7	826.0	83.27	186.6	13.20	18.43

\*Figures are projections

**Source: Based on Five year Plan Document, Government of India.**

**The term forages means the plants used for feeding domestic animals. This includes both fodder plants and pastures.**

Fodders are the plants which are cultivated as forage crops and they are cut and

fed to animals in the stalls whereas pastures are grasses and legumes, grown in pasture lands where the animals are lead to graze them.

### Do you know ?



**Various forage crops grown in your locality.**

## 7.1 CLASSIFICATION OF FODDER CROPS

Forage crops can be grouped as follows :

1. Cereal forages
2. Leguminous forages
3. Grasses
4. Fodder trees and shrubs

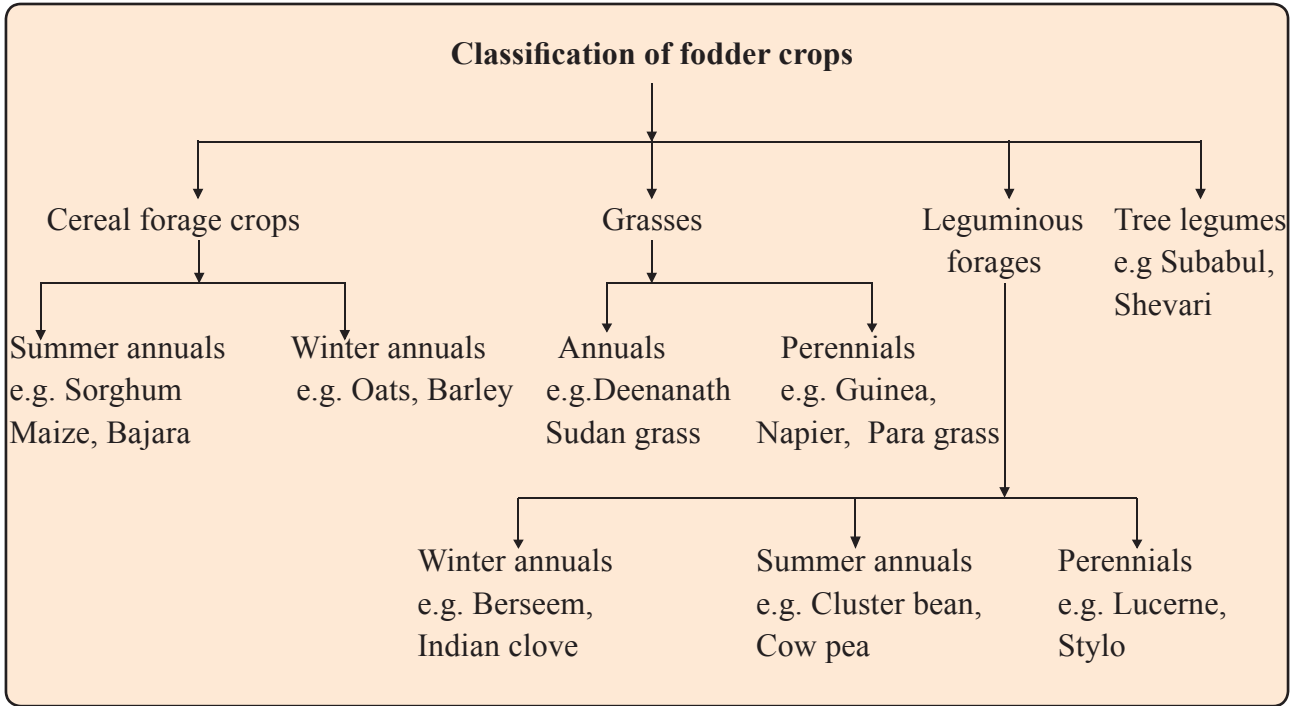


Fig. 7.1 Classification of fodder crops.

## 7.2 CULTIVATION PRACTICES OF COMMON FODDER CROPS

Fodder crops are the plant species cultivated and harvested for feeding the animals in the form of forage (cut green and fed fresh), silage (preserved under anaerobic condition) and hay (dehydrated green fodder).

### 7.3.1. Cereal forages

#### Can you recall ?

Terms viz. cereals, interculturating, manures and harvesting



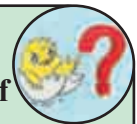
#### 1. Maize (*Zea mays* (L))

Maize or corn is one of the cereal crops of the world serving as food for man and forage for cattle. It is fast growing, high yielding, highly

nutritious and palatable green fodder. It is rich in carbohydrates. Its feeding stimulates milk production in milch animals. It can be cut and fed at any stage with no risk and therefore it is called as 'king of forage crops.'

#### Do you know ?

- Maize is called as the king of fodder crops
- Maize fodder contains 9 – 11 % crude protein and 25-35% crude fiber.



**Soil:** It can be grown on all kinds of soils with pH 7.5 to 8.5. It requires a good supply of moisture and warmth from germination to flowering.

**Land preparation:** The soil should be deeply ploughed and harrowed. Before last

harrowing 5-10 tons of Farm Yard Manure (FYM) /ha should be added .

**Seeds and sowing:** Maize can be cultivated in all three seasons. *kharif*, *Rabi*, Summer with sowing in June - July, September - October and February – March, respectively. The recommended seed rate is 40-50 kg/ha. Spacing should be 25-30 cm between rows and 10-15 cm between plants.



**Fig. 7.2 Maize (*Zea Mays L.*)**

**Interculturing:** The first weeding is given at 20-25 cm height and second weeding at about 60 cm height.

**Manures and fertilizers:** The crop requires heavy manuring and responds well to fertilizers. At the time of sowing, FYM@5-10 tonnes/ha and N:P:K shall be given @ 100:50:50 kg/ha. One half of N i.e. 50 kg/ha, full P & full K shall be given as a basal dose. The remaining one half of nitrogen shall be given at 30 days after sowing.

**Irrigation:** Maize is fairly draught tolerant and it can withstand a draught period up to 4-5 weeks. Irrigation is necessary immediately after sowing. Subsequent irrigation shall be given at 10-15 days intervals.

**Varieties:** African Tall, Ganga-5, Vijay Composite, Manjari Composite, Ganga-3, Ganga safed-2.

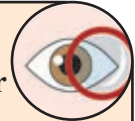
### Do you know ?



**African tall is a the very famous and popular variety of maize fodder.**

**Harvesting and storage:** Cut at teaseling to wax-ripe stage for green fodder purposes. However, for silage making medium dough stage is recommended. Green fodder yield ranges from 40 - 50 tons/ha.

### Observe and Record...



**The cultivation practices for maize fodder crop.**

## 2. Jowar (*Sorghum bicolor (L)*)

Jowar is one of the most important cereal fodder crop of dry-land agriculture. Its grains are used both by both man as food and animals as feed.

**Soil :** Sorghum can be grown on variety of soils, but medium and deep black soils are suitable. This crop tolerates saline and alkaline conditions to some extent and can also thrive well in acidic soils with pH 5.5

### Remember...



**Jowar fodder contains 8 - 10 % crude protein and 32 % crude fiber.**

**Land preparation:** Deep ploughing with clod crushing and 2 to 3 harrowings are required.

**Seeds and sowing:** Sowing is done in June-July, Sept.-Oct. and February-March for *kharif*, *rabbi*, and *summer*, respectively. A seed rate of 6-8 kg/ha is recommended. Spacing usually followed is 25-30 cm between rows and 10-15 cm between plants.

**Interculturing:** For early season weed control, apply Attrazine @ 1.0 kg/ha, pre-emergence for broad leaf weed control, 2,4-D can be applied post- emergence by 4-5 weeks @ 0.75-1.0 kg/ha for the parasitic weeds.

**Manures and fertilizers:** For a rainfed Jowar crop, Farm Yard Manure (F.Y.M.) @ 10 tons/ha and for irrigated crop @25 tons/ha is to be applied 20-25days before sowing. Total requirements of N:P:K is 100:50:40 kg/ha. One half of nitrogen, full phosphorous and full potassium is given as basal dose and remaining one half nitrogen shall be given after 30 days of sowing .

**Irrigation:** The irrigated crop must be given water at least every fortnight. Usually, five to seven irrigations are required.

**Varieties/ cultivars:** Ruchira (R.S.-11-4), Maldandi (35-1), Nilwa, M.P. Chari, Pusa Chari, PC-6, PC-9, PC-23, JS-3, S-1049, Phule Amruta, Phule Godhan

**Harvesting and storage:** Fodder sorghum is very palatable, especially in flowering stage. Harvesting is normally done at 50 percent flowering stage i.e. at 60-75 days. In case of Multicut jowar, first cutting is made after 50-55 days and subsequent cutting after 40-45 days. Yield may be in the range of 35 - 40 tons/ha (single cut) and 100-150 tons/ha (Multicut jowar).

**Remember...**

The feeding of Jowar up to 45 days from germination is avoided in cattle due to higher content of Hydrocyanic acid (HCN).



Sorghum is one of the best crops for silage because of its high yields, sugar content and juiciness of the stalk. Sorghum is harvested at the milk or soft dough stage for silage making.

### 7.2.2. Leguminous forages

#### 1. Lucerne (*Medicago sativa* (L))

Lucerne or Alfalfa is considered as the 'Queen' of fodder crops. It is one of the most important perennial, irrigated, leguminous forage crops of India grown extensively in the Rabi season.

**Do you know ?**

1. Lucerne contains 19 – 22 per cent crude protein and 25.7 per cent crude fiber.
2. Saponin, a glycoside, present in lucerne is responsible for bloat.



**Soil:** Lucerne is grown under varied range of soil types. It prefers a fertile soil, which is rich in organic matter.

**Land preparation:** Lucerne needs very fine seed bed as the seeds are small. The required tilts may be obtained by giving one deep ploughing followed by two harrowings and cross planking.



Fig. 7.3 Lucerne (*Medicago sativa* (L))

**Seeds and sowing:** The best time of sowing is middle of October to end of November. The seed rate is 12-15 kg/ha. The recommended row to row spacing is 30 cm. Seeds are treated with Rhizobium culture to stimulate the crop for N-fixation

**Interculturing:** Lucerne is a poor competitor with weeds. In the initial stages, an interculturing especially three weeks after planting, will be effective for controlling weeds.

**Manures and fertilizers:** FYM @ 25 to 30 tons/ha may be given in the first year, and 10 tons/ha in the later years. Each year NPK fertilizers is given @ 20:150:40 kg/ha before sowing and for vigorous growth every four

months 20 kg N plus 50 Kg P or 100 Kg DAP is given.

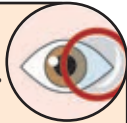
**Irrigation:** The crop responds well to irrigation. A pre-sowing irrigation is necessary for germination. Initially, irrigation is given immediately after sowing and the seed bed is kept continuously moist. The crop requires 15 to 18 irrigations in a year with interval of 12 to 15 days in winter and 8 to 10 days in summer.

**Varieties:** Anand -1, Anand – 2, Anand-3, Anand-4, Anand-8, Sirsa-8, Sirsa-9, CO1,CO3 and RL 88.

**Harvesting and storage :** First cutting at flowering stage i.e. 45-60 days after sowing and the subsequent cuttings every 25-35 days interval. Annual total green fodder yield is 80-100 tons/ha from 10-12 cuttings.

### Observe and Record...

The cultivation practices for lucerne fodder crop.



## 2. Berseem (*Trifolium alexandrinum* (L))

Berseem is leguminous forage crop grown as *rabi* crop. It is highly nutritious, succulent and palatable. It is high in crude protein (20-24% ) and low in carbohydrates.

### Remember...

- In Maharashtra berseem is called as “Horse grass”
- The best sowing time for berseem is the first fortnight of October.
- Berseem contains 17 - 19 % crude protein and 27.7 % crude fiber.



**Soil:** The soil must be well drained. Clay loam soil rich in calcium and phosphorus are the best soil types for this crop.

**Land preparation:** Fine seed bed is required as berseem seed is very small. After harvest of *Kharif* crop, 3 to 4 ploughings followed by planking for breaking the clods and leveling the surface are recommended.

**Seeds and sowing:** Seed rate usually used is 25- 30 kg/ha. Seed treatment with *Rhizobium* strain may be made before sowing. To eliminate chicory in berseem crop, the seed should be poured in one per cent common salt solution and the floating chicory seeds should be taken out and berseem seed is cleaned with fresh water, dried under shade and then sown. The best time for sowing is the first fortnight of October. The recommended row to row spacing is 30 cm.



Fig. 7.4 Berseem (*Trifolium alexandrinum* (L))

**Interculturing:** Generally 2 to 3 weedings are sufficient. Shallow hoeing may be necessary to facilitate better development of crop. Chicory is a problematic weed in berseem. Therefore, efforts should be taken to eliminate this weed.

**Manures and fertilizers:** FYM is to be applied @ 10-15 tons/ha. NPK fertilizers @ 20:80:40 kg/ha and @ 20kgN/ha at each cutting.

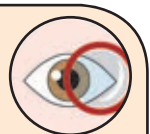
**Irrigation:** Entire crop needs 10-12 irrigations with interval of 10 days in October and 15 to 20 days during November to January.

**Varieties:** Mascavi, Wardan -4, JB-1, JHB-146

**Harvesting and storage:** The first cut can be taken at 50-60 days after sowing and subsequent cuttings after every 30-35 days. It yields 60 - 80 tons green fodder/ha.

### Observe and Record

Is berseem fodder crop grown in your area ?





### 3. Cowpea (*Vigna sinensis* (L))

Cowpea is an important leguminous pulse crop of high protein content, which can be grown as fodder crop. Cowpea is a quick growing crop, which produces tremendous quantity of bulk in short span of time. Therefore, it is esteemed as a valuable catch crop as fodder.

#### Do you know ?

- Cowpea has very good feeding value as it contains 13 - 15 % crude protein.
- Cowpea fodder is cultivated as sole and mix crop.
- Cow pea is valuable catch crop for fodder.



**Soil:** Cowpea can be grown on wide range of soils from sandy to well drained clays. It adapts to a wide range of pH, but prefers slightly acid to slightly alkaline soils usually with a pH range of 5 to 6.5.



Fig. 7.5 Cowpea (*Vigna sinensis* (L).)

**Land preparation:** Two or three ploughings are given to produce a coarse seedbed for the crop.

**Seeds and sowing:** The seeds can be broadcasted, drilled or dibbled in lines. Seed rate recommended is 40 kg/ha. Typically, a row to row distance of 30 to 40 cm and plant to plant distance of 10 to 15 cm is essential. The proper sowing time is June to August.

**Interculturing:** Trifluralin may be applied to soil @ 0.75 kg/ha. 6-8 days before sowing. One or two weedings may be required in early growth stages to control weed problems.

**Manures and fertilizers:** FYM @ 10 tonnes/ha, 20 kg N and 40 kg P shall be given before sowing. Cowpea responds favorably to calcium where the pH is low.

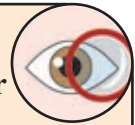
**Irrigation:** A pre-sowing irrigation is important for the proper germination of the crop. If soil moisture is deficient, shallow irrigation at 3-4 cm depth once in 15 days during summer and once in a month during post monsoon period be given.

**Varieties:** EC 4216, *Sweta* (No-998) U.P.C -625, *Bundel lobia 2*, CO-8

**Harvesting and storage:** The first cutting can be given at about 50-60 days ( 50% flowering stage). A green fodder yield is about 40 tons/ha annually.

#### Observe and Record...

The cultivation practices for cowpea as a fodder crop.



### 7.2.3. Grasses

#### 1. Hybrid napier (*Pennisetum purpureum* x *P.americanum*)

Napier grass is a native of Zimbabwe in tropical Africa. It is a tall clumped grass with thick growth, which gives the name elephant grass. Its peculiarity is its high forage yield.

Hybrid Napier is superior in quality than Napier grass and usually contains about 10.2 per cent crude protein and 30.5 per cent crude fiber.

**Soil:** Napier grass can be grown on a variety of soils. However, sandy loams to clay loams are preferred. Deep fertile soil, rich in organic matter and nutrients are ideal. Water logged and flood prone areas are not suitable. It can tolerate a pH ranging from 5 to 8.

**Land preparation:** Three to four ploughings followed by a harrowing are required. Add FYM @20 to 30 tons/ha before a month of planting.



**Fig. 7.6 Hybrid Napier** (*Pennisetum purpureum x P.americanum*)

**Seeds and sowing:** In *kharif* planting time is July to August and during summer it is February to March. It is planted with rooted stubbles of previous crops having three buds. It is planted with 2 buds below and 1 bud above the soil. The recommended spacing is 90 x 60 cm.

**Inter culturing:** Weeding and inter-cultivation is required in the early stages. Initially inter cultivation once or twice is necessary for better development. Later on inter cultivation may be given as and when necessary after harvest to stir the soil and to control weeds.

**Manures and fertilizers:** FYM or compost @ 25 tons/ha at the time of land preparation. As the grass is a heavy yielder, it responds well to nitrogen application. NPK required is 50:40:20 kg/ha. Nitrogen @ 25 kg/ha is given after each cutting.

**Irrigation:** If sufficient rains are not received, about two irrigations are required for the development. During the summer regular irrigation at weekly or fortnightly interval depending on soil types is required.

**Varieties:** Co-1, Co-2, Co-3, DHN-6, Gajraj and Phule Yashwant, Phule Jaywant (R.B.N. -13), Phule Gunvant are some of the varieties recommended

**Can you tell ?**

**Improved varieties of Hybrid napier cultivated in you locality.**

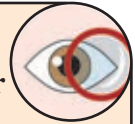


**Harvesting and storage :** Hybrid Napier is commonly used in a cut and carry system. The crop will be ready for the first harvest by 75 days after planting. Subsequent cuts can be given at an interval of 30-45 days or when the plants attain a height of 1.5m. Annual green fodder yield is 200 - 250 tons/ha within 8 cuttings and near about 20-25 tons during fist cutting.

## 2. Marvel Grass (*Dichanthium annulatum*)

**Observe and Record...**

**The cultivation practices for hybrid napier as a fodder crop.**



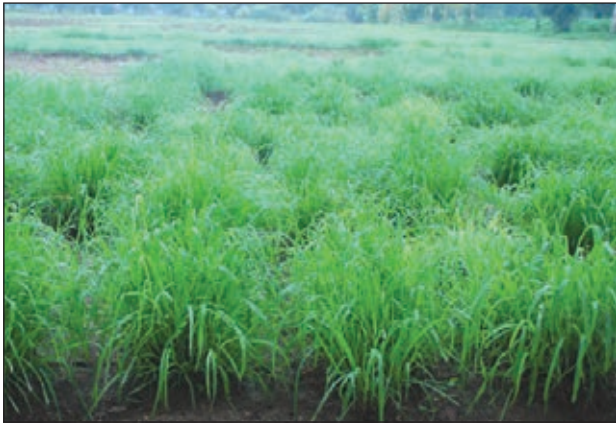
Marvel grass is an important monocot forage crop from family poaceae. It is grown for pasture purpose. It contains 6.5 to 7.5 % protein.

**Soil :** Marvel is grown under light to medium soil in rainfed condition while in irrigated condition it is grown in light ,medium fertile and well drained soil.

**Land preparation :** Marvel grass needs well pulverized soil. The required tilth may be obtained by one ploughing and one harrowing both in irrigated and rainfed conditions.

**Seeds and sowing:** In rainfed condition grown only in kharif season and in irrigated condition grown in both kharif and summer season.

Rainfed –June to August Irrigated – Kharif - June to August Summer: February to March



**Fig. 7.6 Marvel Grass**  
(*Dichanthium annulatum*) (L.)

Seed requirement is 75000 sets per ha for rainfed as well as irrigated condition. The recommended spacing is 45 × 30 cm.

**Interculturing:** Only one weeding is required for rainfed condition and 1 or 2 weedings for irrigated condition.

**Manures and fertilizers :** Rainfed: FYM @ 5-10 tons per ha may be given . 30 Kg N , 30 Kg P and 20 Kg K should be applied before sowing. After every harvesting 30 Kg N is given.

Irrigated: 10-15 tons FYM per ha may be given. 30:40 : 20 Kg NPK before sowing and 30 Kg N after every harvesting should be applied .

**Irrigation:** In kharif irrigation is not required, however, in summer it is given with 10-15 days interval.

**Varieties:** Phule marvel 06-40, Phule marvel -1(rainfed), Phule gowardhan (irrigated)

**Harvesting:** Only 2 cuttings should be done in rainfed condition while 6-8 cuttings in irrigated condition. First cutting should be done at 50-60 days after sowing and the subsequent cuttings at 45 days interval.

**Yield:** Rainfed : Green fodder 350-450 qtl /ha/year. Irrigated : Green fodder 600-700 qtl per ha per year.

**Can you tell ?**



- 1 **Crude protein content in marvel grass?**
- 2 **Whether marvel grass is cultivated in your area.**

**3. Stylo (*Stylo hemmata*)**

Stylo is an important perennial leguminous forage crop. It contains 12-14% protein.

**Soil-** Stylo is grown under light to medium and well drained soil.

**Land preparation:** The required tilth may be obtained by one ploughing and one harrowing.



**Fig. 7.7 Stylo (*Stylo hemmata*)**

**Seeds and sowing:** Sowing is done in kharif season (June-July). Sowing can be done by drilling method at 30 cm distance or broadcasting method. Seed should not be covered by soil. 10 kg seed is required for 1 ha. Seed should be treated with *Rhizobium* @ 250 gm/10 kg seed before sowing.

**Interculturing:** Only one weeding is required.

**Manure and Fertilizers:** 20:40:20 kg NPK/ha before sowing and in the month of July-August 50 kg P/ha is given at every year.

**Irrigation:** Water is given as per the crop need.

**Varieties:** Phule Kranti

**Harvesting:** Two cuttings per year should be done.

**Yield:** Green fodder yield is 250 to 300 qtl/ha annually.

**Observe and Record...**

**The cultivation practices for stylo fodder crop.**



**7.2.4 Fodder trees and shrubs**

**1. Subabul (*Leucaena leucocephala*)**

Subabul is the most well known perennial legume tree in the world. It is draught resistant because of its very deep root system. It tolerates large differences or variations in rainfall, sunlight, salinity compared to other legumes. It is grown in many countries as a good source of organic manure. The wood is used as firewood and for timber purposes.



**Fig. 7.9 Subabul (*Leucaena leucocephala*)**

It is highly palatable and nutritious.. The leaves and seed contain uncommon amino acids, a glycoside called ‘Mimosine’ which is toxic to non-ruminants and its continuous feeding to ruminants results into alopecia.

**Soil:** Subabul is not very specific in its soil requirements, but flourishes in deep well drained neutral soils.

**Land preparation:** Land is prepared with help of deep ploughing and the clod crushing.

**Seeds and sowing:** Usual seed rate is 5-6 kg/ha. Seeds are soaked in hot water overnight and planted at 1 m x 1 m spacing. Planting is preferred in June to August.

**Interculturing:** Weeding or weed control is necessary during initial stages of establishment. During first three months of planting, two or three inter cultivations are needed to control weeds. Once developed, no further weeding is required.

**Manures and fertilizers:** Organic manures such as compost and farm yard manure (FYM) shall be applied @ 8 to 10 tons/ha before planting. A basal application of NPK @ 25:60:40 kg/ha is required.

**Irrigation management:** During monsoon season there is no need of water but during summer season irrigation and its interval is most important.

**Varieties:** Hawaiian type(K341).Salvador type(K-8) , Subabul CO-1(P),FD 1423

**Harvesting:** Normally first cutting is made at five to six months after planting and subsequent cuts can be made at 50-60 days interval depending on regrowth. It is commonly done at about 100 cm height.

**Yield:** Green fodder yield is 40-50 tons / ha annually.

**Can you tell ?**

**Why subabul leaves and seeds are not given to ruminants continuously?**



**2. Dasharath (*Desmanthus virgatus*)**

It is perennial crop. It contains 11-12 % Protein. It is grown throughout the year under irrigation and during June-October as rainfed crop.

**Soil:** All types of soils particularly well drained, light to medium are preferred.



**Fig.7.9 Dasharath (*Desmanthus virgatus*)**

**Land preparation :** Land is prepared with the help of deep ploughing and two harrowings.

**Seeds and sowing:** Dashrath is sown in the month of June-July(Kharif season). Usual seed rate is 15 kg/ha. Spacing required is 60-100 cm.

**Manures and fertilizers:** Organic manures such as compost and farm yard manure (FYM) shall be applied @ 8 to 10 tons/ha. NPK is applied @ 20:20:50 kg/ha.

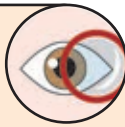
**Varieties:** CO-5, Russian giant, EC-4216, UPC-287

**Harvesting:**4-5 cuttings per year be done.

**Yield:** Green fodder- 55 – 60 tons/year.

**Observe and Record...**

**Different types of trees used for livestock feeding**



**3. Shevari (*Sesbania grandiflora*)**

Shevari tree grows throughout the year even in less fertile and saline soils. It is drought resistant, fast growing tree suitable for all livestock. It contains 25% protein. It must constitute only 8-10% of the feed.

**Soil:** All types of soil especially well drained medium soil is good for cultivation.

**Land preparation :** Land is prepared with the help of deep ploughing and two harrowings.

**Do you know ?**

**Shevari is highly preferred by small ruminants as a feed.**



**Fig.7.10 Shevari (*Sesbania grandiflora*)**

**Seeds and sowing:** Shevari is planted preferably in the months of June-July (Kharif season). About 7.5-8.0 kg seed /ha is planted at 1m x 1 m spacing.

**Manures and fertilizers:** Organic manures such as farm yard manure (FYM) shall be applied @ 20 to 25 tons/ha before planting. NPK is applied @ 20:50:20 kg/ha.

**Varieties:** Local variety

**Harvesting:** First cutting is done at 5-6 months and subsequent cuttings are made after every 50-60 days.

**Yield:** Green fodder yield is 50 – 60 tons annually.

**Observe and Record...**

1. The cultivation practices for Shevari fodder crop.
2. Identify and classify different fodder crops grown in your area.
3. Prepare the album of various fodder crops available in your region.



**7.4 Azolla Production**

Azolla is a floating fern and belongs to the family of Azollaceae. Azolla hosts symbiotic blue green algae, *Azolla pinnata*, which is responsible for the fixation and assimilation of atmospheric nitrogen. It is rich in essential amino acids, vitamins (vitamin A, vitamin B12 and Beta-Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc.



Fig.7.12 Azolla Production

Table 7.2 : Nutritive value of Azolla

Dry matter	Crude protein	Crude fibre	Calcium	Phosphorous
4.7%	22.48%	14.7%	1.64%	0.34%

### Procedure

The following method suggested by Natural Resources Development Project (NARDEP) may be followed for its production.

1. Dig or build a pit preferably of 2 x 2 x 0.2m.
2. Cover the pit with polythene sheet to avoid percolation of water from pit.
3. All corners of the pit should be at the same level so that a uniform water level in the pit can be maintained.
4. Mix about 10 – 15 kg of sieved fertile soil in sufficient quantity of water and spread on polythene sheet.
5. Make slurry of 2 kg cow dung and 30 g of super phosphate in 10 litres of water and pour on the sheet. Pour more water to raise the water level to about 10 cm.
6. Place about 0.5–1 kg of fresh and pure culture of *Azolla* in the water. This will grow rapidly and fill the pit within 10–15 days.
7. From then on, 2 to 2.5 kg fresh *Azolla* can be harvested daily. A mixture of 20 g of super phosphate and about 1 kg of cow

dung should be added once every 5 days in order to maintain rapid multiplication of the *Azolla* and to maintain the daily yield of 500 g.

8. Harvest the floating *Azolla* plants from pit using a scoop net to drain the water.

### Remember...

- Temperature should be around 35°C.
- The fodder plot is to be covered with a plastic sheet in cold regions so as to reduce the impact of cold weather.
- Places with adequate sunlight should be preferred (under the shade of a tree/ green shed net)
- pH of the medium should be between 5.5 to 7.0

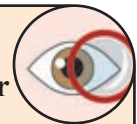


### Preparing Azolla as livestock feed

- For use as a livestock feed, the fresh *Azolla* should be mixed with commercial feed in 1:1 ratio to feed livestock. After a fortnight of feeding on *Azolla* mixed with concentrate, livestock may be fed with *Azolla* without added concentrate.
- For poultry, *Azolla* can be fed to egg layers as well as broilers.
- In case of severe pest attack the best option is to empty the entire bed and lay out a fresh bed in a different location.

### Observe and Record...

The cultivation practices for *Azolla* production.



**EXERCISES**

**Q.1 Fill the blanks**

1. Immature Jowar plant contains ..... toxin.
2. .... is the king of forage crop.
3. .... crop is called as 'Queen' of forage crops.
4. In Maharashtra berseem is called as .....
5. .... is the popular variety of stylo.

**Q.2 Make the pairs**

Group A	Group B
1. Saponin	a. Shweta (No-998)
2. <i>Medicago sativa</i>	b. Perennial legume tree
3. Maize	c. Queen of fodder
4. Lucerne	d. Summer annuals
5. Subabul	e. Cereal forage crop
	f. Lucerne
	g. Responsible for bloat

**Q.3 Identify the odd one out**

1. DHN6, CO-1, CO-2, CO-3, Mascavi.
2. Jowar, Maize, Bajara, Oats, Subabul.
3. Anand-1, Anand-2, Anand-3, Anand-4, Anand-5.
4. M.P. Chari, PUSA Chari, Maldandi, Nilwa, CSH-1.
5. Lucerne, Berseem, Cowpea, Stylo, Jowar.

**Q.4 State true or false**

1. Sorghum is the cereal forage crop.
2. Deficiency of feed and fodder is identified as one of the major constraints in achieving desired level of livestock productivity in India.

3. Hybrid napier is also called as elephant grass.
4. Phule gowardhan is the variety of stylo grass.
5. Maldandi is the variety of Jowar.

**Q.5 Answer in brief**

1. Why maize is called as king of forage crops ?
2. Write the seed rate and sowing of lucerne.
3. Why the harvesting of jowar fodder is normally done at flowering stage?
4. Why the cow pea is considered as valuable catch crop fodder?
5. Write the soil and climatic conditions required for berseem.

**Q.6 Answer the following questions**

**1. Complete the following table**

Sr. No.	Name of the forage crop	% crude protein	% crude fiber
1	Maize		
2	Jowar		
3	Lucerne		
4	Berseem		

**Q.7 Answer the following questions**

1. Describe in detail the common cultivation practices of maize.
2. Describe in detail the common cultivation practices of Jowar.
3. Discuss in detail the cultivation practices of Lucerne.
4. Explain in detail the cultivation practices of Azolla production.

## 8. FEED TECHNOLOGY

### Can you recall ?

1. The different types of feed fed to the animal
2. Methods of feed preservation



### 8.1 PRESERVATION OF FORAGES

In our country, the availability of greens is limited to a particular season only. During the lean months of April to July, green forages are not available for feeding to the dairy animals, however, during Kharif season plenty of greens are available but excess greens are neither properly utilized nor preserved scientifically. Hence, when green forages are in plenty, they need to be conserved as either hay or silage to meet the demand during the lean season.

### Remember... that

Green forages are preserved without reducing their palatability or nutritive value by converting them into hay or silage.



Besides the main advantage of feeding greens during the lean period in the form of hay or silage, preservation of greens has following advantages -

1. Hay making protects green forages of the pasture land from fire hazards.
2. Preserving large quantity of greens in limited space releases the land for the cultivation of other fodder-crops.
3. Such preservation retains higher proportion of nutrients more than keeping forages in the field which may have the risk of nutrients loss due to shattering or natural maturity of the forage.

4. Both hays as well as silages are more nutritious than their unpreserved counterparts.
5. During the process of preservation, harmful compounds present in the weedy plants are destroyed.

#### 8.1.1 Hay making

**Hay is defined as green forage dried up to 15 percent moisture level enough to inhibit the action of plant and microbial enzymes.**

Crops suitable for hay making:

1. All thin and hollow stemmed legumes and grasses are best suited for hay making.
2. Forages like Oat, Lucerne, Berseem, Soybean, Jawar, Bajara, Cow peas and quality grasses like Marvel, Napier can form a good hay.

#### Methodology for hay making

1. There should be plenty of sunshine during the complete process of hay making.
2. The crop for hay making should be cut when it is in 50 percent flowering stage.
3. Keep it in the field for further 2 days with morning and evening turning till it achieves 60 percent DM.



Fig. 8.1 Lucerne hay



- From 3<sup>rd</sup> day, keep the bundles of the partially dried forage on a structure of tripod for further drying. This tripod curing conserves the carotene more effectively and accelerates the drying action by increasing the total area of the exposure to the sun.
- When the DM reaches to about 85 percent, the material is taken in the shed and stored in the form of heap or bails.

**Remember...**

Hay should not contain more than 15 per cent moisture.

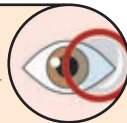


**Characteristics of good hay**

- It contains 15 per cent moisture.
- It has typical aroma of the forage and it is palatable.
- It is rich in carotene and calcium.
- It contains 9 to 11 per cent DCP and 50 to 60 per cent TDN.

**Observe and try this :**

- Forage crops used for hay making in your area
- Observe the process of hay making in your locality



**8.1.2 Silage making**

Silage is defined as green fodder preserved in more or less in its original form with a minimum deterioration of nutrients under anaerobic conditions for minimum 60 days.

Silage is a fermented feed resulting from the storage of high moisture crops, usually green forages, under anaerobic conditions in a structure known as a silo.

**Do you know ?**

- Silage is the pickle for dairy animals



**Ensiling / Ensilage**

It includes all physical and chemical changes that take place when forage with sufficient moisture is stored in a silo in the absence of air.

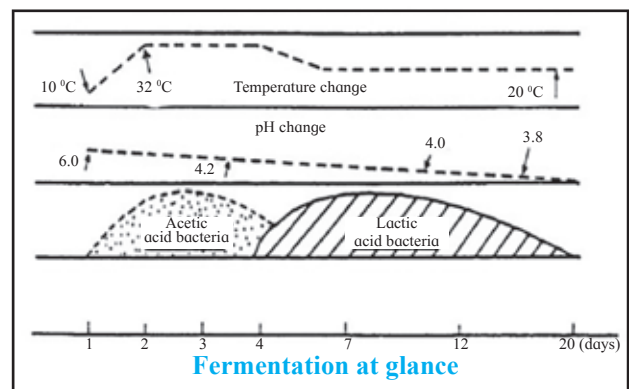


**Fig. 8.2 Silage making**

The entire ensiling process requires two to three weeks for converting forage into silage.

**Remember...**

If the lactic acid production is insufficient, butyric acid fermentation begins and quality deterioration occurs.



**Fig. 8.3 Diagram showing the fermentation process of silage**

**Qualities of forage crops suitable for silage making**

- It should have minimum 30 to 35 percent dry matter and 8 to 10 percent soluble carbohydrates.

2. It should have pliable and soft stem which can be compressed properly to create anaerobic conditions.
3. Green maize, jawar, bajra, hybrid napier, oats and quality pasture grasses are best suited for silage making.
4. Leguminous forages such as lucerne, berseem or cow peas are not suitable for silage making because they contain high moisture, proteins and minerals.

### Silos

Silo is an airtight to semi- airtight structure designed for the storage and preservation of high moisture feeds as silage.

### Silos are of different types

1. Pit silos
  2. Horizontal silos
  3. Temporary silos
1. **Pit silos:** A pit silo is shaped like the tower silo, but inverted into the ground. It resembles a well. This type of silo can be made only in places where the water table is low enough (in semi- arid or in arid regions) that the silo will not fill with water.



Fig.8.4 Pit silo

Silo pit : is the chamber in which green fodder is kept in an airtight condition for converting it into silage.

- The pit may be round or trapezoid in shape.
- The pit is constructed on a well drained and elevated land.
- The inside walls of pits should be protected with concrete to avoid the entry of air and percolation of water.
- The size of the silo pit directly depends upon the quantity of green forage to be ensiled.

### Advantages

1. They are never damaged by storm.
2. They require less reinforcing.

### Disadvantages

1. They are dangerous, due to the frequent presence of suffocating  $CO_2$ .
2. Labour requirement is more in removing the silage.

### Internet my friend

1. Collect the videos and PPT's about silage preparation
2. Collect the information about different types of silos



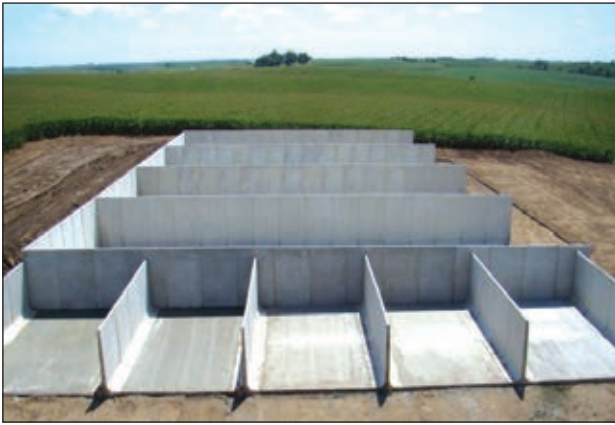
### 2.Horizontal Silos

They are of two types

1. Trench silos (below ground level)
2. Bunker silos (above ground level)

### A.Trench Silo

- This type of silo can be constructed quickly at a comparatively low cost.
- It is most popular in areas where the weather is not too severe and where there is good drainage.
- A trench silo should be wider at the top than at the bottom, and the bottom should slope away from one end so that excess juices will drain off if material with high moisture content is ensiled.



**Fig. 8.5 Horizontal trench silo**

#### **Advantage**

1. Low initial cost and ease of construction.

#### **Disadvantages**

1. It requires larger space to seal.
2. When filling is completed, the top should be carefully sealed by **polythene**, plastic or by wet straw mixed with mud or by saw dust to make it air tight.

**B. Bunker silos :** As a labour saving measure, bunker type of silos above the ground (for slightly recessed) usually with concrete floors are generally catching the attention of many farmers.



**Fig. 8.6 Bunker silo**

#### **3. Temporary Silos :**

**Plastic Silage Bag:** The bag silo is the one of the fastest growing silo types in dairy farming in India. Forages are ensiled at approximately the same moisture content as in bunker and pit silos while specialized equipment's are required.



**Fig. 8.7 Plastic bag silo**

#### **Advantages**

1. Less weather losses during filling compared to silo pit
2. Lower total annual costs
3. Low storage losses due spoilage
4. Higher quality silage
5. Safe to store

#### **Methodology of silage making**

1. Maize fodder at dough stage, jawar-bajra-oats-grasses at 50 percent flowering stage and hybrid napier at one meter-height stage are to be considered for ensiling
2. During the period of ensiling, fair weather conditions will ease the harvest, its transport and chaffing operations.
3. The fodder from maize, jawar, bajra and hybrid napier should be chaffed and oats be wilted for 6-8 hours before putting them into silo pit.
4. Ensiling involves operation of putting 'prepared' fodder into the silo pit, its proper trampling and finally proper sealing to protect the ensiled material from the entry of air and rains.
5. Common salt at 0.5 per cent and urea at 1 per cent level are added during trampling to improve the palatability and nitrogen content. For grass silage, molasses at 3 to 3.5 per cent is added to improve the sugar content.

6. The fodder chaffed by the chaff cutter is filled in the bamboo baskets (capacity 60-75 kg green chaff) is brought near the silo pit which is then filled in layer after layer. Each layer of about one feet thickness should be trampled properly by moving roller, men, tractor or bullocks depending upon the shape and size of the pit.
7. The pit should be filled in 3-4 feet above the ground level in a form of a heap and allowed to settle for 2 days.
8. Well settled heap-shaped ensiled material should be covered properly either by straw and smeared with a slurry of mud and dung or by polythene sheet (80 mm thick) in such a way that complete covering extends 3-4 feet from the rim of the silo pit. This will prevent the entry of air and water.
9. The ensiled material will get fermented under anaerobic conditions inside and quality silage will be ready for feeding after 60 days.

**Internet my friend**

Collect the information on different methods of silage making used in your area.



**Table 8.1 Characteristics of silage depending on the quality**

Sr. No.	Quality	Characteristics of silage
1	Very Good	<ul style="list-style-type: none"> <li>• Taste is pleasing, not bitter or sharp</li> <li>• The pH is between 3.5 and 4.2.</li> <li>• The ammoniacal nitrogen is less than 10 per cent of the total nitrogen.</li> <li>• It is uniform in moisture content and green or brownish in colour.</li> <li>• It is free from butyric acid, moulds, sliminess and proteolysis.</li> </ul>
2	Good	<ul style="list-style-type: none"> <li>• The taste is acidic.</li> <li>• The pH is between 4.2 and 4.5.</li> <li>• The amount of ammoniacal nitrogen is 10-15 per cent of the total nitrogen.</li> <li>• There may be traces of butyric acid.</li> </ul>
3	Fair	<ul style="list-style-type: none"> <li>• It has little bit bad odour</li> <li>• The pH is between 4.5 and 4.8.</li> <li>• Ammoniacal nitrogen is 15-20 per cent of the total nitrogen.</li> <li>• Colour of silage varies between tobacco brown to dark brown.</li> <li>• The silage is mixed with a little amount of butyric acid.</li> <li>• There may be slight proteolysis along with some mould.</li> </ul>
4	Poor	<ul style="list-style-type: none"> <li>• It has a bad odour due to high butyric acid and high proteolysis.</li> <li>• It is less acidic with pH above 4.8.</li> <li>• The amount of ammoniacal nitrogen is more than 20 per cent.</li> <li>• Its colour tends to be blackish.</li> <li>• The silage may be infested with moulds.</li> <li>• This type of silage should not be fed to livestock</li> </ul>

**Remember...**

**Silage should not be fed to the calves below 6 months of age and breeding bull.**



**Observe and try this...**

**The crops suitable for silage making in your locality.**



2. To increase the feed efficiency by increasing the voluntary intake and thus the nutritive value.
3. To make the availability more of the nutrients through one or more methods.
4. To show the cumulative effect of nutrients in 'complete ration'.
5. To increase the palatability of the processed feedstuffs.

**8.2 PROCESSING OF FEED STUFFS**

The processing of feed increases the nutrients utilization from feeds and fodders in the animal system. This involves physical, chemical, biological and engineering techniques

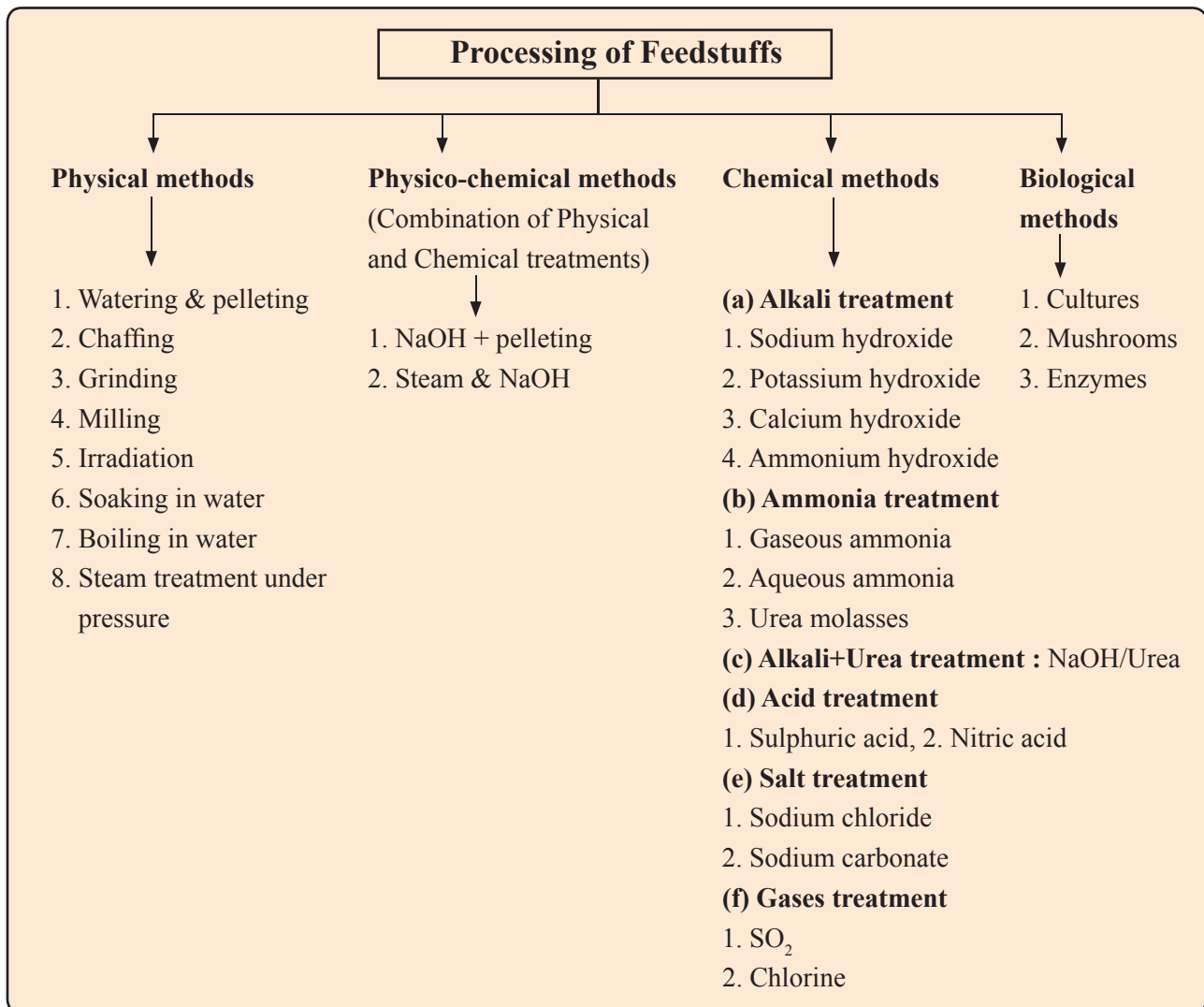
**Objectives of feed processing**

1. To increase the economic value of a feedstuff.

**Methods of processing of feedstuffs**

The feedstuffs, preferably meant for ruminants, are processed by applying various physical, chemical, biological and engineering techniques.

**Table 8.2 Processing of feedstuffs**



## 1. Physical methods

### Do you know ?

1. Different methods used for processing of feedstuffs.
2. The best method used for feed processing.
3. Advantages of feed processing.



### i) Soaking

1. Small sized grains which could not be ground properly should be soaked in fresh and clean water and fed.
2. The demerit of dustiness in grinding the grains is overcome by soaking them in water.
3. Soaked feeds should not be kept for more than 3 hours during summer and 6 hours during the winter otherwise they will first become stale and will be prone for fungus / mould development.



**Fig. 8.8 Soaking of seed**

4. Bajra grains and some dusty feed mixtures are soaked and fed.
5. Chopped straw is soaked in water overnight. Softens the straw leading to increased intake.
6. Soaking the straw for overnight in 1:1 ratio with water reduces dustiness and improves the palatability, DM intake and nutrient utilization.

### Try this...

Soak bajra grains and observe changes



### ii) Chaffing

1. Chaffing decreases the particle size.
2. It increases surface area for action of rumen microbes and thus increase digestibility.



**Fig. 8.9 Chaffing of green fodder**

3. It provides more sites for the cellulytic enzymes of the rumen.

### iii) Grinding

1. Grains with hard kernels and large size are generally ground roughly so that the inner contents are available for digestion.
2. Fine grinding of such grains should be avoided as the grains ground into flour cannot be consumed by the animals effectively.



**Fig. 8.10 Grinding machine**

3. Fine grinding results in increase in propionic acid content in the gut which results in narrowing the ratio between acetate to propionate, a factor responsible for reduction in milk fat content.
4. Maize, jawar, legumes are ground and fed either solely or in mixture.
5. Grinding reduces particle size to 0.1 to 0.3 cm.

#### iv) Steam pressure

1. Straw treated with Steam at pressure of 21.1 kg/cm<sup>2</sup> for 10 to 30 seconds causes rupture of ligno- cellulosic bonds to a certain extent and makes cellulose available for microbial action.
2. Disadvantage is that it increases rumen flow rate, decreases retention time in the rumen resulting in low milk fat syndrome.

#### iv) Pelleting

1. Pelleting increases the palatability of feed and thereby improves the feed intake.
2. It increases feeding value of roughages.
3. It increases the density of feed thereby it reduces the storage space.

4. It reduces the feed wastage and it does not allow the animal for selective feeding.
5. Particle size is reduced to 0.1 to 0.3 cm and pelleted through 1-2 cm diameter.
6. Retention time of feed in the rumen enhances digestion

## 2. Chemical methods

### i) Acid treatment

1. Straw is soaked in dilute sulphuric/Nitric acids for a specified period of time, washed with water drained and fed to the animals.
2. It causes rupture of ligno- cellulose bonds and makes cellulose available for microbial action.
3. It is not popular due to the corrosive action of acids.

### ii) Alkali treatment

1. Straw is treated with alkali viz., NaOH, NH<sub>4</sub>OH, CaOH, KOH, urea.
2. When straw is exposed to the alkali the ester linkages between lignin and cellulose / hemicellulose are hydrolysed causing the cellulose / hemicellulose to be available for digestion by microbes.

### iii) NaOH treatment

1. **Beckman process:** Straw is soaked for 1-2 days in dilute solution of NaOH (15-30 g / litre), washed to remove excess alkali and fed to the animals.
2. **Dry method:** Straw is chopped and sprayed with NaOH 300g/ litre (170 litre / tons of straw)

### iv) Ammonia treatment

1. Anhydrous form or concentrated solution is used @ 30 to 35 kg/ tons of straw.

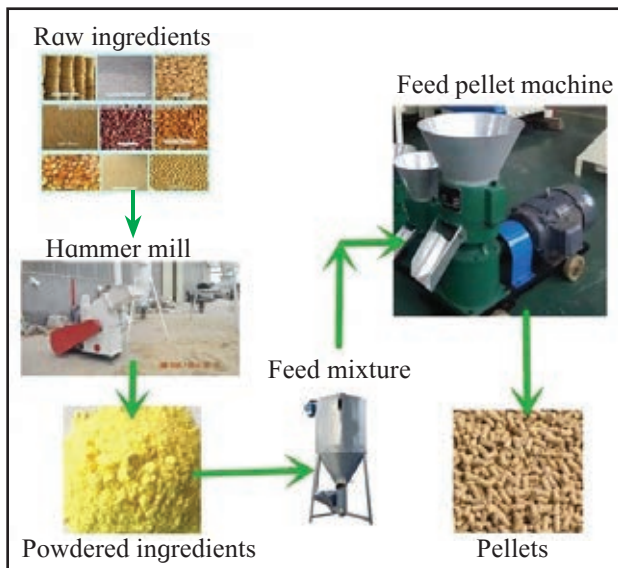


Fig. 8.11 Pellet making machine

2. Straw is stacked, ammonia solution is sprayed over the straw, kept covered for 20 days and then fed to the animals.
3. This method not only increases the digestibility of the straw but it also increases the nitrogen content of it.
4. Most of the ammonia is lost by volatilization on opening the stack.
5. Sometimes there is formation of toxic imidazoles from reactions between ammonia and sugars leads to dementia (Bovine bonkers)
4. Spray the fountain mixture over the straw evenly.
5. Follow second spraying immediately.
6. Repeat the process of spraying 4-5 times, folding the whole treated straw upside down.
7. After completion of spraying, stack the 'treated' straw and cover it by gunny bags or plastic bags completely to prevent the entry of air into the stack and loss of ammonia.

#### Precautions

#### v) Urea molasses treatment

##### Materials required

1. A source of NPN compound: it may be fertilizer grade urea or biuret.
2. Easily available and cheap source of energy. it may be low quality jaggary or molasses
3. Water drum
4. The substrate i.e. dry fodder
5. A 50' x 50' floor space in a spreading and drying 'shed' protected against rains and sun
6. Miscellaneous items like barrel, buckets, water fountain and spreading unit
1. Dirty water should not be used to dissolve urea and molasses,
2. The 'solution' should be sprinkled uniformly and thoroughly over each of the layers to prevent localized concentrations of urea which may have toxic effects.
3. Stacking should be done thoroughly and compact by trampling.
4. The stack should be properly covered from all sides.
5. The stacked treated straw should be stored for 3-4 weeks to allow the physiochemical reactions to complete inside the stack.
6. Before feeding, the treated straw should be exposed for an hour to remove the smell of ammonia gas.

##### Procedure

1. Spread 1' thick bed of the available straw (minimum 500 kg) over the floor of the 'shed'.
2. Dissolve 20 kg of urea or biuret and about 50 to 75 kg jaggary or molasses( as per the availability) + 10 kg mineral mixture and 5 kg common salt in 400 litres of clean water by stirring the mixture well till all get dissolved in the water completely.
3. With the help of bucket, pour the mixture into the water fountain.
7. It should not be given to young animals below 6 months of age.
8. Adequate drinking water should be made available

**Feeding rate :** For dry animals @ 5 to 6 kg and for milking animals @ 4 to 5 kg; however, these animals be fed with required and balanced ration.



**vi) Urea - molasses mineral block (UMMB)**

The UMMB licks supply most of the nutrients generally deficient in straw-based diet. These are urea, molasses, mineral supplements, common salt and brans/cakes. Gaur gum powder, sodium bentonite and lime were used as binding agents. The range of different ingredients that can be used in the UMMB formulation under various climatic condition is as follows.

**Table 8.4 Composition of UMMB**

Ingredients	Parts/100 kg Mixture
Molasses	36.0
Rice bran	38.0
Urea	10.0
Cement (Gaur gum powder, sodium bentonite and lime)	8.0
Salt	1.9
Dicalcium phosphate	2.0
Trace minerals	0.1
Water	4.0
Total	100.0

It has been observed that the UMMB licks increased straw by 53 % and reduced the concentrate requirement by 40 % and proved economic in lactating as well as growing cattle.

**Fig. 8.12 Urea molasses mineral block (UMMB)****3. Biological treatment****i) Enzyme treatment**

- Pre-treatment of straw with lignase
- Addition of lactobacillus culture

**8.3 RUMEN BYPASS NUTRIENT TECHNOLOGY****Can you recall ?**

- Bypass protein and bypass fat
- Benefits of feeding by pass fat



Bypass nutrients are the nutrient fractions which escape the rumen fermentation, gets fermented at a lower degree in the rumen and became available at the lower part of the gastrointestinal tract for the subsequent digestion and absorption.

**Do you know ?**

Whole oil seeds, when fed without processing except drying have natural bypass fat properties due to their hard outer seed coat, which protects the internal fatty acids from lipolysis and biohydrogenation in rumen.



Nutrients like protein and fats that escape rumen fermentation partially and digested and absorbed in the small intestine. This concept is useful not only for better utilization of nutrients but also minimize the ruminal fermentation losses thereby reducing the wastage of nutrients into the environment.

**8.3.1 Bypass fat**

Dietary fat which is not degraded in upper part of digestive tract (rumen) of animal but gets digested in lower alimentary tract is known as bypass fat.

**Advantages of feeding bypass fat**

1. It is rich source of energy
2. Improves negative energy balance.
3. Enhances milk production and persistency of lactation.
4. Increase reproductive efficiency after calving.
5. Decreases metabolic disorders such as ketosis, acidosis and milk fever.

6. Increases productive life of animals.
7. Improves general body condition and prevents postpartum weight loss.
8. Protects from heat stress

### 8.3.2 Bypass proteins

In order to increase the efficiency of protein utilization from the highly degradable cakes, which needs to be protected from excessive ruminal degradation and can be used as bypass protein, so that the amino acids from these protein feeds are absorbed intact in the intestines of the animal.

1. **Naturally protected proteins** : in some feed resources the proteins are protected naturally
  - a. *Lower degradable protein* : Maize gluten meal, cottonseed cake, fish meal, coconut cake and maize grain.
  - b. *Medium degradable protein* : Linseed cake, deoiled rice bran and soybean meal.
  - c. *Highly degradable protein* : Mustard cake and Groundnut cake (GNC).

### 2. Chemical treatment (Formaldehyde)

1. It is most widely used chemical treatment for the protection of protein developed by Ferguson in 1967.
2. In this method 3-4 kg of commercial formalin (37-40per cent) per 100 kg of CP or 1-1.2 g formalin / 100g CP is used.
3. Formalin binding to the proteins by formation of methylene bridge makes them resistant to microbial attachment.

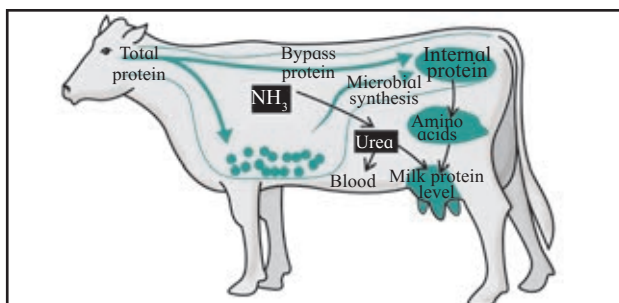


Fig. 8.13 Bypass protein

4. The method is also low cost and feasible.

### Advantages

1. Efficient source of protein for ruminants
2. Increases availability of essential amino acids
3. Improvement in milk production
4. Improvement in fat and SNF per cent
5. Better growth in young animals
6. Improvement in reproduction efficiency
7. Better resistance against diseases

## 8.4 FEEDING OF TOTAL MIXED RATION (TMR)

Dairy rations must contain good-quality forages and concentrate mixture to provide, energy, protein, minerals and vitamins. Feeds must be fed in the right amount and combination to provide a balance of nutrients avoiding excesses or deficiencies.

### Remember..

A TMR or total mixed ration is a method of feeding cows that combines forages, grains, protein feeds, minerals, vitamins and feed additives into a single feed mix.



### Advantages of TMR feeding

1. Minimizes the selective consumption of feeds by cows.



Fig. 8.14 Total mixed ration (TMR)

2. Reduces the risk of digestive upsets.
3. Stabilizes rumen pH and optimizes rumen digestion.

4. Maximizes rumen fermentation and the production of rumen bacteria.
5. Optimizes milk production and keeps cows healthy.
6. Reduces the work of feeding cows and saves labour costs.
7. Provides more control and accuracy of the feed amounts fed than when feeds are fed as separate ingredients.
8. Small amounts of low quality forages or unpalatable feed ingredients can be successfully fed.
9. Easy to measure daily feed intake of cows.
10. Minimizes feed wastage and reduces the cost of feeding as correct amounts of feed and nutrients can be fed.
11. Grain mixtures can be liberally fed to high producers without overfeeding the cows in late-lactation or lower-producing cows, resulting in more efficient use of feeds.

#### Disadvantages of feeding TMR

1. To correctly feed a TMR, a mixer is required. Feed mixers with weighing equipment are expensive.
2. Dry forages such as hay or straw are not mixed very well in some TMR mixers.
3. Dairy farms need to group cows to effectively utilize TMR feeding.
4. Cows are fed as a group and cows in the group should be as uniform in milk production and body weight as possible.
5. The equipment must have the capability to thoroughly blend the feed ingredients.
6. The mixer-wagon, preferably mobile, must be capable of accurately weighing each ingredient

#### Try this...

Visit livestock feed manufacturing company near to you



### 8.5 COMPLETE FEED BLOCK

A complete feed block has been defined as a system of feeding all ingredients including roughages, processed and mixed uniformly, to be made available *ad lib* to the animals in form of single block.



Fig. 8.14 Complete Feed Block

#### Advantages

1. Provides a balanced ration to ruminants
2. Feed blocks require lesser storage space
3. Feed blocks are trouble free and easier to transport
4. Less feed wastage
5. Improves productive and reproductive performance
6. Better health status of animal
7. Development of Feed Banks as pre-disaster management measure
8. Better utilization of non-conventional feed ingredients

#### Disadvantages

1. This method is expensive and requires machinery
2. Requires technical expertise

### 8.6 HYDROPONIC FODDER PRODUCTION

Hydroponics fodder is a method of growing green fodder without soil in an environmentally controlled houses or machines.

**Remember...**

**Hydroponics is Greek word. Hydro means water and ponics means working.**



When hydroponics is used for cultivation of green fodder, seed, water and sunlight are the only inputs that are required as the green fodder is fed to the animals after about 7-10 days of plant growth, which is achieved using the energy reserves of the seed itself.

Maize, barley, oats, wheat, cowpeas, etc., are commonly cultivated using hydroponics to produce high quality nutritious green fodder for dairy animals.

**Process**

- Seed :** Dry the seeds under direct sunlight one day prior to seed washing. Remove broken seeds and dirt's from the seeds and store seeds in a dry and safe place.
- Washing of seed :** Take good quality seeds in a washing chamber/ tub. Wash the seeds with proper scrubbing by hand and keep for settling for 5 minutes. Remove the light weight floating seeds.
- Seed soaking :** Allow the seed to soak for about 4 -8 hours.
- Seed germination/ sprouting :** Transfer the soaked seeds in clean dry fumigated wet gunny bag for sprouting. Keep the seeds loaded gunny bags away from direct sunlight and sprinkle water on gunny bag every 2-3 hours so that the gunny bag remains wet.
- Loading seeds in trays and racking :** Ensure that the trays are clean, washed with cleaning solution & are free from any dust / dirt etc. About 1 to 1.25 kg of soaked maize seed is spread out on to each plastic tray. Place the tray in rack in proper arrangement. Spray water intermediately to maintain the

relative humidity about 70 per cent. Ensure that all trays receive sufficient water.



**Fig. 8.15 Hydroponic maize fodder production**

- Harvesting :** At the end of 7-8 days the seeds have germinated and have formed plants measuring about 15-20 cm in height. The tray resembles a mat with the roots intermingled and seeds intact. About 5 to 7 kg succulent fodder is produced from each kg of maize. Wash the trays in clean water and then in cleaning solution before reusing it for the next cycle.

**Advantages**

- No land/ soil is required.
- Less water is required.
- Labour required is less.
- The green fodder is available within short time, (7-8 days).
- The yield is not influenced by environment.
- No interculturing viz. weeding is required.
- The succulent nutritious green fodder is available throughout the year.

**Table 8.5 Chemical composition of hydroponic maize fodder**

Parameters	percent content
Dry matter (on fresh basis)	18.30
Crude protein	13.30
Crude fiber	6.37

**EXERCISES**

**Q.1. Fill in the blanks**

1. Hay should not contain more than ..... moisture.
2. .... a system of feeding all ingredients including roughages, processed and mixed uniformly, to made available *ad lib* to the animals in form of single block.
3. Hydroponic maize fodder contain ..... per cent crude protein.
4. .... increases the palatability of feed and thereby improves the feed intake.
5. Chemical treatment (Formaldehyde) procedure for bypass proteins is developed by .....

**Q.2 Match the following**

Group A	Group B
1. Physical methods	a. pH 3.5 and 4.2.
2. Good Silage	b. pH 4.5 and 4.8
3. Very Good Silage	c . pH 4.2 and 4.5
4. Formaldehyde	d. Soaking in Water
5. TMR	e. By pass fat
	f. Mixing of all required nutrients

**Q.3 State true or false**

1. Silage is the pickle for dairy animals.
2. Silage should be fed to the calves below 6 months of age and breeding bull.
3. Mustard cake contain highly degradable protein.
4. NaOH + pelleting is physical method of processing of feedstuff.

5. TMR mixers can reduce the work of feeding cows and save labor costs.

**Q.4 Answer in brief**

1. Write objectives of feed processing.
2. Give examples of naturally protected proteins.
3. Why hay is stored in the form of stack or bail ?
4. What are the forage quality required for hay making.
5. Give difference between very good silage and fair silage.

**Q.5 Answer the following questions**

1. Write concept of complete feed block.
2. Explain urea treatment method of feedstuff processing.
3. Enlist the qualities of forage crops suitable for silage making
4. Give advantages of TMR feeding.
5. Give advantages of hydroponic fodder production.

**Q.6 Answer in detail**

1. Write in detail method of silage making.
2. Enlist method of processing feedstuff with example. Explain grinding method.
3. Write in detail procedure of urea molasses treatment.
4. Explain in detail process of hydroponic fodder production.
5. Enlist the different types of silos. Explain in detail Pit silos.

## 9. ANATOMY AND PHYSIOLOGY OF LIVESTOCK

### Can you recall ?

1. Body structure of cow, buffalo, sheep and goat?
2. What are the different body systems?



### 9.1 SKELETAL SYSTEM

The skeleton is composed of bones, cartilages and ligaments. Bones are the principal components of skeleton.

### Do you know ?

- Bones are living tissues as they can grow and are supplied with nerves and blood vessels.
- Bone is a mineralized connective tissue



#### 9.1.1 Structure of bones

1. Bones are composed of two types of substances –compact and spongy.
  - a. **Compact bone** : It is hard layer of bone that covers most bones and forms almost entire shaft of long bones.
  - b. **Spongy bone** : It is composed of small bony plates arranged to form a porous or spongy structure.
2. An outer surface of bone is covered by a fibrous membrane known as **periosteum** whereas thin membrane which lines the medullar cavity and various marrow spaces is known as **endosteum**.
3. The cartilage which covers the articular surface of a bone is called as **articular cartilage**.

4. A hollow cavity in the middle of long bone filled with bone marrow is called as **medullary cavity**. Bone marrow is a soft pulpy tissue which fills marrow cavity of long bones and marrow spaces of all the bones.

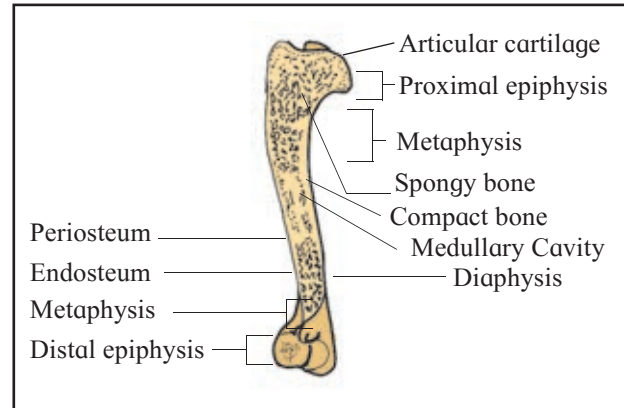


Fig. 9.1 Structure of Bone

#### 9.1.2 Composition of bones

1. **Fresh or wet bone** is composed of water (25%), ash or mineral matter (45%) and organic matter (30%).
2. **Dried bone** consists of organic and inorganic matter in the ratio of 1: 2.
3. The **organic matter** mainly consists of collagen (major), mucopolysaccharides, fatty acids, glyco-proteins, phospholipids (minor). The organic matter gives toughness and elasticity to bone.
4. The **inorganic or mineral** matter includes calcium, phosphorus, carbonates, citrates, sodium, potassium, magnesium, chlorides etc. The mineral matter gives hardness and rigidity to the bones.

#### 9.1.3 Functions of bones

1. They give definite shape to the body.
2. They offer support to the body.

3. They help in locomotion.
4. They protect the vital organs such as brain, lungs and heart.
5. They provide minerals like calcium and phosphorus to the body.

#### 9.1.4 Classification of bones

According to the gross appearance, the bones are classified into seven groups as long, short, flat, irregular, sesamoid, pneumatic and visceral.

#### Can you tell ?

1. What are the different types of bones
2. Total number of bones in forelimb of cattle
3. In which species you will find pneumatic bones.



#### 1. Long bones

1. These are greater in length than any other dimension.
2. They contain marrow/medullary cavity.
3. They are located mostly in the region of the limbs.
4. **Functions:** They aid in support and locomotion.
5. Examples are Humerus, Radius-ulna, Metacarpal, Femur, Tibia-fibula, Metatarsal.

#### Do you know ?

- Femur is the largest long bone in the animal body.



**Elongated bones** - These are the diminutive forms of long bones. These are slender, long bones without medullary cavity. e.g. Ribs.

#### 2. Short bones

1. These are small bones of uniform dimensions.
2. They do not contain marrow cavity.
3. They are mainly found in joints between two large bones.
4. **Function :** They increase the mobility of the joints and distribute pressure.
5. Examples are Carpal and Tarsal bones.

#### 3. Flat bones

1. They are relatively thin and expanded in two dimensions.
2. **Functions :** They protect the vital organs and provide large area for muscle attachment.
3. Examples are Scapula and Pelvic bones.

#### Try this...

Enlist names of short and long bones



#### 4. Irregular bones

1. These are irregular in shape.
2. They are generally unpaired and located on the median plane.
3. **Functions :** They serve for protection, support and muscle attachment.
4. Examples are Vertebrae.

#### 5. Sesamoid bones

1. These are small, sesame seed like short bones.
2. These are placed between the bones and tendons.
3. **Function :** They work as pulley to avoid friction.
4. Example is Patella.

**Remember...**

**Patella is the largest sesamoid bone in the animal body.**



**6. Pneumatic bones**

1. They contain air spaces or sinuses which communicate with the exterior.
2. The bones of bird are light in weight due to presence of air sacs.
3. Examples are long bones of birds.

**Internet my friend**

Search number of bones in different species of livestock



**7. Visceral Skeleton**

1. These are the bones developed in visceral organs.
2. They give support and rigidity to the organ.
3. Examples are os cardis (Heart of ox), os penis (Penis of dog) and os opticus (Eye of birds).

**9.1.5 Skeleton**

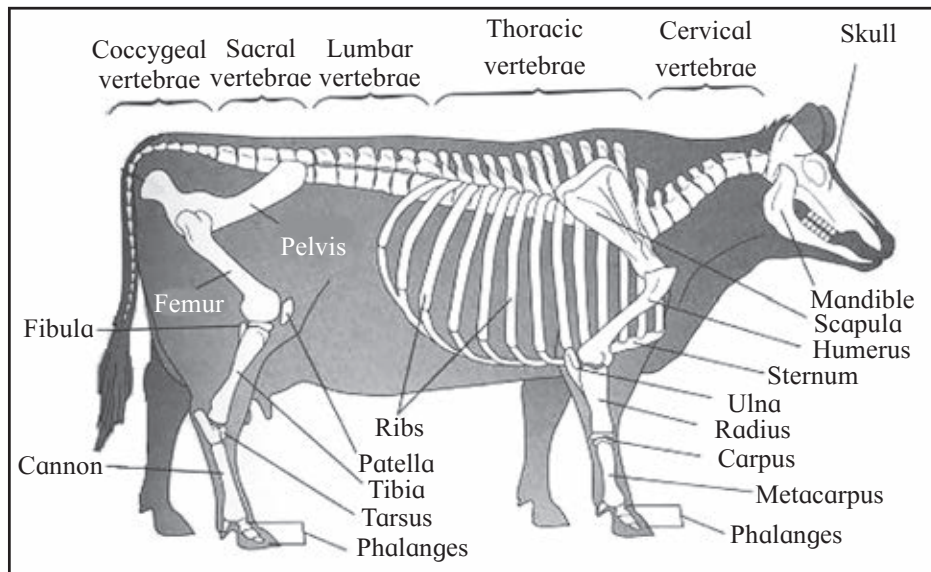
**Skeleton** can be defined as a hard framework of the body which supports soft structures.

The skeleton is divided into two parts as-axial and appendicular.

1. **Axial Skeleton:** It consists of bones of skull, vertebral column, ribs, and sternum.
2. **Appendicular Skeleton:** It consists of the bones of fore limbs and hind limbs.

**Table 9.1 Bones - their location and classification.**

Bone	Location	Classification	No. in body
<b>Appendicular Skeleton</b>			
<i>A) Forelimb/ Pectoral limb</i>			
1) Scapula	Shoulder	Flat	2
2) Humerus	Arm	Long	2
3) Radius	Forearm	Long	2
4) Ulna		Long	2
5) Carpus	Knee joint	Short	12
6) Metacarpus	Manus	Long	4
7) Phalanges		Long	12
8) Sesamoids		Sesamoid	12
			<b>48</b>



**9.2 Skeleton of Cow**



<b>B) Hind limb/</b>			
<b>Pelvic limb</b>			
1) Pelvic bones	Rump/Hip	Flat	2
2) Femur	Thigh	Long	2
3) Patella	Stiflejoint	Sesamoid	2
4)Tibia- Fibula	Leg	Long	4
5) Tarsus	Hock joint	Short	10
6) Metatarsus	Pes	Long	4
7) Phalanges		Long	12
8) Sesamoids		Sesamoid	12
			<b>48</b>
<b>Axial Skeleton</b>			
1) Skull	Head	Flat	32
2) Cervical Vertebrae	Neck	Irregular	7
3) Thoracic Vertebrae	Chest	Irregular	13
4) Lumbar Vertebrae	Loin	Irregular	6
5) Sacral Vertebrae	Croup	Irregular	5
6) Coccygeal Vertebrae	Tail	Irregular	20
7) Ribs	Chest	Elongated	13 Pairs
8) Sternum	Floor of Chest	----	1
			<b>110</b>
<b>Visceral Skeleton</b>			
Os cordis	Heart	Visceral bone	2
<b>Total Number of bones in cattle</b>			<b>208</b>

### 9.1.6 Joints

Joints are the structures formed by the union of two or more articular ends of the bones or cartilages.

#### Do you know ?



1. The functions of joints
2. What are the different types of joints?

Study of structure and functions of various joints is called as **arthrology** or **syndesmology**.

**Classification of Joints :** On the basis of structure and degree of mobility, joints are classified into following three groups.

#### 1. Fibrous joints

1. They do not contain joint cavity.
2. These are immovable joints.
3. The bones are united by fibrous tissues.
4. Example - Skull joints.

#### 2. Cartilagenous joints

1. They do not contain joint cavity.
2. They permit limited movements.
3. The bones are united by cartilage.
4. Example - Pelvic symphysis.

#### 3. Synovial joints

1. These are true joints.
2. These are movable joints.
3. These contains joint cavity or articular cavity.

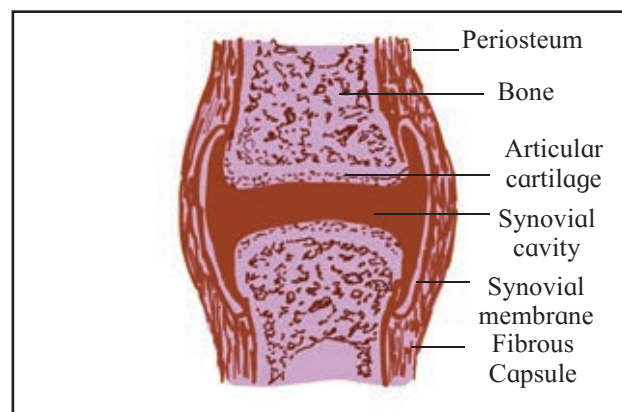


Fig. 9.3 Typical synovial joints

- Joint cavity is surrounded by the *joint capsule* which consists of an external fibrous layer and internal synovial membrane.
- The *synovial membrane* secretes a lubricant fluid known as *synovial fluid*.
- The *articular cartilage* covers the surface of the bone over joint and lessens the concussion and friction.
- Ligaments bind the bones. These are placed around the joints.
- Examples : Knee joint, Hock joint.

**Table 9.2 : Joints of forelimb and Hind limbs**

Joint	Bones involved
<b>Forelimb</b>	
1. Shoulder joint	Scapula and humerus
2. Elbow joint	Humerus and radio-ulna
3. Knee joint	Radius-ulna, carpals and metacarpals
4. Fetlock joint	Metacarpal and first pair of phalanges
5. Pastern joint	First and second phalanx
6. Coffin joint	Second and third phalanx
<b>Hindlimb</b>	
1. Hip joint	Pelvic bone and femur
2. Stifle joint	Femur and tibia
3. Hock joint	Tibia, tarsal and metatarsal bones.
4. Fetlock joint	Metatarsal and first pair of phalanges.
5. Pastern joint	First and second phalanx
6. Coffin joint	Second and third phalanx.

## 9.2 CIRCULATORY SYSTEM

The circulatory system includes heart, blood vessels and blood.

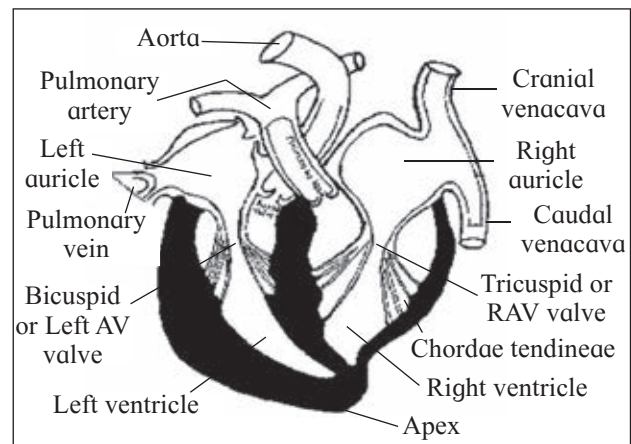
### 9.2.1 Heart

#### Do you know ?

Heart is situated in the chest/ thoracic cavity between 3<sup>rd</sup> and 6<sup>th</sup> rib



- The heart is a cone shaped, hollow, muscular organ having broad base and pointed apex.
- It is reddish brown in colour and weighs about 2.23 kg i.e.0.4-0.5% of the body weight.
- It is enclosed in membranous sac called **pericardium**.
- The heart wall consists of three layers viz. **epicardium** (outer), **myocardium** (middle) and **endocardium** (inner).
- The heart consists of 4 chambers i.e. two **auricles** (upper) and two **ventricles** (lower).
- The two auricles are separated from one another by **inter-auricular septum**.
- The right auricle (RA) receives impure blood from the body through anterior and posterior vena cavae.



**Fig. 9.4 Structure of Heart**

- The right auricle communicates with right ventricle (RV) through right auriculo - ventricular opening guarded by **tricuspid valve**.

9. The left auricle receives pure blood from the lungs through right and left pulmonary veins.
10. The left auricle communicates with left ventricle through left auriculo-ventricular opening guarded by *bicuspid or mitral valves*.

#### Internet my friend

- Search number of chambers in heart of different livestock species.
- Heart beats in different species.



11. The ventricles are thick walled and muscular.
12. The ventricles are separated from each other by *inter-ventricular septum*.
13. Pulmonary artery originates from right ventricle which carries impure blood to the lungs for oxygenation.
14. The left ventricle discharges pure blood into aorta through aortic orifice guarded by **aortic valve**.
15. The free margins of bicuspid and tricuspid valves are indirectly attached to the ventricular wall by means of fibrous cords called as **chordae tendineae**.

#### Remember...

**Pumping of blood is the main function of heart.**



### 9.2.2 Blood Vessels

Blood vessels that carry blood away from the heart are called *arteries* while those which carry the blood towards the heart are called *veins*. The fine blood vessels which connect arteries and veins are called **capillaries**.

#### Do you know ?

**Aorta is the largest artery whereas Venacava is the largest vein.**



### 9.2.3 Blood

**Blood is defined as liquid connective tissue composed of blood cells and plasma.**

#### Properties of blood

1. Blood is red in colour and viscous in nature.
2. The pH of blood is slightly alkaline i.e. 7.4.
3. Its average specific gravity is 1.043 in cattle.
4. Blood clotting time in cattle is 6.5 minutes.
5. The average blood volume in cattle is 7.7% of the total body weight.

#### Use your brain power !

**Blood volume of different species.**



#### Functions of Blood

1. Transport of nutrients from digestive tract to the tissues.
2. Transport of waste products from tissues to the organs of excretion.
3. Transport of O<sub>2</sub> from lungs to tissues.
4. Transport of CO<sub>2</sub> from tissues to lungs.
5. Transport of hormones from the site of production to the site of action.
6. Regulation of body temperature.
7. Maintenance of body pH i.e. acid - base balance.
8. Maintenance of water balance.
9. Protection of body from disease-producing organisms.
10. Its clotting ability prevents excess loss of blood from injuries.

Table 9.1 : Difference between Arteries and Veins

Arteries		Veins	
1)	They carry blood away from the heart.	1)	They carry blood towards the heart
2)	They carry pure blood except pulmonary artery	2)	They collect impure blood from various tissues except pulmonary vein.
3)	The arterial blood is bright red in colour	3)	The venous blood is purplish red in colour.
4)	They have thick, muscular and elastic wall.	4)	They have thin, less muscular and less elastic wall.
5)	They do not collapse when empty.	5)	They collapse when empty
6)	They do not have valves	6)	They have valves.
7)	They are pulsatile	7)	They are non-pulsatile
8)	Blood flow is rapid and under pressure	8)	Blood flow is slow and under low pressure
9)	They are always smaller than their respective veins	9)	They are always larger than their respective arteries
10)	They are deeply situated in the body i.e. well protected.	10)	They are generally superficial

### Composition of blood

#### Do you know ?

Why the colour of blood is red?



Blood is composed of - (a) Plasma - 66% and (b) Blood cells - 34%

**A. Plasma :** It is fluid portion of the blood. It is straw coloured. It consists of 90 - 92 % water and 8 - 10 % other substances (solids). The other substances include inorganic matter and organic matter.

**a. Organic constituents:** They constitute about 7-9% of plasma.

1. Proteins (6-8%) : Albumin, Globulin, Fibrinogen and Prothrombin
2. Carbohydrates : Glucose, Fructose.
3. Lipids : Neutral fats, Triglycerides, Cholesterol, Phospholipids.
4. Non-Protein Nitrogenous Substances (NPN) : Urea, Uric acid, Creatinine, Ammonia.

5. Other Substances : Hormones, Enzymes, Vitamins, Pigments like bilirubin and carotene

**b. Inorganic constituents :** They form about 1% of plasma. These include calcium, phosphorus, magnesium, chlorides, bicarbonates, sulphates, phosphates, potassium, sodium, iron, iodine, copper, zinc etc.

**B. Blood Cells :** They are of three types-

1. Red blood cells
2. White blood cells
3. Platelets

**1. Red Blood Cells (RBC)**

1. They are also called as *erythrocytes*.
2. They are red in colour due to *haemoglobin*.
3. These are non-nucleated cells.
4. These are circular biconcave discs having thick margin and a thin centre.

5. They measure about 5 - 7  $\mu$  in diameter.
6. Their life span is 160 days in cattle.
7. The normal RBC count is 6 - 8 millions /  $\mu$ l of blood.
8. They are formed in the red bone marrow.
9. They are composed of water (65%) and solids (35%). The solid part constitutes haemoglobin (95%) and other substances like proteins, lipids (5%)
10. **Function** : They help in transport of respiratory gases i.e. O<sub>2</sub> and CO<sub>2</sub>.
8. There are about 9-12 thousand /  $\mu$ l of blood in healthy animal.
9. They are formed in bone marrow and lymphoid organs.
10. **Function** : These are involved in defense mechanism of body.

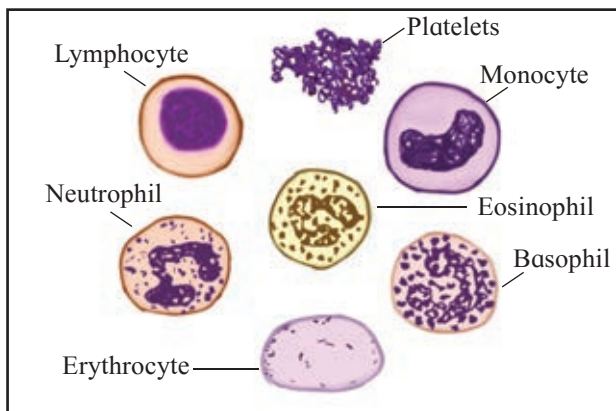


Fig. 9.5 Blood cells

**Internet my friend**

- Life span of RBC's in different animal species.



**2. White Blood Cells (WBC)**

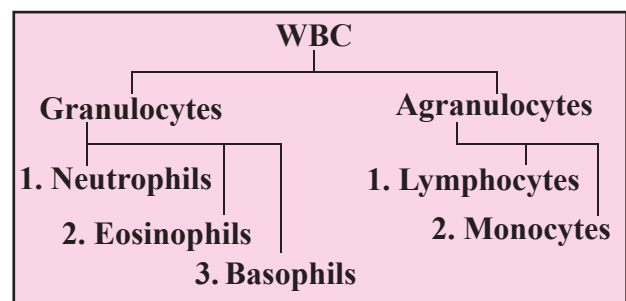
1. These are also called as *leucocytes*.
2. They are white in colour.
3. These are nucleated cells.
4. These are capable of independent movement.
5. They are circular in shape.
6. They are about 8 to 25  $\mu$  in diameter.
7. The life span varies from few hours to few years.

**Do you know ?**

**Phagocytosis is the process of engulfing and destroying foreign material like microorganisms.**



**Classification of leucocytes (WBC):**



These are classified as A) Granulocytes and B) Agranulocytes.

- A. **Granulocytes** : They contain granules within the cytoplasm. On the basis of the shape of nuclei and staining reaction of their granules, they are classified as – Neutrophils, Eosinophils and Basophils.
- B. **Agranulocytes** : They usually do not contain granules and their nuclei are non-lobulated. They are classified as Lymphocytes and Monocytes.

**Remember...**

**Monocytes are the largest leucocytes.**



**3. Platelets**

1. These are also called as *thrombocytes*.
2. These are colourless and non-nucleated cells.
3. They are oval or irregular in shape.

4. These are the smallest blood cells and measure about 2-5  $\mu$ m in diameter.
5. Their life span is 8 - 11 days.
6. Their number varies from 3.5 to 5 lakhs /  $\mu$ l of blood.
7. They are formed in bone marrow.
8. **Function** : They help in clotting of blood.

**Internet my friend !**

- In which disorders of human and livestock platelet count is lower than normal ?



- B. **Systemic circulation** : It refers to the movement of oxygenated blood to all areas of the body and the subsequent return of deoxygenated blood to the heart. The pure or oxygenated blood from the left ventricle passes to all parts of the body through the aorta and its branches. The deoxygenated blood from different parts of the body is brought to the right auricle by the vena cavae and their branches.

**Try this...**

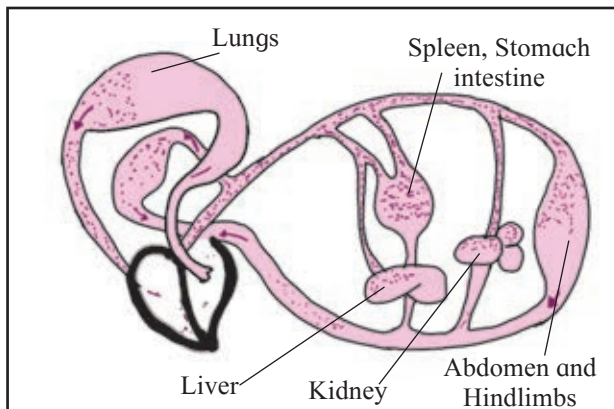
1. Collect information about various blood groups in animals & human being.



**9.2.4 Blood circulation**

The blood circulation in animals is carried out by two pathways-

- A) Pulmonary circulation
- B) Systemic circulation



**Fig. 9.6 Schematic diagram of blood circulation**

- A. **Pulmonary circulation** : It is that part of vascular system which circulates all the blood through the lungs. The impure or deoxygenated blood from right auricle passes through the right ventricle and from right ventricle to lungs for oxygenation via pulmonary arteries. The pulmonary veins bring oxygenated or pure blood from lungs to the left auricle of the heart.

**9.2.5 Lymphatic System**

1. It serves as system for draining tissue fluid.

**Can you tell ?**

**The functions of lymphatic system**



2. It includes lymph, lymph vessels and lymphnodes.
3. **Lymph** : It is colourless tissue fluid drained by lymphatics.
4. **Lymph vessels** : These are the vessels which carry tissue fluid i.e. lymph to the blood stream.
5. **Lymph nodes** : They are spherical, oval or bean shaped. Grey rosy structures of variable sizes. They serve as filters for the lymph and act as one of the first body defence against infection.

**9.3 RESPIRATORY SYSTEM**

Oxygen is a vital requirement of animals. An animal may survive for few days without water or for weeks without food but cannot survive for few minutes without oxygen. Supply of oxygen to blood and removal of carbon

dioxide from blood are the two important functions of respiratory system. In addition respiratory system also helps in the regulation of body temperature, pH of body fluid and voice production.

### 9.3.1 Respiratory organs

The respiratory system of cattle comprises of nasal cavity, pharynx, larynx, trachea, bronchi and lungs.

#### Can you recall ?

Different parts /organs of respiratory system.



#### 1. Nasal cavity

1. It is the first part of the respiratory passage which extends from exterior to pharynx.
2. It is cylindrical or tubular passage enclosed by facial bones and cartilages.
3. It is separated into two compartments by *nasal septum*.
4. It opens externally by *nostrils* and internally by two *posterior nares*.
5. It is located above the mouth cavity.
6. **Functions :** It is a passage for air. It gives sensation of smell.

#### 2. Pharynx

1. It is funnel shaped musculo-membranous sac common for both digestive and respiratory system.
2. There are *seven* openings in pharynx viz. mouth (1), posterior nares (2), eustachian tubes (2), larynx (1) and oesophagus (1).
3. It is located just behind the mouth cavity.
4. **Function :** It is common passage for food, water and air.

### 3. Larynx

#### Remember...

Larynx is also known as 'Sound box' or 'Voice box'.



1. It is elongated cartilaginous structure.
2. It is made up of five cartilages namely *epiglottis (1), cricoid (1), thyroid (1) and arytenoids (2)*.
3. There are vocal cords on internal surface of the wall of the larynx.
4. It is located between pharynx and trachea.
5. **Functions :** It regulates the air flow to and from the lungs. *Epiglottis* prevents inhalation of foreign bodies.

#### Remember...

The vocal cords produce voice (phonation).

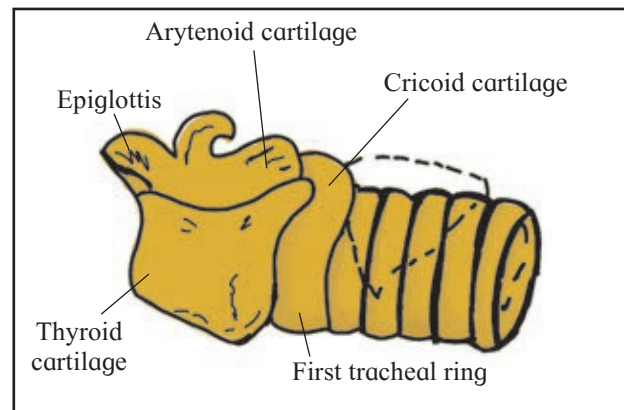


Fig. 9.7 Larynx of Cattle

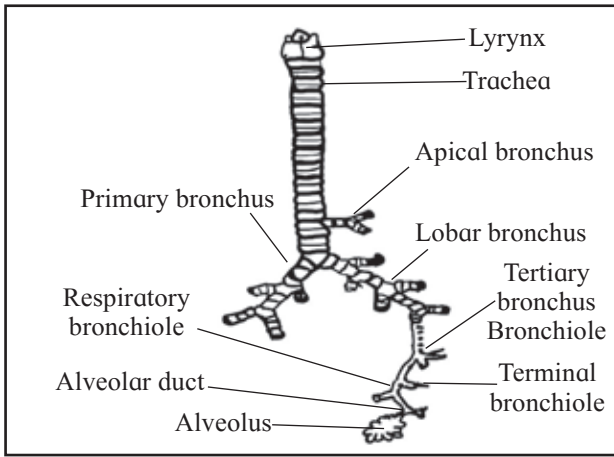
### 4. Trachea

#### Do you know ?

Trachea is also known as 'Wind Pipe'



1. It is cartilaginous tube which extends from larynx to lungs.
2. It is made up of 50 - 60 incomplete 'C' shaped cartilaginous rings.



**Fig 9.8 Trachea & branches of bronchi**

3. It is located on the ventral side of neck and passes into thoracic cavity and divides into bronchi.
4. **Functions :** It is a passage for air. It filters the air, removes dirt and dust. It secretes mucin which moistens the dry air.

#### 5. Bronchi

1. The trachea is divided into three bronchi in cattle viz. - **left, right** and **apical**.
2. The right branch supplies to right lobes, left to left lobes and apical to the right apical lobe of lung.
3. Each bronchus divides and subdivides into small fine tubes as primary, secondary and tertiary bronchi.
4. The tertiary bronchi divides into minute **bronchioles**.
5. The bronchioles ends into minute compartments known as **alveoli**.

6. **Function :** It is passage for air.

#### 6. Lungs

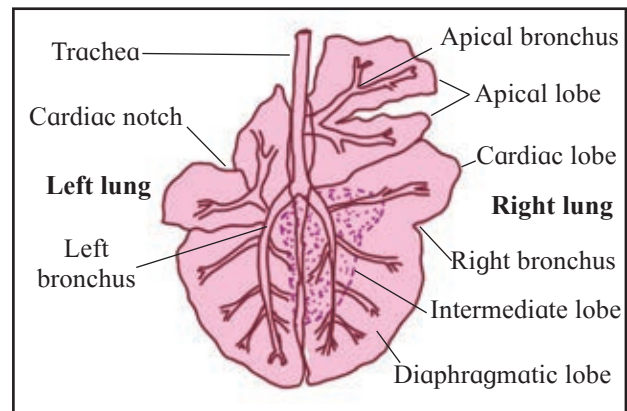
1. They are two in number i.e. left and right.
2. They are enclosed in a serous membrane called **pleura**.
3. They are soft, spongy and highly elastic.

#### Do you know ?

- Lungs are the main organs of respiration.
- Alveolus is the structural and functional unit of lungs.



4. They are brownish grey in colour, conical in shape and light in weight.
5. They crepitate on pressure and floats on water.



**Fig. 9.9 Lungs of cattle**

6. Right lung is larger than the left and average weight is 3.5kg.
7. Right lung consists of 4 lobes namely apical, cardiac, intermediate and diaphragmatic.
8. Left lung is divided into 3 lobes namely apical, cardiac and diaphragmatic.
9. Cardiac notch is larger in left lung than in right one.
10. **Functions :**
  - i. The main function of lung is exchange of gases. viz. supply of oxygen to blood and removal of carbon dioxide from blood.
  - ii. It also helps in regulation of body temperature by eliminating heat through breath.
  - iii. It helps in elimination of water.



**Remember...**

Lungs are located in thoracic cavity



**Internet my friend**

Find the difference between human and cattle lungs.



**9.3.2 Mechanism of Respiration**

**Respiration** is defined as exchange of gases between the organism and the environment. It includes breathing and external, internal as well as cellular respiration.

1. **Breathing** : It involves inspiration and expiration. During inspiration, air rich in oxygen is taken into lungs, whereas during expiration air containing more carbon dioxide and water vapours is given out of the lungs.

a) **Inspiration** : It means inflow of air into lungs. It results whenever the volume of thorax is increased. During inspiration, intercostal muscles contracts and draw ribs forward and outward. This increases the volume of the thoracic cavity. It leads to lowering of air pressure in the lungs and thereby air gets entry into lungs.

**Do you know ?**

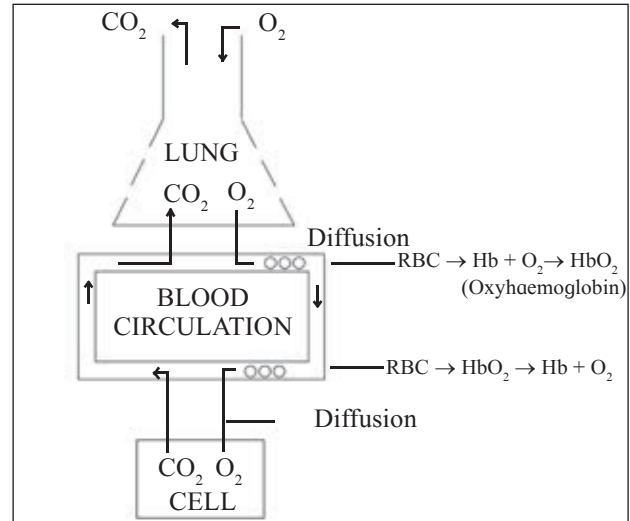
Diaphragm is muscular, dome shaped partition between the thoracic and abdominal cavities. It is the chief inspiratory muscle.



b) **Expiration** : It means outflow of air from lungs. It results whenever the volume of thorax is decreased. The decrease in volume of thorax is largely passive because of the tendency of elastic structures like intercostal muscles, diaphragm, lungs

and abdominal wall. The decrease in volume results in contraction of lungs which results in outflow of air from lungs.

2. **External respiration** : This constitutes movement of  $O_2$  from the alveolar air into the blood and release of  $CO_2$  from the blood into the alveolar air.



**Fig. 9.10 Mechanism of Respiration**

3. **Internal respiration** : This involves transfer of  $O_2$  from the blood to the tissues and  $CO_2$  from tissues to the blood.

4. **Cellular Respiration** : During the process of oxidation of glucose in tissues,  $CO_2$ , water and energy is produced. The  $CO_2$  and water vapour thus produced are transported by blood to the lungs for expulsion.

**Internet my friend**

Respiration rate in different livestock species.



**9.4 DIGESTIVE SYSTEM**

**Can you tell ?**

1. Different organs of digestive system in ruminants
2. Differentiate between ruminants and non-ruminants system.



The primary functions of digestive system are prehension, mastication, digestion and absorption of food and elimination of faeces. The digestive system converts the major nutrients viz. carbohydrates, proteins and lipids of food to their simplest form. These simple form of nutrients are then absorbed and utilized by the body for energy production and building other compounds to be incorporated into body tissues.

The digestive system is composed of alimentary canal and its accessory glands.

### 9.4.1 Organs of Alimentary Canal

The alimentary canal consists of mouth cavity, pharynx, oesophagus, stomach, small and large intestines. The accessory glands include salivary glands, liver and pancreas.

#### 1. Mouth cavity /oral cavity

1. It is an elongated cavity which consists of lips, cheeks, palate, tongue and teeth.
2. Lips are thick musculo-membranous structures externally lined by skin which are situated at the opening of mouth. They close the mouth cavity anteriorly.
3. Cheeks are muscular structures externally covered by skin and forms lateral wall of mouth cavity.

**Use your brain power !**

**Number of teeth in different adult animal species and human being.**



4. Palate is divided into-hard palate (anterior) and soft palate (posterior).
5. Hard palate is comprised of dense connective tissue, internally lined by mucous membrane and attached to the bony plate. It forms roof of mouth cavity.

6. Soft palate is musculo-membranous mass present behind hard palate in the roof of mouth cavity which acts as a partition between the mouth and pharynx.
7. Teeth are hard, dense whitish structures embedded in gum and project into mouth. They help in chewing of food material. There are four types of teeth namely incisors (front teeth), canines (corner teeth), premolars and molars.
8. Tongue is muscular organ situated on the floor of mouth cavity. It is the chief organ of prehension and taste of food in cattle.
9. Gums/gingiva is composed of thick layer of dense layer of fibrous tissue in which teeth are embedded.
10. **Functions** : The mouth cavity helps in taking food into the mouth, chewing and mixing of food with saliva, swallowing of food, and rumination.

**Remember...**

**Incisors are absent in upper jaw and canines are absent in either jaw in ruminants.**



#### 2. Pharynx

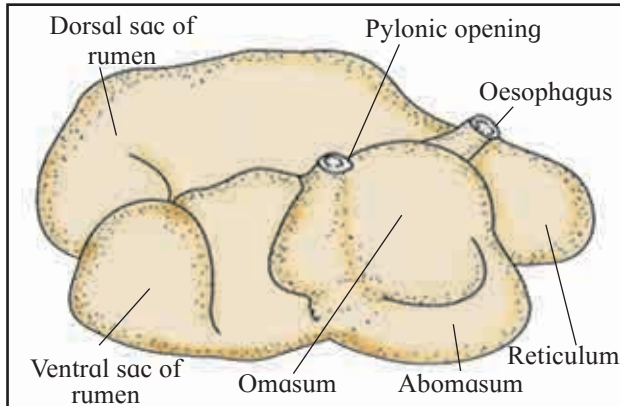
1. It is conical or funnel shaped musculo-membranous sac.
2. It is common cavity for both digestive and respiratory system.
3. It is located just behind mouth cavity.
4. There are seven openings in pharynx viz. Mouth cavity (1) , posterior nares (1), Eustachian tubes (2) ,Oesophagus (2) and Larynx (1).
5. **Function** : It is a common passage for food, water and air.

### 3. Oesophagus

1. It is a musculo-membranous tube extending from pharynx to the stomach.
2. **Function :** It is a passage for food.

### 4. Ruminant Stomach

1. It is also called as **compound stomach**.



**Fig. 9.11 : Ruminant stomach**

2. It is made up of four compartments viz. rumen, reticulum, omasum and abomasum .
3. The first 3 compartments are collectively called as **forestomach** while the fourth compartment, abomasum, is called as **true stomach**.
4. The average capacity of the stomach in adult cattle ranges from 100 - 230 liters depending upon the size of animal.

#### Do you know ?

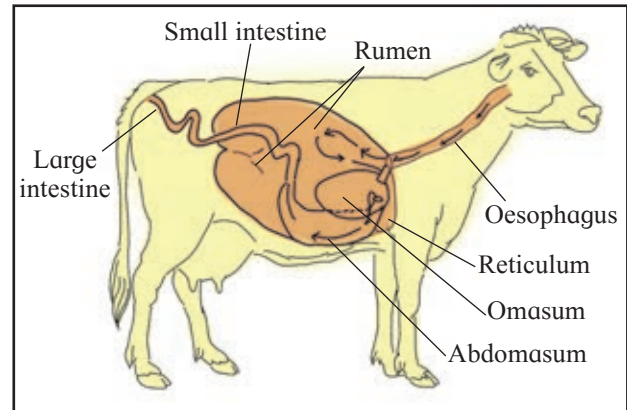
Different parts of ruminant stomach.



#### Remember...

Rumen is the largest fermentation chamber of ruminant stomach.

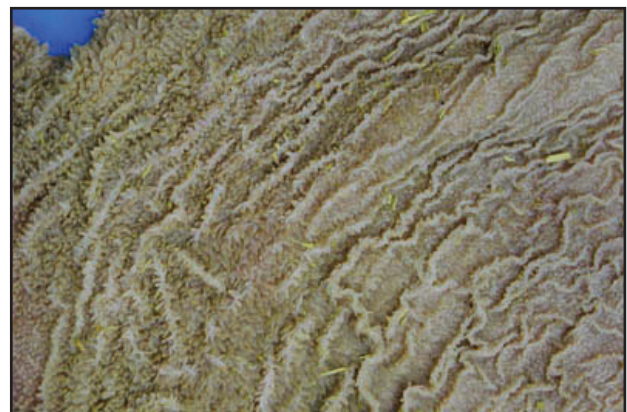
The pH of rumen fluid is 6.4 to 7



**Fig. 9.12 : Digestive system of ruminants**

#### a) Rumen

1. It is the first and the largest compartment of ruminant stomach.
2. It forms about 70-80% portion of ruminant stomach.
3. It is located in the left side of abdominal cavity from diaphragm to pelvis.
4. The rumen is subdivided into dorsal and ventral sacs by muscular pillars.
5. It is **turkish towel** like in appearance on its inner side.
6. It communicates with oesophagus and reticulum by means of cardiac



**Fig. 9.13 Internal structure of Rumen**

#### Can you tell ?

1. The function of reticulum.
2. True stomach in ruminants.



and rumino-reticular openings, respectively.

7. **Functions :** It stores food and helps in churning and proper mixing of ingesta (food). It helps in microbial digestion of proteins, fats and carbohydrates, synthesis of vitamins of B-complex, absorption of volatile fatty acids and expulsion of gases like CO<sub>2</sub> and methane.

### b) Reticulum

1. It is the second and smallest compartment of ruminant stomach.
2. It forms approximately 5% portion of stomach.
3. It has **honeycomb** like structure on its inner side.



**Fig. 9.14 Internal structure of Reticulum**

4. It is located behind diaphragm and opposite to heart.
5. It communicates with rumen and omasum by rumino-reticular and reticulo-omasal orifices, respectively.
6. **Functions :** It acts as a filter for food material and helps in regurgitation of food while rumination.

### 3) Omasum

1. It is third compartment of ruminant stomach.
2. It is spherical or elliptical in shape.



**Fig.9.15 Internal structure of Omasum**

3. It forms approximately 7-8% portion of ruminant stomach.
4. It is located on right side of the abdominal cavity just behind reticulum.
5. It contains 100 folds in its inner side called '**laminae**'.
6. It communicates anteriorly with reticulum and posteriorly with abomasum by means of reticulo-omasal and omaso-abomasal orifices, respectively.
7. **Functions :** It removes about 50% of water from ingested food material and also grinds coarse food particles. It absorbs volatile fatty acids.

### 4) Abomasum

1. It is fourth compartment of ruminant stomach.
2. It is elongated, saccular in shape.
3. It forms approximately 7-8% portion of ruminant stomach.
4. It is situated on the floor of abdominal

#### Remember...

Abomasum is called as **true stomach** of ruminants as it resembles the simple stomach in form and structure.



cavity, ventral to the omasum on right side of the rumen.

5. The anterior part of abomasum is known as '*fundus*' while the terminal part is known as '*pylorus*'.
6. There are about 12 oblique folds in its inner side.
7. It communicates anteriorly with omasum and posteriorly with duodenum by means of omaso-abomasal and pyloric openings, respectively.
8. **Functions :** It helps in digestion of microbial proteins and absorption of volatile fatty acids to some extent. It secretes gastric juice which contains hydrochloric acid and enzymes like *pepsin* and *rennin*.

### Use your brain power

Why ruminants digest more cellulose than non ruminants?



### 5. Small intestine

1. It extends from abomasum to caecum.
2. Its average length is about 50-52 meters and diameter is 5-6 cm in cattle.
3. The innermost lining of small intestine has long finger like projections called *villi*.
4. The villi increases the surface area for absorption of food nutrients.
5. It is divided into 3 parts viz. duodenum, jejunum and ileum.
6. **Duodenum :** It is the first part of small intestine located in sublumbar region. It forms 'S' shaped loop and is approximately 1 metre in length. The bile and pancreatic ducts open into duodenum.

7. **Jejunum :** It is indistinctly separated from duodenum and is located on the floor of abdominal cavity on right side. It is approximately 48-50 meters in length (longest)
8. **Ileum :** It is the terminal part of small intestine extends up to ileo-caecal junction. It is approximately 1 meter in length.
9. **Functions :** It secretes digestive juices. It helps in digestion and absorption of food .

### 6. Large intestine

1. It extends from ileum to the anus.
2. It is about 11 - 12 meters in length.
3. Its diameter varies from 5-15 cm.
4. Villi are absent.
5. It is divided into 3 parts viz. caecum, colon and rectum.
6. **Caecum :** It is a blind sac situated between ileum and the large colon. It is located on right side of the abdominal cavity. It is about 0.8 meter in length and 5'' in diameter.
7. **Colon :** It is the second portion of large intestine which is located on the right dorsal part of the abdomen. It is arranged in coils and is approximately 10 meters in length and 5'' in diameter.
8. **Rectum :** It is the terminal part of large intestine located in the pelvic cavity. It is little less than 30 cm in length. Its wall is more thick and dilated than caecum and colon. It is closed posteriorly by sphincter muscles called *anal sphincter*.
9. **Functions :** It helps in microbial digestion and absorption of food nutrients to some extent. It helps in

absorption of water from ingesta and stores food residue temporarily in rectum.

### 9.4.2 Accessory glands

Accessory glands of digestive system include salivary glands, pancreas and liver.

#### 1. Salivary Glands

1. They include parotid, mandibular and sublingual glands.
2. **Parotid glands** : These are paired, triangular, and reddish brown glands situated at the base of ear. The secretion of these glands is carried by *stenson's duct* into mouth cavity.
3. **Mandibular or Submaxillary glands**: These are paired, elongated, pale yellow, lobulated glands situated along the medial border of the angle of mandible. They open on the floor of mandible as mandibular or submaxillary duct.
4. **Sublingual glands** : These are two glands situated under tongue. Their secretions are transported to mouth cavity by small ducts.
5. **Functions**: They secrete saliva which acts as lubricant and helps in chewing and swallowing of food. Saliva maintains pH and fluidity of ruminal contents. The saliva of domestic animals contains little or no amylase.

#### Do you know ?

An adult cattle may secrete up to 200 liters of saliva per day.



#### 2. Pancreas

1. It is flat and irregularly quadrilateral in shape.
2. It is located in the duodenal loop.

3. It is reddish yellow in colour and weighs about 300-500 gm.
4. **Pancreatic duct** carries secretion of pancreas to duodenum

#### Remember..

Pancreas is *endocrine* as well as *exocrine* gland



5. **Functions** : The endocrine portion contains *Islets of Langerhans* which produces hormones like *insulin* and *glucagon*. The exocrine portion secretes *pancreatic juice*. The pancreatic juice contains three digestive enzymes namely trypsin, lipase and amylase which helps in digestion of proteins, fats and carbohydrates respectively.

#### 3. Liver

#### Do you know ?

Liver is the largest gland in the body.



1. It is situated on right side of the abdominal cavity near diaphragm.
2. It is irregularly rectangular with rounded corners.
3. It is reddish brown in colour, soft and pliable.
4. It weighs about 3 - 5 kg in adult animals and consists of a body and two small lobes.
5. A pear shaped sac attached to liver is called as *gall bladder* which stores *bile* and *bile duct* carries bile from gall bladder to duodenum.

#### Internet my friend

Search in which animal species gall bladder is absent.



**Functions**

1. It secretes bile which helps in emulsification and absorption of fats.
2. It helps in synthesis of plasma and tissue proteins.
3. It converts highly toxic ammonium salts into less toxic urea.
4. It helps in the synthesis and storage of glycogen.
5. It helps in the synthesis of fats from fatty acids and glycerols.
6. It stores minerals like Fe, Cu and Co.
7. It detoxifies toxins present in blood circulation.
8. It stores fat soluble vitamins like Vit. A, D, E & K.

**9.4.3 Ruminant Digestion****Remember...**

**Digestion is the process of conversion of complex food material into its simpler form.**



The organ wise process of digestion of food material and absorption of food nutrients in ruminants is as follows.

1. **Mouth** : The feed is taken up by the animal with the help of tongue and lips and is partially chewed and swallowed. The swallowed food reaches rumen. Animal during rest brings back the food into mouth by regurgitation. In mouth this food is again chewed and swallowed. This process is called as **rumination** which is the typical feature of ruminant animals. After rumination, food reaches the rumen where major digestion takes place.
2. **Ruminant stomach** : In rumen, the carbohydrate components of the diet like cellulose, hemicellulose, starches, sugars are converted to volatile fatty acids i.e.

**Acetic acid, Propionic acid and Butyric acid** along with production of gases viz. methane and carbon dioxide. These volatile fatty acids are absorbed through ruminal wall and the gases are eructed through mouth during rumination.

The feed proteins are hydrolysed to amino acids and peptides by the proteolytic enzymes produced by ruminal microbes, while small portion of dietary proteins escape ruminal action which are called as **bypass proteins**. Some amount of amino acids formed are used by microbes for their body protein synthesis. The remaining amino acids are then deaminated to produce ammonia, CO<sub>2</sub> and short chain fatty acids. Further the non protein nitrogenous(NPN) substances from the food are also converted to ammonia in rumen. The ammonia thus formed in the rumen is mostly utilized by rumen micro-organisms to synthesize their body proteins.

Fats/Triglycerides are converted to glycerol and galactose which are then converted to volatile fatty acids (VFA) by microbial enzymes.

The heavier food components settles down in the reticulum, thus reticulum acts as a filter for food material. The food then reaches the omasum where about 50% of water from food material is removed. The omasum also helps in fine grinding of food material.

The food then reaches abomasum where the gastric juice containing hydrochloric acid, mucin and enzymes (pepsin, rennin and lipase) acts on food and helps in digestion.

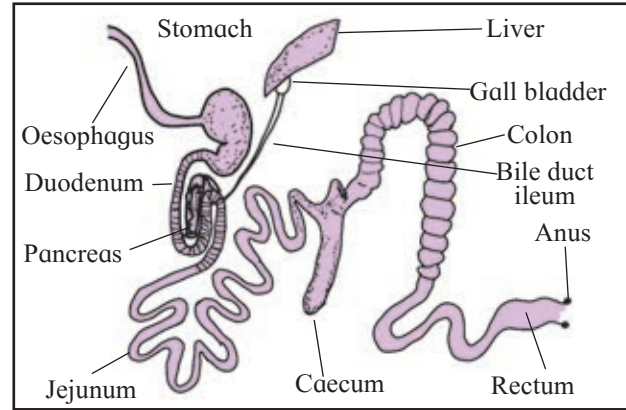
- a. **Hydrochloric acid** provides suitable pH for enzymatic action of pepsin.
- b. **Rennin** is present only in calves and which coagulates milk proteins.

c. **Pepsin** hydrolyses small amount of microbial body proteins and bypass dietary proteins into peptones / polypeptides.

3. **Small intestine** : The partially digested food then reaches to small intestine where the action of bile, pancreatic juice and intestinal juice complete the remaining digestion.

The bile salts help in the emulsification of the fats.

The pancreatic juice contains three enzymes namely **trypsin, lipase and amylase**



**Fig. 9.16 Digestive system of non ruminants**

which helps in digestion of microbial proteins, fats and carbohydrates.

**Table 9.4 : Difference between ruminants and non – ruminant animals**

Ruminants	Non-ruminants
1. They possess ruminant or compound stomach.	1. They possess simple stomach
2. Stomach is four chambered	2. Stomach is single chambered
3. Capacity of stomach is high	3. Capacity of stomach is less
4. Rumination takes place	4. No rumination
5. They ingest large quantity of feed	5. They ingest small quantity of food
6. Microbial digestion is major	6. Microbial digestion is minor
7. Enzymatic digestion is minor	7. Enzymatic digestion is major
8. Maximum digestion of feed takes place in rumen.	8. Maximum digestion of food takes place in intestine.
9. They can synthesize high quality proteins with the help of rumen microbes.	9. They can not
10. They can utilise non-protein nitrogenous (NPN) substances for protein synthesis.	10. They can not
11. They can digest cellulose.	11. They can not
12. End product of carbohydrate digestion is volatile fatty acids (VFA)	12. End product is glucose
13. Major carbohydrate digestion takeplace in rumen	13. Carbohydrate digestion takes place in intestine.
14. Major lipid digestion takes place in rumen	14. Lipid digestion takes place in intestine.
15. <b>e.g.:</b> Cattle, Buffalo, Sheep, Goat.	15. <b>e.g.:</b> Dog, Pig, Man, Horse.



The intestinal juice contains enzymes like *enterokinase, peptidase and invertase* which helps in digestion of amino acids and diasccharides

The end products of nutrient digestion are then absorbed through villi of small intestine into blood and lymph circulation.

4. **Large intestine** : The digested but unabsorbed food components and water are absorbed through large intestine. While the undigested and unabsorbed portion mixes with the mucous secreted by large intestine and also with the glycerols and soluble soaps to form *faeces*. The peristaltic movement of large intestine expels out the faeces through anus via rectum.

## 9.5 URINARY SYSTEM

Metabolic activities taking place in the animal body produce a variety of waste products such as nitrogenous substances and carbon dioxide. These waste products are not only useless but also toxic and their accumulation in the animal body is harmful. These toxic nitrogenous substances are eliminated by the urinary system.

### Can you tell ?

Which are the nitrogenous waste products excreted through urine in cattle ?

Excretion means elimination of liquid metabolic waste from the animal body.

### 9.5.1 Organs of Urinary System

The urinary system of cattle consists of two kidneys, two ureters, an urinary bladder and an urethra.

## 1. Kidneys

### Remember..

Kidneys are the main excretory organs, although liver, lungs and skin serve as part time workers in the process.

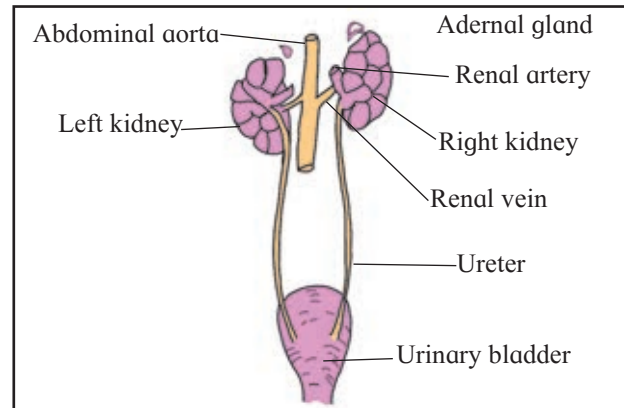


Fig. 9.17 Urinary system of cattle

1. They are two in number i.e. right and left.
2. They are situated on dorsal aspect of abdominal cavity just below lumbar vertebrae.
3. They are oval to elliptical in shape and dark brown in colour.
4. They possess 20-25 lobes in cattle.
5. They weigh about 600-700 gms. Left kidney is heavier than right.
6. The right kidney is *fixed* in position while left one is *floating* or movable.
7. Kidneys are covered by thin fibrous membrane called as *renal capsule*.
8. The outer portion of kidney is called as *cortex* which is dark brown in colour.
9. The inner portion of kidney is called as *medulla* which is pale yellow or light brown in colour.
10. The kidneys are made up of large number of *nephrons*.

## Functions

1. The main function of kidney is formation of urine.
2. They excrete nitrogenous waste products.
3. They maintain the normal pH of body fluids.
4. They help to maintain the water balance of the body.
5. They eliminate drugs and various toxic substances from the body.
6. They help to maintain the osmotic pressure in blood and tissues.
7. They help in the maintenance of electrolyte balance.

### Internet my friend

Composition of urine of indigenous and cross breed cow.



## 2. Ureter

1. These are two (i.e. right and left) excretory ducts extend from kidneys to urinary bladder.
2. They are 50-60 cm in length and 6-8 mm in diameter.
3. **Function** : They carry urine from the kidneys to urinary bladder.

## 3. Urinary bladder

1. It is a hollow, muscular oval sac.
2. It is situated on the floor of the pelvic cavity.
3. It consists of a vertex, body and neck.
4. **Function** : It stores urine.

## 4. Urethra

1. It is a single musculo-membranous tube.
2. It extends from neck of the bladder to tip of glans penis in male and up to vagina in female.

3. Female urethra is shorter than male urethra.
4. **Functions**: It acts as a passage for urine in female and for the urine and semen in male.

## 9.5.2 Structure of Nephron

Kidneys are made up of large number of nephrons. Each nephron consists of glomerulus, Bowman's capsule, proximal convoluted tubule, Loop of Henle and distal convoluted tubule

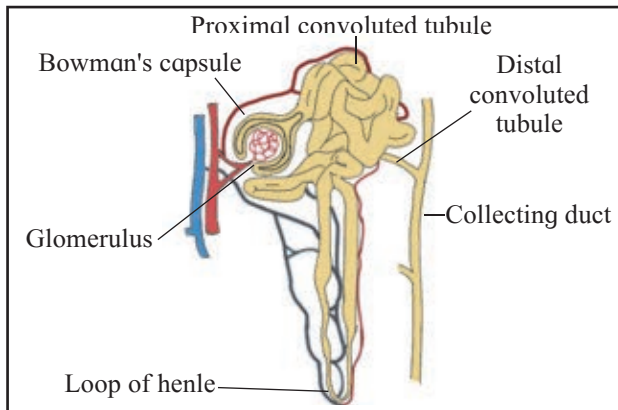
### Use your brain power

Which is the structural and functional unit of kidney ?



1. **Glomerulus** : It is the network of capillaries formed on the course of an arteriole.
2. **Bowman's capsule** : It is an expanded blind end of proximal convoluted tubule which almost entirely surrounds glomerulus.  
The complex of glomerulus and Bowman's capsule is called as **Malpighian corpuscle** or **renal corpuscle**.
3. **Proximal Convoluted Tubule (PCT)**: It is connected directly with outer layer of the glomerular capsule. It is the longest and most winding portion of nephron. It forms much of the tissue of renal cortex. It reabsorbs most of the constituents of glomerular filtrate.
4. **Henle's loop** : It is located between the proximal and distal convoluted tubule. It is U-shaped. It reabsorbs  $\text{Na}^+$ ,  $\text{Cl}^-$  and water.
5. **Distal Convoluted Tubule (DCT)** : It is shorter and less twisted than proximal convoluted tubule. It extends from the termination of ascending limb of Henle's loop to the collecting tubule. It secretes few substances like potassium ions, dyes etc. in urine.

6. **Collecting Tubule** : The DCT opens in collecting tubule which in turn opens in the renal pelvis.



**Fig. 9.18 Structure of Nephron**

### 9.5.3 Mechanism of formation of urine

Formation of urine takes place in three steps-

- 1) Ultrafiltration
- 2) Selective reabsorption
- 3) Tubular Secretion

#### 1. Ultrafiltration

It takes place in Malpighian corpuscle. The blood in the glomerulus is under great pressure because the diameter of the efferent arteriole is smaller than that of afferent arteriole. Therefore all the constituents of blood except blood corpuscles/cells and few plasma proteins are filtered into the Bowman's capsule. This filtrate is called as **glomerular filtrate**.

#### Remember...

**Renal corpuscle is the major site for filtration of fluid from the blood.**



#### 2. Selective reabsorption

It takes place in the tubular region. When the glomerular filtrate reaches the tubule, the cells of the tubule reabsorb useful substances like glucose, amino acids,

some salts and requisite quantity of water from filtrate and give it to blood separating out urea, surplus salt and water.

#### 3. Tubular secretion

This takes place in distal convoluted tubule. The substances which escapes the ultrafiltration in Bowman's capsule passes into the blood capillaries surrounding the tubular region. The cells of tubules separate the substances like ammonia, potassium ions, hydrogen ion, creatinine and put them back into the filtrate. The resulting fluid is the urine.

#### Do you know ?

**Urine is watery solution, pale yellow in colour. Its pH is alkaline i.e. 7.4 to 8.4 and its specific gravity is 1.032 in cattle. The smell of urine is due to presence of volatile organic acids.**



### 9.6 REPRODUCTIVE SYSTEM

Reproduction is a process by which living organisms produce new generations of individuals similar to themselves. Reproduction is one of the fundamental characteristic of living organism. It is an essential life process which helps in continuity of the species. Reproduction is of two types viz. asexual and sexual. In mammals it is sexual reproduction which involves male and female animals of same species as parents.

#### 9.6.1 Male Reproductive System

The male reproductive system of cattle consists of a pair of testes in the scrotum, epididymis, vas deferens, penis and accessory sex glands viz. seminal vesicles, prostate and bulbo-urethral glands.

##### 1. Testes

1. Testes are suspended in the scrotum by **spermatic cord**.

- They are two in number, oval in shape.
- The average weight of adult testis is 300 - 500 gms.
- Each testes consist of a mass of **seminiferous tubules**
- Seminiferous tubule is made up of two types of cells i.e. **Germ cells** and **Sertoli cells**.

**Remember...**

Testes are the primary sex organs in male.



- Functions** : They produce sperms i.e. male gametes and male sex hormone i.e. androgen which promotes development of secondary sexual characters in males.

**2. Scrotum**

- It is a cutaneous pouch in which testicles are located.
- The scrotal skin is thin, pliable and relatively hairless.
- It is divided into two chambers by central membrane called '**scrotal septa**'.
- Functions** : It holds the testes and located external to the body.

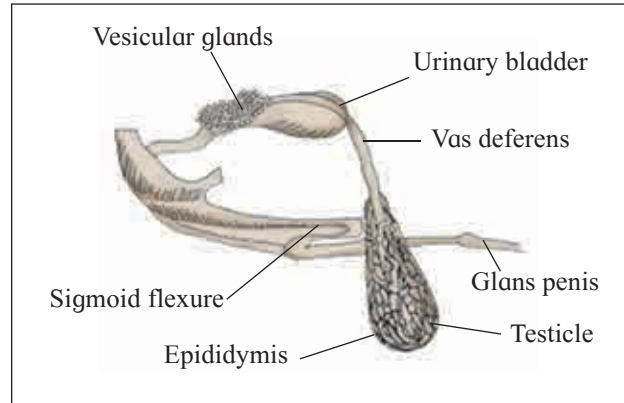
**Do you know ?**

- Scrotum regulates the temperature of testes by contractions, relaxations and through sweating.
- Temperature of testes is less by 1-2<sup>o</sup>c than body temperature.



**3. Epididymis**

- It is coiled tube originating at dorsal part of the testes.
- It is approximately 30-35 meters long.
- It consists of head (**caput**), body (**corpus**) and tail (**cauda**).



**Fig. 9.19 Urogenital organs of cattle**

**Functions**

- It helps in migration of spermatozoa from testes to vas deferens.
- It concentrates diluted sperm suspension.
- It helps in maturation of sperms.

**Remember...**

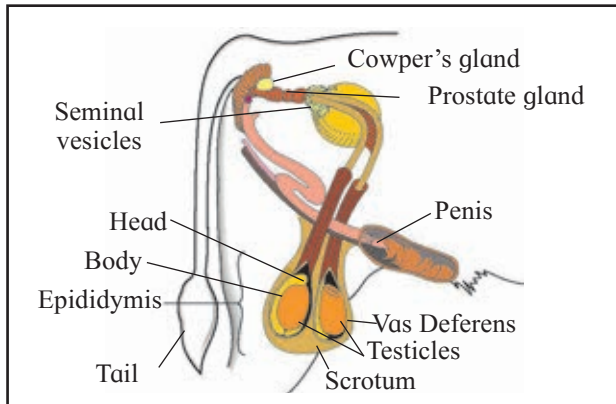
The tail (cauda) of epididymis is store house of sperms.



**4. Vas deferens**

- These are two slender tubes extending from tail of epididymis to urethra.
- Spermatic arteries, veins, nerves, muscles and vas deferens forms **spermatic cord**.
- Each vas deferens goes through the **inguinal ring** and opens into urethra.
- Terminal portion of both the tubes is little dilated and called as '**ampulla**'.

5. **Function:** Transport of sperm from epididymis to urethra.



**Fig. 9.20 Reproductive system of Bull**

### 5. Urethra

1. It extends from the neck of the bladder to tip of the glans penis.
2. It has three distinct parts viz. pelvic part, bulb of urethra and penile part
3. **Function :** It is a common passage for urine and semen.

### 6. Penis

1. It is cylindrical in shape. It is about 3 feet long and 1 inch in diameter in adult bull.
2. It consists of 3 parts - root, body and glans.
3. The free portion of penis in non-erectile state remains covered by a cutaneous pouch known as '*prepuce*'.
4. **Function :** It is an organ of copulation in male.

### Accessory Sex Glands

Accessory sex glands of male reproductive system include seminal vesicles, prostate glands and bulbo-urethral gland or Cowper's gland.

#### 1. Seminal vesicles

1. These are two lobulated elongated glands situated in pelvic cavity.
2. They are located on either side of

ampulla above the neck of urinary bladder.

3. They secrete **seminal fluid** which is rich in fructose and citric acid.

#### 2. Prostate gland

1. It is unpaired gland situated at the junction of bladder and urethra.
2. It is composed of body and glandular part.
3. Its secretions are drained by approximately 30 ducts into urethra.
4. Its secretion is high in proteins, enzymes and minerals.

#### 3. Bulbo-urethral glands or Cowper's glands

1. These are two, small, round and compact glands.
2. These are situated above the urethra near ischial arch.

#### Do you know ?

Secretions of the cowper's gland cleans the urethra from the harmful effects of urine.



### 9.6.2 Female Reproductive System

Female reproductive system of cattle consists of a pair of ovaries, a pair of fallopian tubes, the uterus, the cervix and the vagina.

#### 1. Ovaries

1. These are paired glands situated in pelvic cavity.
2. They are oval in shape.
3. They weigh about 7-15 gms. Right ovary is slightly larger than left.
4. Each ovary consists of number of primordial follicles ranging between 75,000 to 3,00,000. The follicles

reach maturity through successive developmental stages viz. primary, growing and mature follicle.

**Remember...**

**Ovaries are the primary sex organs of female.**



**Functions**

1. Formation of ova or eggs (Oogenesis) i.e. female gamete.
2. Secretion of female sex hormones -
  - a) **Estrogen** – secreted by follicular cells, is responsible for development of secondary sexual characters, sexual behaviour and regulation of estrous cycle.
  - b) **Progesterone** - secreted by corpus luteum, is essential for maintenance of pregnancy.

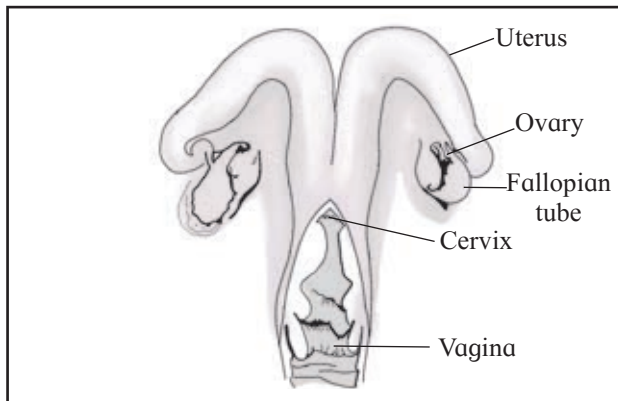
**Use your brain power**

**Which cells secrete oestrogen ?**



**2. Fallopian Tubes**

1. These are also called as oviducts or salpinx or uterine tubes.
2. These are paired, slender, zigzag like tubes extend from ovaries to uterus.
3. Each fallopian tube is divided into infundibulum, ampulla and isthmus.



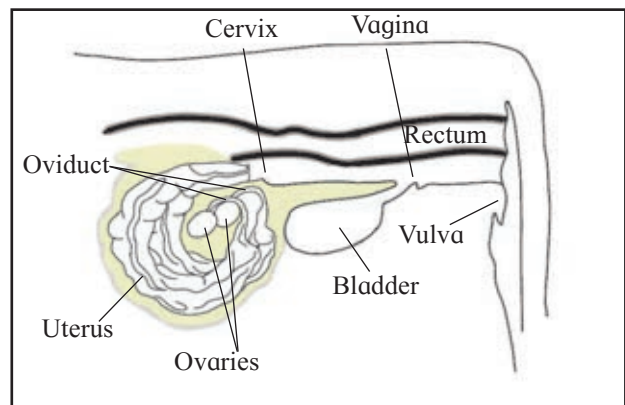
**Fig. 9.21 Genitalia of cow ( Dorsal view)**

**Functions**

1. Infundibulum collects ovum or egg released by ovaries.
2. Facilitate transport of sperms to the site of fertilization.
3. Involved in transport of zygote to the uterus.

**Do you know ?**

**Fertilization of ova takes place in ampulla.**



**Fig. 9.22 Genitalia of cow ( Dorsal view)**

**3. Uterus**

**Do you know ?**

**In which part of reproductive system foetus develops ?**



1. It is hollow, elongated, musculo membranous ‘Y’ shaped sac.
2. It is located in pelvic cavity in non-pregnant animals, however in pregnant animal it descends in abdominal cavity.
3. It continues anteriorly with fallopian tubes and posteriorly with cervix.
4. It consists of short body and two horns.

5. The inner mucosa of uterus has raised spots called '*caruncles*'.

#### Functions

1. Transport of sperms towards the fallopian tubes.
2. Secretion of *uterine milk* for nourishment of early embryo.
3. Implantation of zygote and maintenance of the pregnancy.
5. Uterine contractions help in expulsion of foetus during parturition.
6. Regulates oestrus cycle by secreting prostaglandins.

#### 4. Cervix

1. It is also known as '*neck of the womb*'.
2. It is thick walled fibrous structure ,lies between the uterus and vagina.
3. Its inner wall is arranged in the form of annular rings which gives spiral shape to the cervical canal.
4. The cervical canal is tightly closed during pregnancy and anoestrus, however relaxes during oestrus and parturition.

#### Functions

1. Storage and transport of sperms during oestrus.
2. Secretion of mucus during oestrus stage.
3. Acts as a barrier against ascending type of infections.

#### Remember...

Cervix remains open during parturition, oestrus (heat) period and in case of uterine infections



4. Formation of cervical seal during gestation/pregnancy.

#### 5. Vagina

1. It is highly elastic musculo-membranous tube.
2. It is situated on floor of pelvic cavity above the urinary bladder and below rectum.
3. It is about 20-25 cm long and 10-15 cm wide.
4. It extends from cervix upto urogenital sinus or *vestibule*.
5. Urethra opens on floor of vagina as external urethral orifice.

#### Functions

1. It is the organ of copulation in females.
2. It acts as a birth canal.

#### 6. Vulva

1. It is the external opening of the urogenital tract, lies just below the anus.
2. It has two lateral vulval lips, which are large, soft, thick and normally wrinkled.
3. The *hymen* is a transverse membranous partition situated in front of urethral orifice between vulva and vagina.

#### Do you know ?



The clitoris is a small, rod like, erectile muscular elevation present on the posterior floor of the vulva.

## 9.7 UDDER

Mammary gland is considered as an accessory organ of reproductive system. The mammary gland or udder is modified sweat gland that produce milk for nourishment of off spring.

### Do you know ?

In ruminants, individual glands are associated so closely to one another that they are commonly referred to as a single udder.



### Internet my friend

Number of teats in different animal species.



### 9.7.1 Anatomy of Udder

#### External structure

1. The udder in cow is located entirely outside the abdominal cavity in inguinal region.
2. Udder is divided longitudinally into right and left halves by inter mammary groove.
3. Each half of the udder is further separated into front and rear quarters.
4. The rear quarters are usually larger than fore quarters and posses more secretory capacity.
5. Each quarter is associated with teat which serves as a exit for secreted milk.

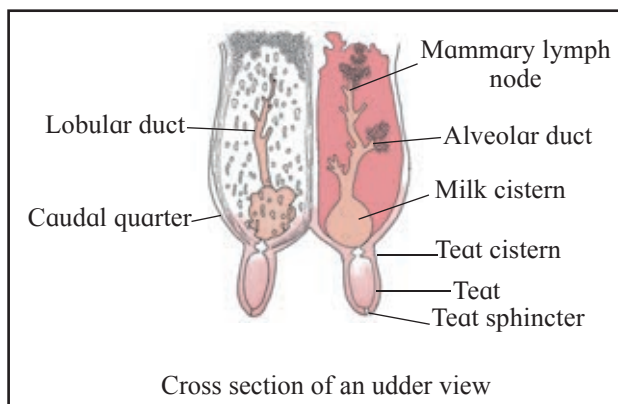


Fig. 9.23 Structure of Udder

6. The teats are long and tubular in shape with conical tip.
7. The skin of teat is smooth and free from hairs and sweat/sebaceous glands.

#### Internal structure

1. The udder is divided into two halves, right and left, by median suspensory ligament.
2. Each half is further divided into fore and hind quarters by thin membrane.
3. Each quarter is composed of secretory tissue and some supporting connective tissue.
4. The secretory tissue comprises of tiny chambers lined with many secretory cells called *alveoli* which secrete milk.
5. Each alveolus is surrounded by myo-epithelial cells. These cells cause contraction of alveoli and thereby help in let-down of milk.
6. Each alveolus is drained by small duct called *alveolar duct*. They unite and reunite to form inter-lobar ducts.
7. The inter-lobar ducts join in the center of gland to form sinus called as *milk cistern*.
8. The milk cistern is continuous below with the *teat cistern*.
9. The teat cistern opens in a streak / teat canal that opens at lower end of the teat i.e. teat orifice.
10. The teat orifice is guarded by a sphincter called *teat sphincter*.



### 9.7.2 Physiology of milk secretion

#### Milk secretion

Milk secretion means synthesis of milk by epithelial cells of alveoli and the passage of milk from the cytoplasm of the cells into the alveolar lumen.

Milk contains water, fats, proteins, lactose, minerals and vitamins.

1. **Milk fat / lipids** : Most of the lipids in milk are in the form of triglycerides which are composed of fatty acids and glycerol. The fatty acids required for synthesis of milk triglycerides are derived from the blood or synthesized within the mammary gland. In non-ruminants blood glucose is used for synthesis of fatty acids whereas in ruminants milk fat is synthesized from blood acetate and beta-hydroxy butyrate. The glycerol is derived from glucose metabolism.
2. **Lactose** : Lactose, the principal carbohydrate in milk, is composed of glucose and galactose. Secretory cells in mammary gland use blood glucose to synthesize galactose and combine it with glucose to form lactose.

#### Remember...

In ruminants glucose is synthesized from propionate which is a substrate for synthesis of lactose.



3. **Proteins** : Milk proteins viz. caseins (major protein),  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin, are synthesized by mammary gland using blood amino acids.
4. **Other constituents** : Milk constituent like water, minerals, vitamins are filtered from the blood through epithelial cells.

#### Do you know ?

For synthesis of 1 ml of milk 400-500 ml of blood must pass through udder.



#### Lactogenesis

Lactogenesis means the initiation/ establishment of milk secretion / lactation.

At puberty, estrogen stimulates the growth of ductile system at each oestrus, while progesterone promotes growth and development

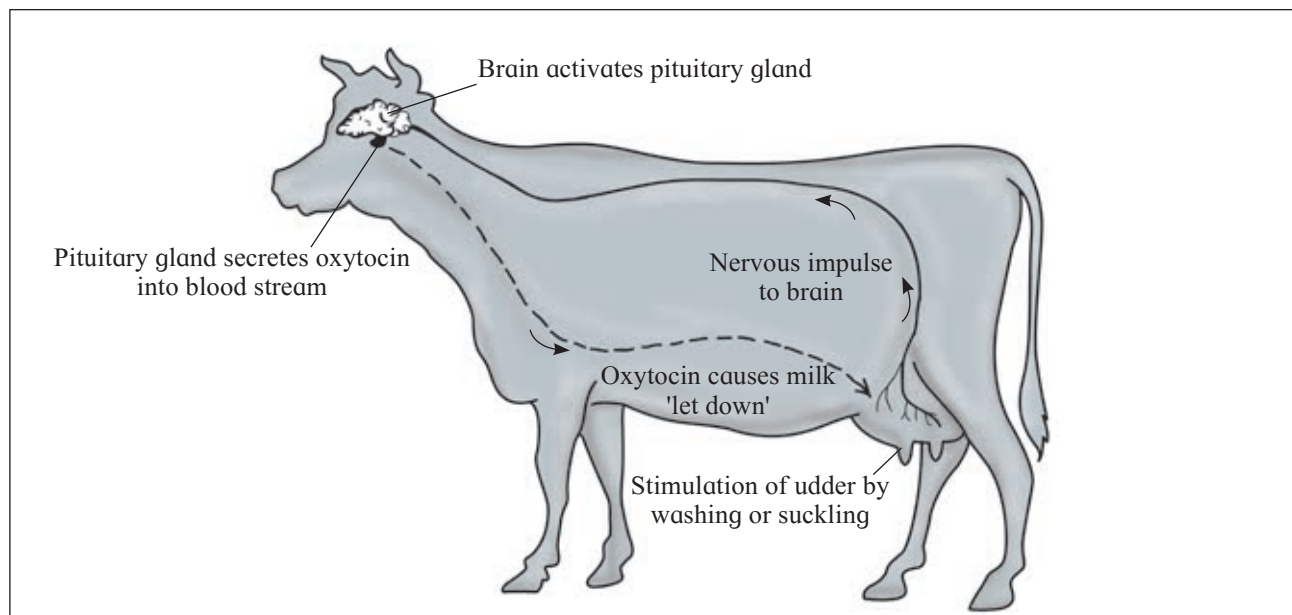


Fig. 9.24 Milk 'let-down' mechanism

of alveoli. Normal secretions of growth hormone and glucocorticoids are also required for complete development of mammary gland.

During pregnancy, progesterone stimulates extensive anatomical development of secretory alveoli but inhibits the functional activity of secretory epithelial cells. By the end of pregnancy, cow's udder is fully developed.

After parturition, sudden decline in placental oestrogen and progesterone and rise in prolactin stimulates production of intracellular enzymes required for milk secretion in secretory cells lining alveoli. This results in establishment of milk secretion / lactation.

### Galactopoiesis

Galactopoiesis means maintenance of lactation or continued production of milk. For continuation of lactation, stimulation of teat either by milking or suckling is required. The stimulation increases secretion of prolactin which is required for maintenance of normal lactation. Along with prolactin, STH, ACTH and TSH are essential for maintenance of lactation.

### Milk ejection or let-down

#### Can you tell ?

The hormone responsible for let down of milk.



Suckling by calf or milking by milkman stimulates sensory nerves from mammary gland. The information reaches hypothalamus which regulates secretion of oxytocin from posterior pituitary gland. The oxytocin stimulates contraction of myoepithelial cells surrounding alveoli which results in milk ejection or milk let-down.

#### Internet my friend

Factors responsible for incomplete milk let down in milk cow.



## 9.8 NERVOUS SYSTEM

Nervous system performs important functions of co-ordination, integration and smooth activities of various parts of the animal body.

### Remember...

Nervous system is the main integrating and coordinating system in animal body.



The nervous system consists of Central Nervous System (CNS) comprising of brain and the spinal cord and the Peripheral Nervous System (PNS) which includes nervous tissue outside CNS.

### 9.8.1 Neuron

1. Each neuron consists of nerve cell body and its processes.
2. Nerve cell body contains nucleus, cytoplasm and Nissl bodies.
3. The nerve cell possesses two types of processes- axon and dendron.
4. The *dendrons* are smaller processes which receives impulses.
5. An *axon* is the long process which conducts impulse away from the cell body.

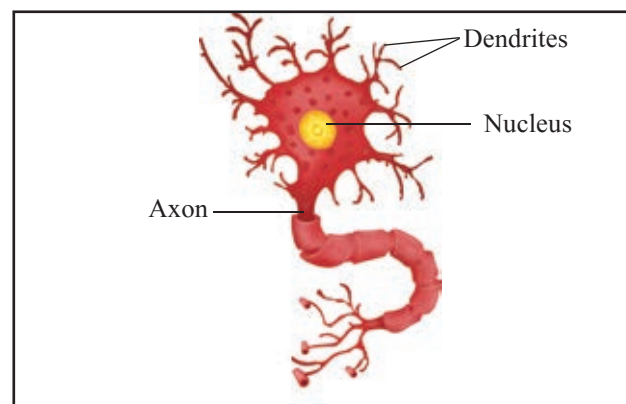


Fig. 9.25 Structure of neuron

6. The groups of axons travelling together are called as *nerve fibres* which group together to form *nerve*.

- Neurons are also classified as sensory and motor neurons. **Sensory neurons** conduct impulses towards CNS while **motor neurons** carry impulses from CNS to the effector organ/periphery.

### 9.8.2 Meninges

- Meninges are the membranous covering of the brain and spinal cord.
- Meninges consist of three layers viz, dura mater, arachnoid and pia mater.
- Dura mater** : It is the outermost tough fibrous covering of brain and spinal cord.
- Arachnoid** : It is the middle very thin delicate layer of meninges.
- Pia mater** : It is the innermost delicate layer of meninges close to brain and spinal cord.

### 9.8.3 Central Nervous System

The central nervous system consists of brain and spinal cord.

#### Can you tell ?



- Different parts of brain
- Overall functions of the brain

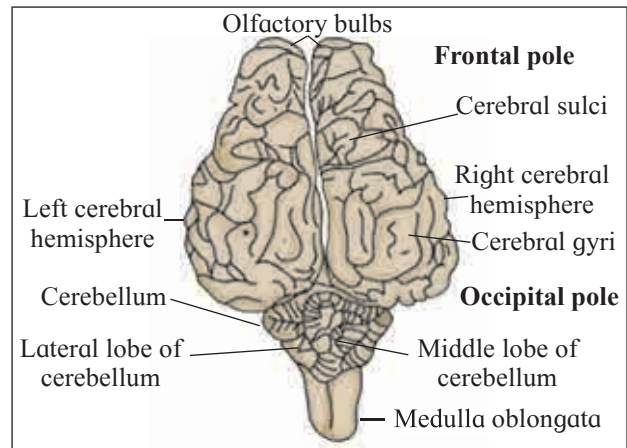
#### A. Brain

It is located in cranial cavity of skull and it is divided in three parts as fore brain, mid brain and hind brain.

##### a. Fore brain

###### Cerebrum

- It is ovoid in shape and represents largest part of brain.
- It is concerned with most highly developed functions of CNS like memory, intelligence.
- It comprises centers for sense of smell, sight, taste and hearing.



**Fig. 9.26 Ventral surface of the brain**

##### b. Mid brain

- It consists of corpora quadrigemina, cerebral peduncles and aqueductus sylvii.
- Corpora quadrigemina is associated with sense of sight and hearing.
- Cerebral peduncles ( crura cerebri) contain nerve fibers that carry motor impulses.

##### c. Hind brain

It consists of cerebellum, pons and medulla oblongata.

##### 1. Cerebellum

- It is irregularly globular structure located above pons and medulla oblongata.
- Cerebellum is the second largest portion of brain.
- It monitors and co-ordinates the voluntary movements.

#### Think about



- Touching to animal body, gives reflexes/shaking reflexes, why is it so?
- Animals are unable to speak like humans

4. It maintains equilibrium of the body and also regulates posture by maintenance of reflex muscle tone.

## 2. Pons

1. It is a transverse square structure situated ventral to the cerebellum.
2. It acts as a reflex center for respiration and reflexes mediated by cranial nerves.

## 3. Medulla oblongata

1. It is the posterior part of brain located between the pons and the spinal cord.
2. It contains the vital centers such as respiratory and cardiac centers and the reflex centers for coughing, salivation, vomiting and swallowing.

### Remember...

- **Ventricles are large cavities in the brain which contains cerebrospinal fluid (CSF).**
- **Cerebrospinal fluid (CSF) protects and nourishes brain and spinal cord.**



## B. Spinal cord

1. It is the thick, cylindrical structure located in the vertebral column/canal.
2. It extends from the skull to the middle of sacrum.
3. The spinal cord is composed of central grey matter surrounded by white matter.
4. It receives sensory afferent fibres by way of dorsal roots of the spinal nerves.
5. It gives off motor efferent fibres to the ventral roots of spinal nerves.
6. The spinal nerves arise from the lateral aspect of spinal cord.

7. *Functions* : It conveys nerve impulses to and from the brain. It serves as the main center for reflex action.

## 9.8.4 Peripheral Nervous System (PNS)

1. The nerves which arise from CNS and extend to the peripheral part of the body form the peripheral or somatic nervous system.

2. PNS provides communication of external and internal environment stimuli to CNS.

3. On the basis of functions, peripheral nerves are classified as follows :

**a. Sensory or afferent nerves** : They conduct impulses from receptors to CNS.

**b. Motor or efferent nerves** : They conduct impulses from CNS to effectors.

**c. Mixed nerves** : They contain both sensory and motor nerve fibres so they have both sensory and motor functions.

4. On the basis of origin peripheral nerves are classified as follows :

**a. Cranial nerves** : They originate from different parts of the brain. There are 12 pairs of cranial nerves. The cranial nerves are either sensory, motor or mixed (sensory & motor).

### Do you know ?

**Vagus nerve is the longest cranial nerve in animal body.**



**b. Spinal nerves** : These are the nerves which originates from the spinal cords. There are 37 pairs of spinal nerves in cattle.. All spinal nerves are mixed in nature.

### 9.8.5 Autonomus Nervous System (ANS)

1. The nervous system that works independently and involuntarily is the autonomus nervous system.
2. It is the visceral component of the nervous system.
3. The nerve fibres are distributed to the visceral organs, blood vessels, glands and smooth muscles.
4. ANS is divided in 2 sections i.e. parasympathetic and sympathetic.
5. It regulates heart rate, respiration, pupil, dilatation and contraction of blood vessels.

**Can you recall ?**  
**Exocrine glands**



### 9.9 ENDOCRINE GLANDS

**Endocrine glands are the ductless glands that discharge their secretions directly in the blood or indirectly via. lymph.**

Hormones are the chemical substances of endocrine gland that are directly secreted into blood which stimulate or inhibit the function of target organ.

Various endocrine glands, the hormones secreted, their sites of actions and functions are mentioned in Table 9.5.

**Use your brain power**

**Which is the master gland in animal body ?**



**Table 9.5 : Endocrine glands, their hormones and functions.**

No.	Name of gland and Hormone	Site of Action (target organ)	Functions/Actions
<b>1. Hypothalamus</b>			
1	Gonadotropin releasing hormone (GnRH)	Anterior pituitary	Releases LH and FSH
2	Thyrotropin releasing hormone (TRH)	Anterior pituitary	Releases TSH
3	Corticotropin releasing hormone (CRH)	Anterior pituitary	Releases ACTH
4	Somatotropin releasing hormone (STH - RH)	Anterior pituitary	Releases STH/GH
5	Somatotropin inhibiting hormone (STH - IH)	Anterior pituitary	Inhibit STH output
6	Prolactin inhibiting hormone (PTH)	Anterior pituitary	Inhibit prolactin output
7	Prolactin releasing hormone (PRH)	Anterior pituitary	Releases prolactin

<b>1. Anterior pituitary (Adenohypophysis)</b>			
1	Growth hormone (GH)/ Somatotrophic hormone (STH)	All tissues	Stimulates growth in young animals, protein and glucose synthesis .
2	Thyroid stimulating hormone (TSH)	Thyroid gland	Stimulates growth of thyroid gland and enhances production of thyroxine
3	Adrenocorticotrophic hormone (ACTH)	Adrenal cortex	Maintenance of adrenal cortex and release of glucocorticoids.
4	Prolactin(PRL)	Mammary gland and CNS	Stimulates lactation and maternal behavior.
5	Follicle Stimulating Hormone (FSH)	Ovaries and Testes	Growth and maturation of ovarian follicles (oogenesis) and sperm development.
6	Luteinizing Hormone (LH)	Ovaries and Testes	Ovulation, development of corpus luteum and progesterone secretion, secretion of androgen.
<b>2. Posterior pituitary glands(Neurohypophysis)</b>			
1	Antidiuretic hormone (ADH)	Kidney, blood vessels.	Regulation of water excretion, Constriction of blood vessels .
2	Oxytocin	Mammary gland and uterus	Helps in milk let down. Promotes uterine contractions.
<b>3. Thyroid glands</b>			
1	Thyroxine and Triiodothyronine	All tissues	Stimulates glucose and protein synthesis. Mobilization of fat.
2	Calcitonin	Bone and Kidney	Lowers blood calcium level
<b>4. Parathyroid gland</b>			
1	Parathyroid Hormone (PTH)	Bone, Kidney and intestine	Increases the level of calcium in blood
<b>5. Pancreas</b>			
1	Insulin	Liver, muscle and adipose tissue	Lowers blood glucose. Stimulates protein and lipid synthesis.
2	Glucagon	Liver and muscle	Elevates blood glucose.
<b>6. Adrenal glands</b>			
1	Ephinephrine/ Nor- ephinephrine	Several organs	Stimulates sympathetic response to stress by action on different organs
2	Glucocorticoids	All tissues	Synthesis of glucose
3	Mineralcorticoids / Aldosterone	Kidneys	Increases reabsorption of sodium and promotes excretion of potassium ions

**EXERCISES**

**Q. 1 Fill in the blanks**

1. Cattle heart is made up of ..... chambers.
3. Platelets are also called as .....
4. .... is the largest long bone in animal body.
5. .... bones contain air space
6. The cervical vertebrae in cattle are ..... in number
7. .... blood cell is involved in blood clotting.
8. .... is also known as sound box.
9. .... is also known as wind pipe.
10. The right lung is divided into ..... lobes.
11. .... is the main excretory organ in cattle
12. .... carries urine from kidneys to bladder.
13. .... is the major site for filtration of fluid from blood.
14. .... is the chief prehensile organ in cattle.
- 15..... number of incisors are present in the lower jaw of cattle.
16. .... teeth are absent in cattle.
17. Ruminant stomach is made up of ..... chambers
18. .... is the largest compartment of ruminant stomach.
19. .... is the primary sex organ in males.
20. .... hormone is required for maintenance of pregnancy.

**Q. 2 Match column I with column II**

Column I	Column II
1. Artery	a) Pumping organ
2. Testes	b) Neck of the womb
3. Cervix	c) Androgen
4. Abomasum	d) Carry pure blood
5. Heart	e) True Stomach
6. Lungs	f) Milk holding hormone
7. Liver	g) Estrogen
8. Adrenaline	h) Largest Gland
9. Ovary	i) Milk lettingdown hormone
10. Oxytocin	j) Respiratory organ

**Q.3 Identify the odd one out**

1. Kidney, Ureter, Lungs, Urinary bladder, Urethra,
2. PCT, Testis, DCT, Henle's loop, collecting tubule
3. Ultrafiltration, Selective reabsorption, Tubular secretion, Circulation
4. Cortex, Medulla, Renal capsule, Ureter, Renal artery, Renal vein
5. Rumen, Reticulum, Omasum, Abomasum, Liver
6. Ovary, Oviduct, Uterus, Cervix, Penis
7. Scrotum, Epididymis, Vas deferens, Testes, Vagina

**Q.4 State True or False**

1. Aorta is the largest artery.
2. RBC are non-nucleated cells.
3. WBC are also called as erythrocytes .
4. Pulmonary artery carry deoxygenated blood.

5. Right side of heart contains oxygenated or pure blood.
6. Nephron is the structural and functional unit of kidney.
7. Kidneys are the main excretory organs.
8. Bowmans capsule is a part of nephron.
9. Urethra is a common passage for urine and semen in male.
10. Single kidney is present in cattle.
11. Alveolus is the structural and functional unit of lungs.
12. Right and left lungs have same number of lobes.
13. Out flow of air is called is called expiration.
14. Exchange of  $O_2$  and  $CO_2$  between blood and tissues is called internal respiration.
15. Nasal cavity is the first part of the respiratory passage.

**Q. 5 Answer in brief**

1. Give the location of kidneys in cattle.
2. Enlist the different parts of nephron.
3. Enlist different phases of urine formation.
4. Give the location of lungs in cattle.
5. Give the location of heart in cattle.
6. Write the function of RBC.
7. Enlist three layers of heart wall.
8. Which is the largest sesamoid bone in animal body ?
9. Write the functions of short bones.

10. Enlist the types of joints.
11. Enlist the various compartments of ruminant stomach.
12. Why abomasum is called as true stomach of ruminants ?
13. Which is the largest gland in the animal body ?
14. Give the function of scrotum.
15. Name the structural and functional unit of the nervous system.

**Q. 6 Differentiate between**

1. Ruminants and non-ruminant animals.
2. Right and left lung
3. RBC and WBC.
4. Arteries and veins.
5. Long and flat bones.

**Q.7 Answer the following questions**

1. Describe in brief lymphatic system.
2. Write short note on platelets.
3. Enlist major constituents of plasma.
4. Write in short about structure and functions of cerebellum.
5. Enlist the hormones secreted by adrenal gland and give their functions.
6. Give the functions of hormones secreted by pancreas.
7. Describe in brief the structure and functions of internal ear.
8. Write in brief about structure of eyeball.
9. Give the functions of bones.
10. Write short note on larynx.
11. Give structure and functions of trachea.

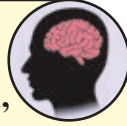


12. Describe in brief structure of nephron.
  13. Enlist the functions of kidney.
  14. Give location and functions of urinary bladder.
  15. Describe in brief structure of lung.
  16. Enumerate functions of liver.
  17. Enlist the functions of intestine.
  18. Give structure and functions of testes.
  19. Enlist the symptoms of heat in cattle.
  20. Describe in brief external features of cow's udder.
- Q.8 Answer the following questions in detail.**
1. Describe functions and composition of bone in detail.
  2. Describe the classification of bones with suitable examples.
  3. Define blood. Give functions and composition of blood.
  4. Describe the structure of heart with the help of well labelled diagram.
  5. Describe the respiratory system of cattle.
  6. Describe the urinary system of cattle with well labelled diagram.
  7. Describe the ruminant stomach with the help of well labelled diagram.
  8. Describe in detail male reproductive system in cattle.
  9. Describe in detail female reproductive system in cattle.
  10. Explain in detail structure of udder in dairy cow.

## 10. POULTRY ANATOMY AND PHYSIOLOGY

### Can you recall ?

Functions of Skeletal system, Digestive system, Respiratory system, Reproductive system and Endocrine system.



### 10.1 SKELETAL SYSTEM

The skeletal system of fowl consists of axial and appendicular skeleton

#### 10.1.1 Axial Skeleton

It consist of skull, vertebral column, ribs and sternum

- Skull :** Skull is small and conical. The anterior extremity is elongated and ends into a pointed beak. The posterior extremity articulates with atlas.

### Do you know ?

- Teeth and paranasal sinuses are absent in fowl/poultry
- Orbital fossa is very large
- Upper jaw is movable



- Vertebral Column :** The vertebral column of fowl consists of - a) Cervical vertebrae, b) Thoracic vertebrae , c) Lumbar and sacral vertebrae and d) Coccygeal vertebrae.

### Remember...

The vertebral formula for the fowl is C14 T7 L+ S14 Cy6.



- Cervical vertebrae :** They are 14 in number. *Atlas* is the first cervical vertebra which is thin and ring like. *Axis*, second vertebra, is short.

- Thoracic vertebrae :** They are seven in number. The first and sixth vertebrae are free where as second to fifth are fused with first lumbr vertebra.

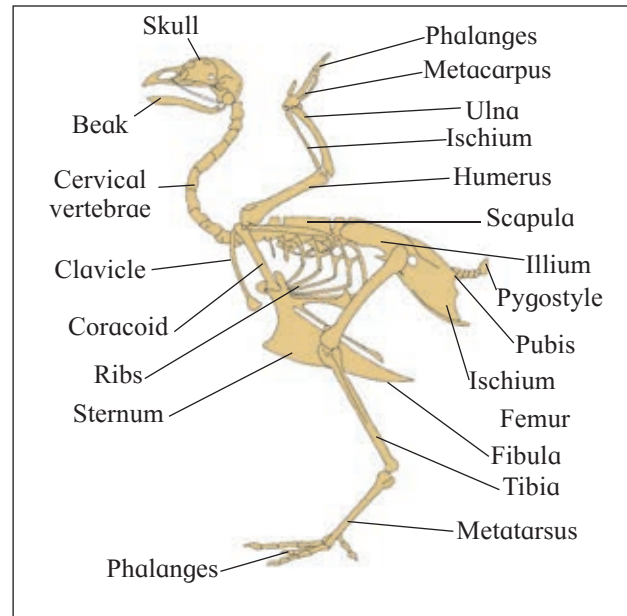


Fig. 10.1 Skeletal system of fowl

- Lumbar and Sacral vertebrae :** They are 14 in number. They fuse to form lumbo-sacral mass.
- Coccygeal Vertebrae :** They are six in number. The first coccygeal vertebra is fused with lumbo sacral mass. The last two or more vertebrae unite to form a three sided pyramid like structure called as '*Pygostyle*'.

### Can you tell ?

- Why birds can fly?
- Why the body temperature in birds is more than other animals species?



3. **Ribs** : There are seven pairs of ribs. They form lateral wall of thoracic cavity. They articulate above to the thoracic vertebrae and below to the sternum.
4. **Sternum** :It is also called as '**breast bone**'. It is quadrilateral curved plate of bone. It forms the floor of thoracic cavity and part of the abdominal cavity.

### 10.1.2 Appendicular Skeleton

Appendicular skeleton of fowl consists of bones of pectoral and pelvic limbs.

#### 1. Bones of Pectoral Limb

- a. **Pectoral girdle** : It comprises Clavicle , Coracoid and Scapula. **Clavicle** is slightly bent, thin rod of bone. **Coracoid** is long, three sided, rod shaped bone. **Scapula** is thin elongated bone.
- b. **Humerus**: The bone articulates with the scapula and the coracoids proximally and with the radius and the ulna distally.
- c. **Radius and Ulna** : The radius is placed external to the ulna. Radius and ulna are separated by a wide interosseous space. These bones articulate with the humerus proximally and with carpus distally.
- d. **Carpals** : There are two bones, namely radial carpal and ulnar carpal in the proximal row. The distal row bones are fused with the metacarpal bones.
- e. **Metacarpals** : There are three metacarpal bones. The first metacarpal is a small projection while the second and third are fused at both extremities.
- f. **Digits** : There are three digits in fowl. The first and second digits have two phalanges while the third digit has one.

#### 2. Bones of Pelvic Limb

- a. **Pelvic girdle** : It comprises of ilium, ischium and pubis or '**lay bone**'. The **ilium** is the largest pelvic bone and is fused with sacrum. The **ischium** is smaller than ilium. The **pubis** is thin bone and has a tendency to straighten out when a bird is in production. The **acetabulum** is large, deep and perforated.
- b. **Femur** :This long bone articulates with pelvic girdle proximally and with tibia- fibula distally.
- c. **Patella** : It is thin triangular bone.

#### Do you know ?

**Tibia is the largest bone of the limb.**



- d. **Tibia** : The proximal end is attached to fibula. The distal end is fused with proximal row of the tarsus.
- e. **Fibula** : It is thin, rod shaped bone. The proximal end has a massive head for articulation with femur. The distal end is pointed and extends up to lower third of the tarsus.
- f. **Tarsals**: They are not found separately in the adult birds. The tarsal bones of the proximal row are fused with the tibia to form **tibio-tarsus**. The tarsal bones of distal row are fused with metatarsal bone to form '**tarso-metatarsus**'.
- g. **Metatarsal** : It is a single large bone in adult fowl. The proximal end is irregular and fused with tarsus. The distal end articulates with second, third and fourth digits .
- h. **Digits** : There are four digits (toes) in fowl. The first and second digits have three phalanges. The third has four phalanges and the fourth has five phalanges.

## 10.2 DIGESTIVE SYSTEM

The digestive system of fowl consists of mouth, oesophagus, stomach, small intestine, large intestine, cloaca and associated glands viz. liver and pancreas.

### 10.2.1 Alimentary Canal

1 **Mouth** : It is triangular in shape closed by upper and lower jaw forming the beak. The shape of tongue is like the barbed head of an arrow. Mouth is directly continuous with the pharynx. The main functions of mouth are prehension and deglutition.

#### Do you know ?

Mouth in birds is characterised by absence of cheeks, lips and teeth.

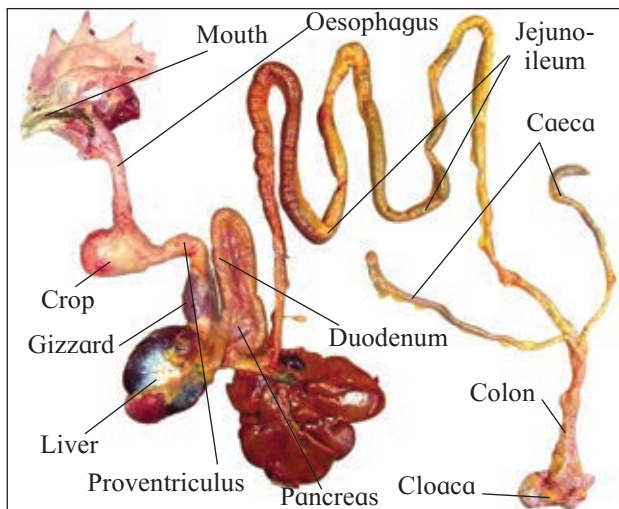


Fig. 10.2 Digestive system of fowl

2 **Oesophagus** : It is thin walled elastic tube. It begins at pharynx and terminates at proventriculus. It is a passage for food.

3 **Crop**: It is an enlargement of the oesophagus. It is simple, oval, musculo-membranous pouch. It stores food material. It also secretes mucus which lubricates and softens food material. It sends food to the proventriculus.

4 **Stomach** : It consists of two parts viz. proventriculus and gizzard.

a. **Proventriculus** : It is also called as *glandular stomach*. It is located 2-3 inch beyond the crop .It is an oval thick walled tube. It passes food from the crop to gizzard. It secretes gastric juice and some acids. It helps in further softening of the food material.

#### Remember...

- Very little digestion take place in poultry through bacterial action
- They can digest small amount of fibre than any other class of farm livestock.



b. **Gizzard** : It is also called as *muscular stomach*. It is located just behind the proventriculus. It is larger than proventriculus. It is reddish green in colour. It is composed of two thick, powerful muscles. Its main function is crushing or grinding of ingested food. It acts as a filter for food material.

#### Do you know ?

Gizzard is the largest single organ of the body.



5 **Small Intestine** : It extends from the gizzard to the caeca and about 2½ ft long in mature bird. It consists of three parts namely duodenum, jejunum and ileum. The duodenum begins from gizzard and forms a loop. The bile and pancreatic ducts open near each other at the termination of duodenum. The jejunum-ileum is arranged in the form of coils. Gastric digestion together with some pancreatic digestion takes place in duodenum. It secretes intestinal juice which helps in digestion

of food material. It acts as an organ for absorption of the digested food material.

- 6 **Large Intestine :** It extends from ileo-caecal junction to cloaca and consists of two caeca and a colon. **Caeca** are two blind sacs about 5 - 7 inch in length and are present at the junction of small and large intestine. They help in digestion of fibre. They act as temporary storage organs for faecal material. The absorption of some digested food material may take place in caeca. **Colon** is a small straight tube which lies between the caeca and the cloaca. It helps in absorption of water.
- 7 **Cloaca :** It is a tubular common cavity for digestive, urinary and genital tracts. The **vent** is an external opening of cloaca. The faecal material and urine are mixed and excreted through vent.

### 10.2.2 Associated Glands

#### Do you know ?

In birds faeces and urine are voided through one opening.



- 1 **Pancreas :** It lies between the folds of the duodenum. It is a thin, narrow and lobulated gland. It is pale yellow or reddish in colour. Two **pancreatic ducts** carry pancreatic juice from pancreas to duodenum. It secretes **pancreatic juice** which contains digestive enzymes viz. trypsin, amylase and steapsin.
- 2 **Liver :** It lies on the floor of the abdominal cavity. It is dark red in colour. It consists of two lobes i.e right and left. A sac is situated on visceral surface of the right lobe of liver called as '**gall bladder**' which stores bile. There are two **bile ducts** which carry **bile** from liver to the duodenum. It secretes the bile which helps in digestion of fats. It helps in protein, carbohydrate and fat metabolism.
3. **Salivary Gland :** It secretes saliva in very small amount which helps in lubrication of food .

#### Remember...

Do you know, liver is the largest gland in the body.



### 10.3 RESPIRATORY SYSTEM

The respiratory system of fowl consist of nasal cavities, larynx, trachea, syrinx (Voice box ), bronchi, lungs and air sacs.

1. Nasal cavity is narrow and comprises of three compartments viz. vestibule, respiratory and olfactory. Nostrils are slit like openings in the upper beak.
2. Larynx consists of four cartilages- a cricoids, a precricoid and two arytenoids.
3. Trachea is formed by about 115 complete cartilagenous rings
4. The syrinx is a sound producing vocal organ of birds. It is dilated cartilaginous compartment located at the point of bifurcation of trachea into two primary bronchi.
5. The bronchi end at the entrance of the air sacs.
6. Lungs are flat and rectangular in shape.
7. Birds have 8 air sacs viz. cervical (1), clavicular (1), anterior thoracic (2), posterior thoracic (2) and abdominal (2).

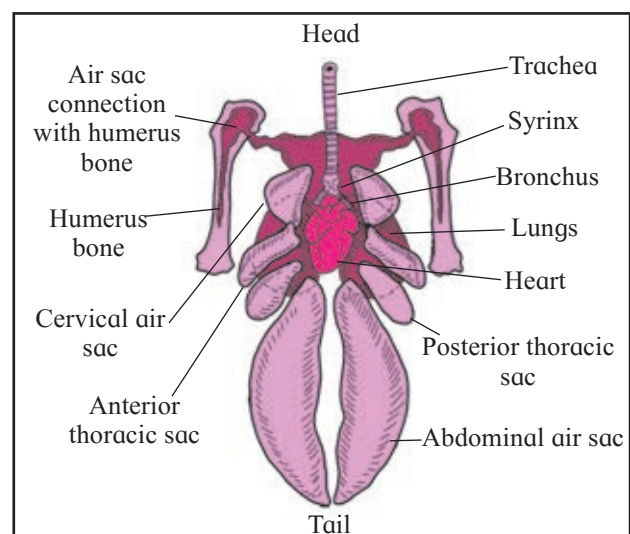


Fig. 10.3 Respiratory system of fowl

8. Birds ventilates their lungs by means of air sacs. These sacs do not play a direct role in gas exchange, but store air and act like bellows, allowing the lungs to maintain a fixed volume with fresh air constantly flowing through them. Air moves in and out of the lungs and the air sacs freely, but the lungs are responsible for most of the respiration. They also function as a cooling mechanism by exhaling water in the form of water vapor.

**Do you know ?**

The main differentiating features of respiratory system between poultry and mammals –

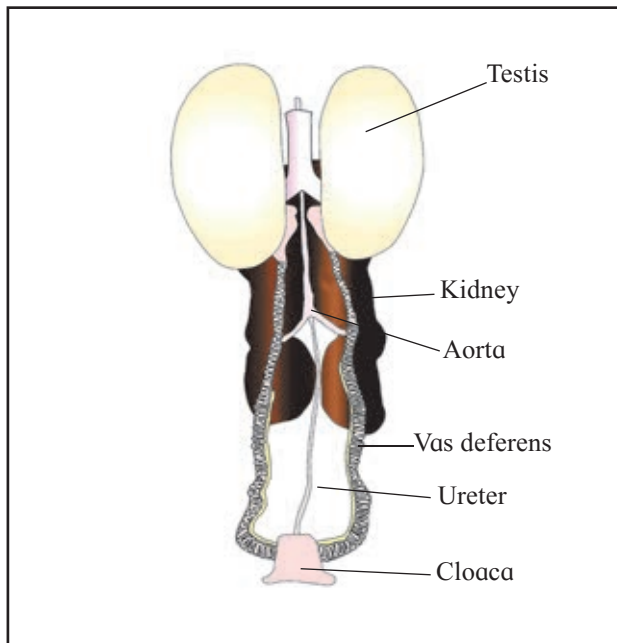
- Syrinx is a sound producing vocal organ in fowl.
- Lungs of chicken are supplemented by air sacs.
- Avian lungs do not have alveoli.



**10.4 REPRODUCTIVE SYSTEM**

**10.4.1 Male Reproductive System**

The male reproductive system of fowl consists of testes, vas deferens and papillae.



**Fig. 10.4** Male reproductive system of fowl

**1. Testes**

1. They are two in number and situated in sublumbar region.
2. They are bean shaped or oval in shape and pale yellow in colour.
3. The left testis is usually larger than right.
4. They consist of large number of slender convoluted tubes known as seminiferous tubule.
5. They produce sperms, seminal fluid and male sex hormone i.e. *testosterone*.

**2. Vas deferens**

1. These are two tortuous tubes which extend from testes to the cloaca.
2. They are narrow at their origin but becomes gradually wider towards the cloaca.
3. They carry sperms and seminal fluid from testis to the cloaca.

**Do you know ?**

The male reproductive system of fowl differs from that of mammals on following aspects-

1. Testes are intra-abdominal and sperms are produced at body temperature .
2. Sperms remain alive for several days in female genital tract.
3. Epididymis is very short.
4. The accessory glands like seminal vesicles, prostate and Cowper's glands are absent.



**3. Papillae**

1. They are located on the median ventral portion of the cloaca.
2. They are rudimentary copulatory organs of the male.

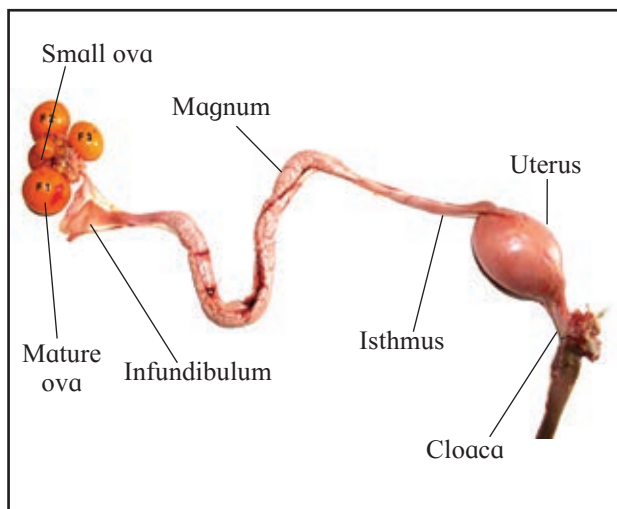
3. They introduce sperms into the oviduct during coitus.

### 10.4.2 Female Reproductive System

The reproductive system of the female consist of ovary, oviduct, uterus and vagina

#### 1. Ovary

1. There are two ovaries in early life, but only left ovary is functional in adult.
2. The left ovary is situated in the upper part of the abdominal cavity opposite to the last two ribs.
3. The functional ovary appears as a cluster of **ova or yolks**.
4. The ovum or yolk is enclosed in a thin membrane called as **vitelline membrane**. The yolk is pale straw or yellow or orange coloured. The yolk and vitelline membrane is enclosed by **follicle**, which holds the ovary by **follicle stalk**.
5. The functions of ovary are formation of ova and secretion of female sex hormones viz. oestrogen and progesterone.



**Fig. 10.5** Female reproductive system of fowl

#### 2. Oviduct

1. There are two oviducts during early life, but only left oviduct is developed in adult.
2. It is a long coiled tube which occupies much of the left side of the abdominal cavity.
3. It is divided into five parts viz. infundibulum, magnum, isthmus, uterus and vagina
4. **Infundibulum** : It is located just below and behind the ovary. It is funnel shaped, delicate, membranous structure. Its anterior end is expanded and presents opening. It measures about 9 cm in laying bird. It receives ova or yolk from the ovary.

#### Remember...

**Infundibulum is the site of fertilization.**



5. **Magnum** : It is the second portion of oviduct. It forms more than half of the total length (33 cm) of oviduct. It secretes thick albumin or egg white .
6. **Isthmus** : It is third part of the oviduct. It is narrow and some what constricted portion. It is about 10 cm in length. It secretes the shell membranes.
7. **Uterus** : It is also known as *shell gland*. It is thick walled, pouch like structure and is placed next to the isthmus. It is 10 - 12 cm in length. It secretes thin egg white, the shell and the shell pigment.
8. **Vagina** : It is short, narrow terminal portion of oviduct which opens into cloaca. It holds the egg until it is laid.

**Do you know ?**

The female reproductive system of fowl differs from that of mammals on following aspects -

1. Only left ovary and left oviduct are functional in adult fowl.
2. Egg or ovum is an article of food.
3. Egg is large and enclosed with food supply for nourishment of embryo.



**10.4.3 Formation of egg :**

**Can you think ?**

1. Egg is a vegetarian food.
2. Testis are inside the body of birds

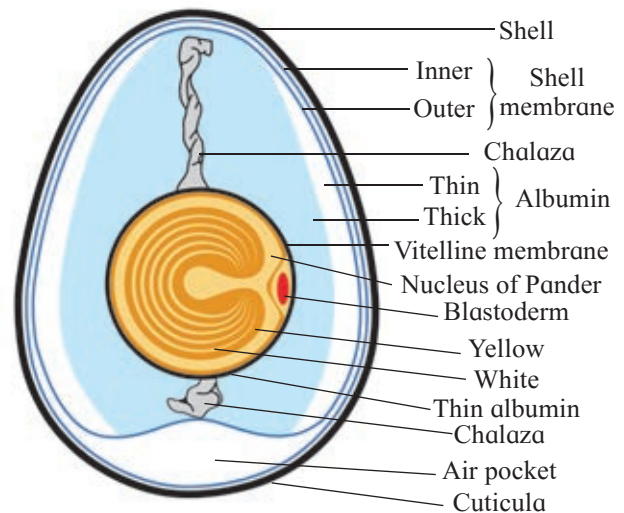


1. When ovary becomes functional, few ova increases in size due to deposition of yolk.
2. The ovum with yolk is enclosed in a **vitelline membrane**.
3. The yolk and vitelline membrane are enclosed into the highly vascular connective tissue called **follicle**.
4. The ovum with yolk when grows in size gets suspended in its follicle and held to the ovary by a **stalk**.
5. The ovum grows rapidly with the formation of concentric layers of light and dark yolk.
6. At maturity, ovum released from follicle (ovulation) is engulfed by the **infundibulum**. If hen is mated with cock then fertilization takes place in infundibulum. The fertilized or unfertilized ova remains for about 18 minutes in infundibulum.
7. Then it moves to magnum where goblet cells secretes **egg albumen**. The ovum remains in magnum for about 3 hours.

8. The peristaltic movement of the magnum propels ovum to isthmus where inner and outer **shell membranes** are formed and also shape of egg is determined. Egg remains in isthmus for about 1 hour 14 minutes.
9. The egg then reaches uterus where watery fluid secreted by the tubular glands of uterus forms inner as well as outer layers of **thin white**. The uterine secretion also contains material (mainly calcium carbonate) for **egg shell** formation. The shell pigments are also formed in uterus during last 5 hours before laying. The egg remains in uterus for about 21 hours.
10. The contractions of uterus propels the fully developed egg to cloaca through vagina during the act of laying.

**10.4.4 Structure of egg**

1. The egg consists of shell, shell membrane, albumen and yolk.
2. The shell is the hard outermost covering composed of calcium carbonate mainly and is 8 to 11% of total egg.
3. Next to the shell are the outer and inner shell membranes.



**Fig. 10.6 Vertical section of fresh egg**



4. The albumen or the egg white is made up of outer thin white (24%) and innermost thick white (34%) .
5. Inner thick white is also known as chalaziferous layer.
6. Albumen accounts for 58-61% of the total egg.
7. The egg yolk is arranged in concentric

layers, is almost spherical and is enclosed in thin vitelline membrane. The germinal disc is very clear in a fertile egg. Yolk is 27-32 percent of the total egg.

### 10.5 ENDOCRINE SYSTEM

Endocrine glands of fowl includes pituitary, thyroid, parathyroid, ovary, adrenal and pancreas.

**Table 10.1 Endocrine glands, hormones and their functions**

Sr. No.	Endocrine gland	Hormone	Tissues influenced	Functions/Physiological actions
1	Anterior pituitary	Follicle stimulating hormone ( FSH )	Ovary	1. Stimulates the growth and maturity of Graffian follicle in female 2. Maturity of sperm in male
		Luteinizing hormone (LH)	Ovary	Releases ovum by rupture of Graffian follicle (Ovulation )
2	Thyroid gland	Thyroxine	All tissues	Affects feather growth and colour
3	Parathyroid	Parathormone	Bone, kidney and intestine	Increases calcium and phosphorous metabolism.
4	Ovary	Estrogens	Oviduct	1. Growth and development of oviduct 2. Secondary sex characteristics 3. Eggs production
5	Adrenal	Adrenaline	Liver, bone, kidney	Helps in carbohydrate, fat and mineral metabolism, breakdown of protein and important in the birds reaction to stress.
6	Pancreas	Insulin	Liver, muscle and adipose tissue	1. Controls blood sugar level. 2. Helps in fat and protein metabolism

**EXERCISES**

**Q.1 Fill in the blanks**

1. The main function of gizzard is .....
2. .... is a common cavity for digestive, urinary and genital tracts.
3. .... portion of oviduct secretes thick egg white.
4. .... hormones releases ovum by rupture of graffian follicle.
5. .... bone of fowl consists of ileum, ischium and pubis

**Q.4 State True or False.**

1. Gizzard is the largest single organ of the body.
2. Larynx is a sound producing vocal organ in fowl.
3. Liver is the largest gland in the body.
4. Proventriculus is called as muscular stomach.
5. Lungs of chicken are not supplemented by air sacs.

**Q.2 Match the pair.**

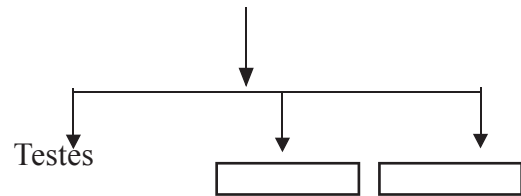
Group A		Group B	
1.	Pancreas	a)	Gastric Juice
2.	Salivary gland	b)	Saliva
3.	Liver	c)	Trypsin
4.	Proventriculus	d)	Grinding of food
5.	Gizzard	e)	Bile

**Q.3 Identify the odd one out**

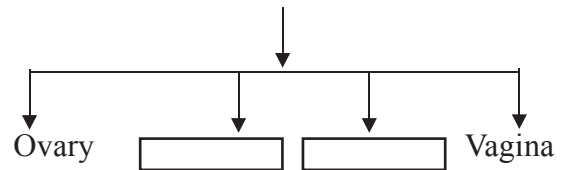
1. Infundibulum, Magnum, Isthmus, Ureter, Vagina
2. Tarsals, Pectoral Girdle, Humerus, Radius and Ulna, Metacarpals
3. Pelvic Girdle, Femur, Patella, Tibia and Fibula, Carpals
4. Larynx, Trachea, Liver, Syrinx, Lungs
5. Estrogens, Saliva, Adrenaline, Insulin, Thyroxine

**Q.5 Answer the following questions in brief.**

1. Differentiate between male reproductive system of birds and mammals.
2. a. Male reproductive system



- b. Female reproductive system



3. Write note on gizzard.
4. Write short note on structure of egg.

**Q.6. Answer the following questions.**

1. Draw neat diagram of male reproductive system of fowl.
2. Describe in brief anatomy of pectoral girdle of fowl.
3. Write functions of small intestine in fowl.
4. Enlist organs of respiratory system. Write differentiating features of respiratory system between poultry and mammals.

5. Write in tabular form, hormones secreted by Anterior pituitary, Thyroid gland with tissue influenced and major functions/physiological actions.
6. Draw neat diagram of vertical section of egg.

**Q.7 Answer the following questions in detail**

1. Describe in detail digestive system of fowl with neat diagram.
2. Explain in detail female reproductive system of fowl with well labeled diagram.

## 11. ANIMAL BREEDING AND SELECTION

### Can you recall ?

**Terms : Breed, breeding and selection**



### 11.1 SYSTEMS OF BREEDING

The animal breeding programmes involves selection of superior animals and mating them to obtain progeny with better genetic potential.

The combination of effective selection with proper mating / breeding system is essential for success of any breeding programme.

#### Objectives of animal breeding

1. To increase production of milk, meat, egg and wool.
2. To improve growth rate.
3. To improve quality of milk, meat, egg and wool.

There are two main systems of breeding

1. Inbreeding. 2. Outbreeding.

### Introduction to scientist



The origin of animal breeding lays in the United Kingdom. Robert Bakewell (1727-1795), who introduced keeping accurate records of performance of animals so that objective selection and breeding became possible. He was the first scientist to improve animals for meat production and carcass quality.

### 11.1.1 Inbreeding

Inbreeding is the mating of related animals.

#### Advantages

1. It increases homozygosity and decreases heterozygosity .
2. It helps in producing seedstock (elite animals) for crossbreeding.
3. It helps in development of families or inbred or purebred lines.
4. It helps in elimination of undesirable recessive genes.
5. It increases uniformity of productive characters.
6. It helps in selection of desirable animals and also culling of undesirable animals.

#### Disadvantages

1. It decreases growth rate, body size and body weight.
2. It reduces reproductive efficiency and production performance of the progeny.
3. It slows testicular development, reduces vigor in males and delays puberty in both sexes.
4. It increases early embryonic death rate and mortality in progeny.

### Remember...

- The decreased growth and reproduction efficiency due to inbreeding is termed as inbreeding depression.
- The inbreeding depression results from homozygosity.



5. It results into appearance of genetic abnormalities.
6. It increases susceptibility to infection.
7. Reduce tolerance to survive under adverse environmental condition.

**Types of inbreeding**

According to the relationship of the mating individuals, inbreeding is classified as:

1. Close breeding
2. Line breeding

**1. Close breeding**

Close breeding means the mating of closely related animals than the average of the population. It involves mating of dam and son or sire and daughter or full brother and full sister.

**Remember...**

- Close breeding should be used if both parents are of outstanding performance.
- It is practiced to develop inbred lines with a high level of homozygosity.



**Advantages**

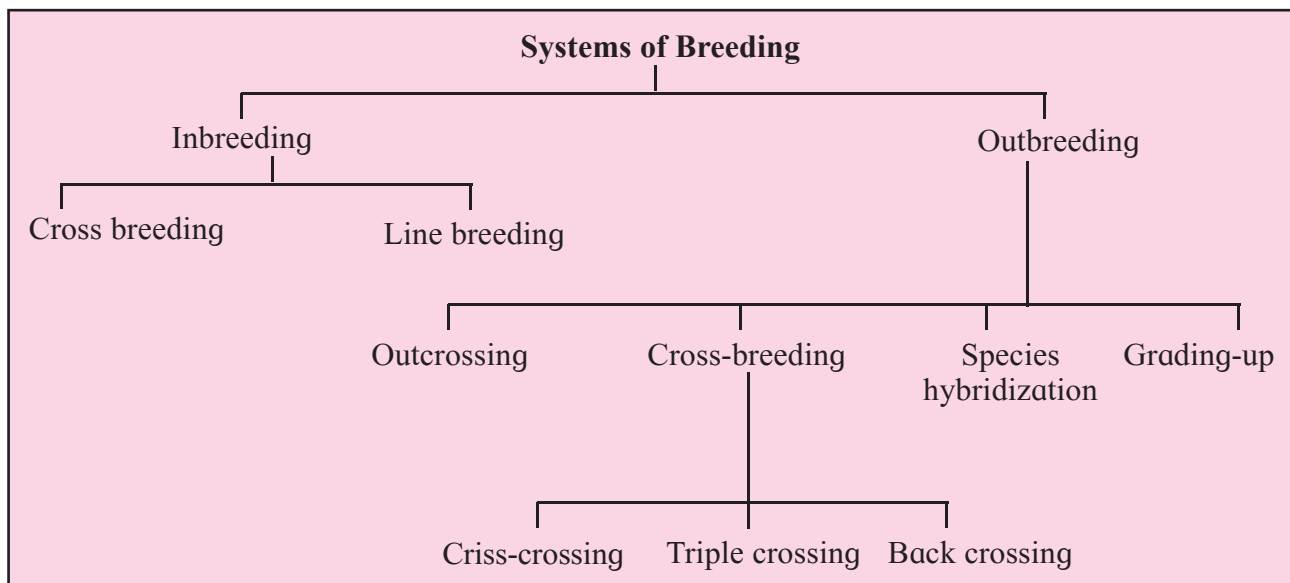
1. It helps in detection and elimination of harmful or undesirable recessive genes.
2. It develops uniform progeny.
3. It is always used for testing of breeding bull to declare him free from undesirable or deleterious recessive genes and brand him as a proven bull.

**Disadvantages**

1. It rapidly increases homozygosity and hence risky.
2. It usually increases breeding problems and reduces resistance to diseases in progeny.
3. It sometimes fixes undesirable characters in the progeny.

**Internet my friend**

Genetic disorders resulting from inbreeding.



**Fig. 11.1 Systems of Breeding**

## 2. Line Breeding

Line breeding means mating of distantly related animals.

It involves mating of grand sire and grand daughter or grand son and grand dam or half brother and half sister

### Advantages

1. It promotes uniformity in progeny.
2. It slowly increases homozygosity and hence less risky than close breeding.

3. It slowly develops undesirable characters.

### Disadvantages

1. It develops desirable characters slowly.
2. It gives less benefit for few generations because animals are selected on the basis of pedigree record giving no importance to real individual merit.

**Table 11.1 : Difference between close and line breeding**

Close breeding		Line breeding
1.	Mating of closely related animals	Mating of distantly related animals
2.	It is intense form of inbreeding	It is mild form of inbreeding
3.	Animals are selected for breeding on individual merit.	Animals are selected for breeding on pedigree record.
4.	Homozygosity reaches quickly, hence more risky.	Homozygosity reaches slowly, hence less risky.
5.	Both desirable and undesirable characters develop rapidly.	Both desirable and undesirable characters develop slowly.

### 11.1.2 Outbreeding

Outbreeding is defined as mating of unrelated animals.

#### Types of outbreeding

The following are the types of outbreeding

1. Outcrossing
2. Crossbreeding
3. Grading up
4. Species hybridization.

#### 1. Outcrossing

Outcrossing means mating of unrelated purebred animals within the same breed.

It involves mating of animals which do not have common ancestors in the first 4 to 6 generations in their pedigree .

e.g. Mating of unrelated Deoni sire and Deoni cow

#### Advantages

1. It is the best method for genetic improvement of cattle within the breed.
2. It helps to bring changes in traits according to market standards or demands.
3. It is good for traits of high heritability (qualitative traits) like body coat and colour.

#### Disadvantage

1. It neither increases nor decreases the variation therefore the improvement in economic characters is very slow.

## 2. Crossbreeding

Crossbreeding is the mating of animals of different well established breeds of the same species.

- e.g. 1) HF (Sire) x Deoni (Cow),  
2) Murrah buffalo bull x Surti buffalo

Crossbreeding is usually practiced to combine desirable characters from different breeds for improving productivity.

Crossbreds are mainly used for production and not for further breeding purpose.

### Do you know ?

European missionaries started crossbreeding of cattle in India in 1875. Taylor breed of cattle was developed around Patna, Bihar by crossing Shorthorn bulls with native Sahiwal, Hariyana, Tharparkar, Sindhi & Gir.



### Advantages

1. It increases the hybrid vigor in the progeny.
2. It helps to bring desirable characters in progeny.
3. It increases growth rate, fertility and productive ability in progeny.
4. It is useful in producing new breeds.
5. It helps to produce animals with better adaptability in adverse environmental conditions.
6. It helps to produce progeny with increased resistance against diseases.

### Disadvantages

1. It requires maintenance of two or more pure breeds.
2. It increases heterozygosity and thereby reduces breeding merits of progeny.
3. It may sometimes produces progeny with undesirable traits.
4. It reduces the uniformity of desirable characters.

### Methods of Crossbreeding

1. **Two Breed crossing** : Mating of two different breeds to produce crossbreds.

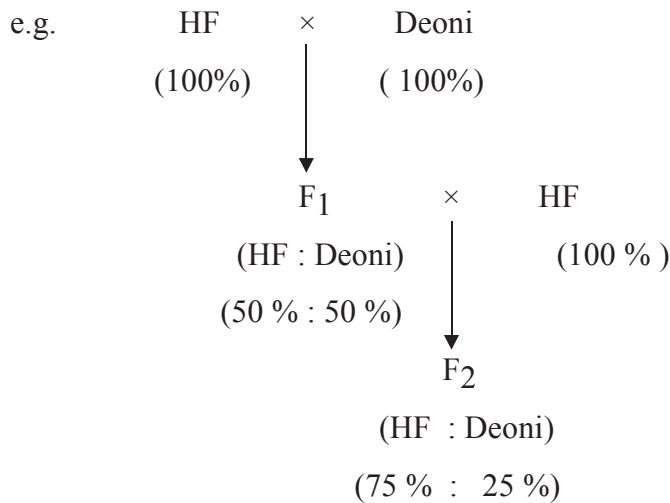
e.g. 1. Holstein Friesian (HF) x Deoni → Holdeo (F<sub>1</sub> : 50 % HF : 50 % Deoni)

2. **Three Breed Crossing** : Mating of three different bred to produce crossbreds.

e.g.

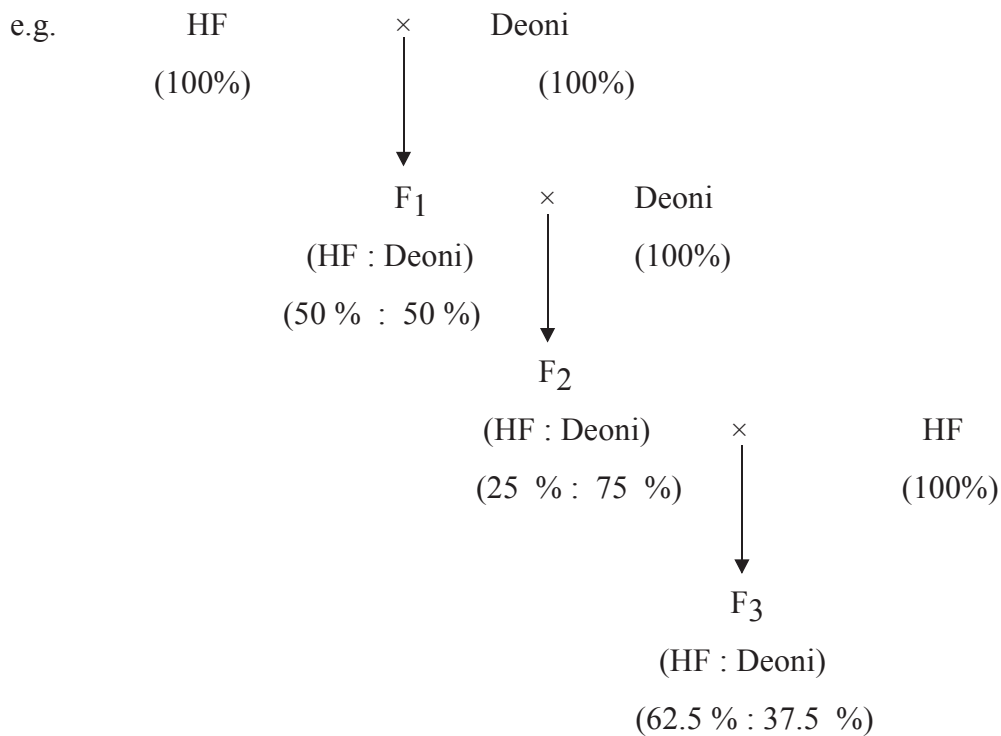
Jersey (Sire)	×	Gir (Dam)
(100%)		(100%)
	↓	
F <sub>1</sub>	×	HF
( Jersey : Gir )		( 100% )
(50% : 50%)		
	↓	
F <sub>2</sub>		
(HF : Jersey : Gir )		
(50 % : 25 %:25 %)		

3. **Back - Crossing** : Mating of crossbred female to one of its purebred parent.



4. **Rotational crossing**

a) **Criss - crossing** : Mating of hybrid with two different breeds in an alternate manner.



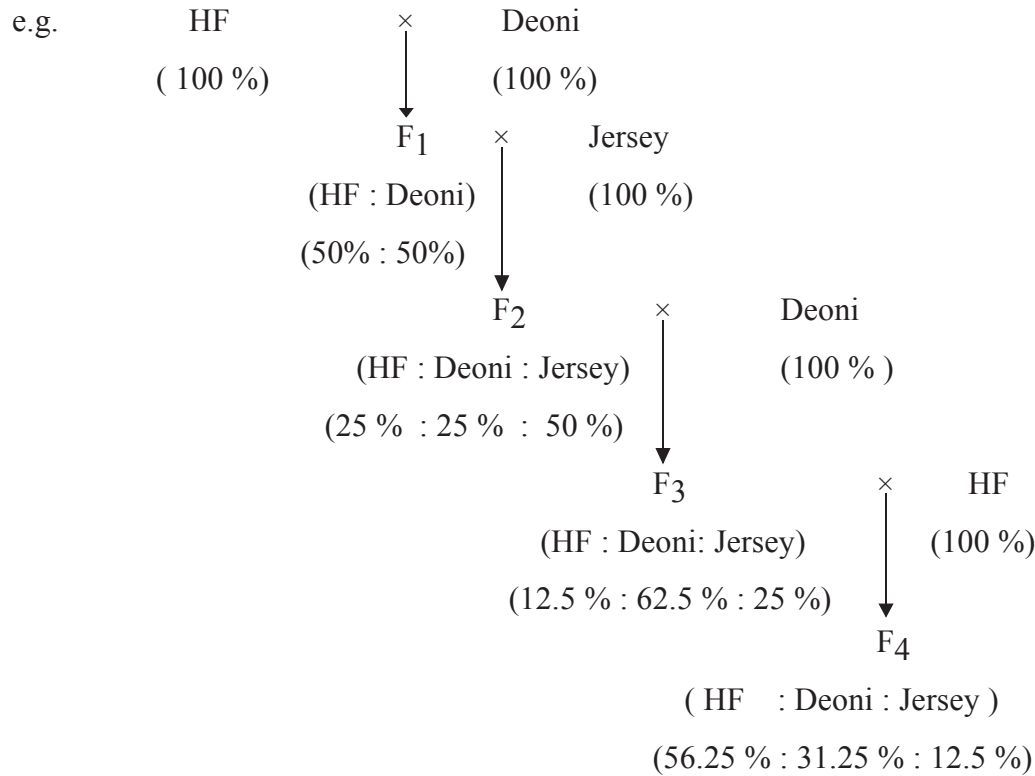
**Can you recall ?**

1. Triple cross cow developed by MPKV, Rahuri
2. Different crossbred cows developed in India.





**b) Triple crossing :** Mating of hybrid with three different breeds in a rotational manner.



### 3. Grading-up

Grading up is defined as mating of purebred sire with non-descript females and their offsprings for generation after generation till the progenies are reaching nearly to 98-99 per cent inheritance of original breed. e.g. Mating of Murrah buffalo bulls with local buffaloes.

Grading up is mainly used for upgradation and improvement of non-descript animals.

**Remember...**

Generally after 5 to 6 generations, the graded animals will be more or less similar to the purebred animal that has been used for grading up.



**Table 11. 2 : Change in % of inheritance due to grading up**

Crossing Sire × Dam	Generation	per cent inheritance in offspring	
		Murrah	Non-descript Buffalo
Murrah × <i>Nondescript Buffalo</i>	F <sub>1</sub>	50.00	50.00
Murrah × F <sub>1</sub>	F <sub>2</sub>	75.00	25.0
Murrah × F <sub>2</sub>	F <sub>3</sub>	87.50	12.5
Murrah × F <sub>3</sub>	F <sub>4</sub>	93.75	6.25
Murrah × F <sub>4</sub>	F <sub>5</sub>	96.87	3.13
Murrah × F <sub>5</sub>	F <sub>6</sub>	98.44	1.56
Murrah × F <sub>6</sub>	F <sub>7</sub>	99.22	0.78

**Advantages**

1. It is the best method for improving the local non-descript animals within reasonable time and expenditure.
2. It helps to develop purebred after few generations.
3. It is simple and economic method for establishing herd of purebreds.
4. It proves the quality of sire and thereby increases its market value

**Disadvantages**

1. Purebreds used for grading up from temperate zone may not give good result in tropical climate.
2. Male offsprings (graded males) are not suitable for breeding purpose.

**Can you suggest ?**

**Breeding methods for improvement of local non-descript cattle/buffalo in you locality.**



**Table 11.3 : Difference between inbreeding and outbreeding**

<i>Inbreeding</i>	<i>Outbreeding</i>
1. Mating of related animals. e.g. Mating of dam to son or sire to daughter.	1. Mating of unrelated animals e.g. Mating of animals of different strains or breeds or species
2. It increases homozygosity and thereby brings uniformity in progeny.	2. It increases heterozygosity and thus decreases uniformity in progeny.
3. It reduces the variation	3. It increases the variation.
4. It increases breeding value.	4. It decreases breeding value.
5. It decreases reproductive efficiency, growth rate and production performance in progeny.	5. It increases reproductive efficiency, growth rate and production performance in progeny.
6. It decreases vigor.	6. It increases vigor
7. It decreases disease resistance.	7. It increases disease resistance.
8. It leads to inbreeding depression.	8. It leads to heterosis or hybrid vigour.

**3. Species Hybridization**

It means mating of animals of two different species. It is extreme form of outcrossing. e.g.

Jack ( Male ass )	×	Mare (Female horse )	→	Mule
Stallion (Male horse )	×	Jennet ( Female ass )	→	Hinny
European cattle	×	American Buffalo	→	Cattalo
Stallion	×	Female Zebra	→	Zebroid

**Advantages**

1. It produces progeny having more vigour and disease resistance than parental species.
2. It produces progeny which shows better adaptability in adverse climatic conditions.

**Disadvantage**

1. Progeny is usually sterile.

## 11.2 SELECTION

Selection is defined as the process in which certain individuals in population are preferred over others for producing offspring of the next generation.

### Do you know !

1. Why selection is important in animal breeding ?
2. How to improve livestock productivity?



### 11.2.1 Kinds of selection

1. Natural selection
2. Artificial selection

#### 1. Natural selection

It is the selection of animal by nature on the basis of survival of the fittest.

#### 2. Artificial selection

It is the selection of animals by human interventions by adopting different basis of selection.

### 11.2.2 Basis of Selection

1. Individual selection
2. Pedigree selection
3. Progeny testing.

#### 1. Individual Selection

It means the selection of individuals on the basis of their phenotypic characteristics. It is the most commonly used method for selective improvement in livestock. Its accuracy depends on the heritability of the traits.

#### Advantages

1. This method is most accurate and easy.
2. It is very effective when heritability of the trait is high.
3. Generation interval in selected animals is very short.
4. Selection can be done on the

farm under normal managerial conditions.

#### Disadvantages

1. It is less effective when heritability of the traits is low.
2. It is not useful for sex-limited traits and carcass traits.
3. It is difficult to make selection for traits which are not expressed until maturity.

#### 2. Pedigree Selection

- It means the selection on the basis of performance of ancestors.
- It is based on the fact that relatives possess many of the same genes.

#### Advantages

1. It is useful when inadequate information is available about the individual.
2. It helps in selection of individuals at young age.
3. It is useful for selecting the individuals when the traits cannot be measured in them.
4. It is very useful when the traits selected are highly heritable.
5. It is useful for selection of sex-limited traits in both males and females.

#### Disadvantage

1. Its accuracy is low as compared to other methods.
2. Pedigree record maintenance is time consuming.

#### 3. Progeny Testing

It means the selection of individuals on the basis of average performance of their progeny.

#### Advantages

1. It is useful for selection of males.

2. It is highly useful for selection of sex-limited traits.
3. It increases the accuracy of selection for traits having low heritability.

#### **Disadvantages**

1. Generation interval is long.
2. High reproductive efficiency is required.
3. Selection intensity is very low because only few animals can be tested.

### **11.2.3 Methods of Selection**

The different methods of selection are

1. Tandem method
2. Independent culling method
3. Selection index method.

#### **1. Tandem method**

In this method, only one trait is selected at a time. The process of selection is continued till goal for selected trait is achieved. After achievement of first goal, selection is directed towards another trait.

#### **Advantage**

1. Selection for one trait results in improvement in other traits also.

#### **Disadvantages**

1. This is highly inefficient method if traits are not genetically related.
2. Sometimes improvement made in the first trait is lost when selection is directed to another trait.
3. The rate of genetic improvement is very slow.

#### **2. Independent culling method**

In this method, selection is made for few traits at a time. The minimum standard is set for each trait and the animals which do not meet the minimum standard are culled. The effectiveness of this method depends on the standard chosen for each of the traits.

#### **Advantages**

1. Selection can be practised for two or more traits simultaneously.
2. Animals which do not meet the minimum standard can be culled at an early age.
3. This method is superior than tandem method.
4. The rate of progress per unit time is more as compared to tandem method.

#### **Disadvantages**

1. The animals which are superior in one trait and little inferior in another trait are also culled.
2. The number of animals selected will be very small, if high standards are fixed.
3. The adequate number of animals are not culled, if low standards are fixed.

#### **3. Selection index method or Total score method**

In this method several traits are selected simultaneously. It is the most effective method of mass selection. The selection is made on the basis of selection index calculated for each individual based on different traits.

The selection index is calculated based on the weightage given for each trait which depends upon relative economics of the trait, heritability of the trait and genetic correlation between traits.

The individuals with higher selection index are selected for breeding.

#### **Advantages**

1. It is superior to both Tandem and Independent culling method.
2. Selection can be made for several traits at a time.
3. The superiority of this method increases as the number of traits increases.
4. There is maximum progress per unit time.

5. Less time and efforts are required.

**Disadvantages**

1. Use of selection index sometimes results into masking certain bad characters.
2. Practical indices are not available for all classes of animals.

**11.4 Conservation of Local Germplasm :**

**Can you tell ?**

**Which is the best method of selection & why?**



**Can you recall ?**

**1. The difference between conservation and preservation of local breed?**

**2. Why conservation of local germ plasm in livestock are essential?**



In India the indigenous cattle breeds have evolved over generations to adapt to the local agro-climatic and socio-economic needs of people. These indigenous breeds of cattle are now subjected to fast genetic degradation and dilution because of unplanned breeding, crossbreeding and introduction of exotic germplasm. The extensive crossbreeding of native breeds of cattle with exotic breeds in order to increase milk production is the main factor which has contributed to loss of cattle biodiversity. Further, mechanization of agriculture and introduction of various means of transportation, the utility of male cattle is reduced.

**Causes of genetic erosion / losses of Indigenous cattle breeds**

1. Low milk producers with poor reproduction performance.
2. More emphasis is given to introduce exotic / crossbreeds.

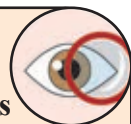
3. Adaption of mechanization in agricultural operations and transport.
4. Natural disasters such as drought and floods.
5. Effect of global warming

The FAO expert panel on conservation of Animal Genetic Resources proposed that whenever the population size of breed reduces to 5000 breeding females, appropriate action should be initiated for conservation. The panel observed that in case of developing countries, a breed with an effective population size of less than 2000 is to be taken as a rare, with less than 500 as vulnerable and less than 100 as endangered. The following classification is suggested for Indian condition.

**Table 11. 4 Classification of breed on the basis of number of breeding females**

Sr. No.	Status	No. of breeding females
1	Normal	more than 25000
2	Insecure	15,000- 25,000
3	Vulnerable	5,000- 15000
4	Endangered	2000-5000
5	Critical	Less than 2000

**Observe and discuss...**



- **Some Indigenous breeds are getting threatened, while others are in process of replacement by certain high producing strains. If this trend continues for few years, the valuable native breeds germplasm would grossly be depleted or even lost forever.**
- **Conservation of Indigenous breeds of cattle is essential due to their potentiality for sustainable milk production with locally available fodder, draught tolerance, high resistance to diseases and heat tolerance ability.**

**Internet my friend**

Classify the status of native breeds of Maharashtra based on current livestock census.



Based on the classification, many of our indigenous breeds are under insecure stage. Therefore, it is necessary to improve and conserve the valuable local germplasm.

**Methods of conservation**

The methods of conservation of animals are as follows:

1. **In-situ conservation:** It means the conservation of germplasm in its natural habitat. It can be achieved by establishment of cattle breeding farms.

**Advantages**

1. Live animals can be evaluated and improved over the years.
2. Genetic defects can be identified and eliminated.
3. Live animals act as a gene bank for future use.

**Disadvantages**

1. It involves a large infrastructure viz., land, building, feed and fodder sources, water supply and man power.
2. This method is not appropriate for the breeds which are uneconomical.

**Remember...**

A herd size of about 100 breedable females is necessary for *in situ* conservation of breed.



2. **Ex-situ conservation** : It means conservation of germplasm outside the natural habitat. This can be achieved by cryogenic preservation of sperms (frozen semen), oocytes, embryos, DNA and embryonic stem cells.

**Advantages**

1. It is possible to maintain population without genetic change.
2. It is comparatively more convenient, economical and easy with the application of modern reproductive technologies.

**Conservation strategies**

1. **Survey of breeding tract** : It is very essential to conduct surveys in the breeding tract to know the present status of breed in terms of its population, management practices, physical characteristics, utility and performance and availability of local feed/fodder. The breeding objectives relevant to an area and needs of people should be identified for each indigenous breed.

**Can you recall ?**

Breeding tracts of native livestock breeds of Maharashtra.



2. **Establishment of livestock conservation boards** : It is necessary to establish livestock conservation boards in each state where data pertaining to the breeds of their state can be maintained in computerized form. The state level data banks should be linked to the national data bank through computer network.
3. **Establishment of Breed Societies / Breeders Association:** There is an urgent need to form breeders association/societies for each breed. The movement of improvement, up gradation and conservation of the native cattle breeds, can't be successful without involvement of farmers. These societies should

**Do you know ?**

Where Maharashtra livestock development board is situated?



monitor all activities related to particular breed including genetic improvement, conducting cattle shows, identifying the areas of research and to act as a liaison between Government, Veterinary/ Agriculture Universities, research institutions, organized farms and farmers.

- Live animal repositories :** The existing farms of native breeds should be declared as bull mother farms and used for production of bulls and semen.

**Can you tell ?**

**The breed Societies registered for different native breeds in India.**



- Human resource development programmes:** Trained personnel are required for undertaking conservation programmes therefore the training programmes should be organized for persons involved in evaluation of animal genetic resources under field condition.

- Information center :** An information center should be established on native breeds of cattle and it should have information about their distribution, physical and molecular characteristics, farming practices, breed herds and availability of elite breeding male and females. The information should be periodically updated and easily available to all through social media.

- Establishment of gene banks :** Germplasm repositories in the form of semen and embryo banks should be established in different regions and even the at national level.

**Internet my friend**

**Collect information about available websites developed for Indian cattle breeds.**



**EXERCISES**

**Q.1 Fill in the blanks**

- ..... is defined as mating of purebred sire with non-descript female.
- In ..... method of selection only one trait is selected at a time
- ..... is the most effective method of selection when heritability of trait is high.
- Mating of unrelated animals of different breeds is called .....
- ..... basis of selection of animals can be done on basis of performance of ancestors.

- When the number of breeding female is less than 2000, the status of breed is categorized as .....

**Q. 2 Make the pairs**

A (Status)	B (Number of breeding females)
1. Normal	a. 2000 to 5000
2. Vulnerable	b. Less than 2000
3. Critical	c. More than 25000
	d. 15,000 to 25,000
	e. 5000 to 15000

**Q.3 State true or false**

1. The mating of animals of same breed having no close relationship in 4 to 6 generation is known as outcrossing.
2. The breeding between indigenous cows with exotic bulls should be more scientifically called as species hybridization.
3. Mating of sire to daughter or son to dam is the example of line breeding.
4. Progeny testing is the highly useful basis of selection for traits having low heritability.
5. Grading up is mainly used for improvement of non-descript animals.
6. Inbreeding increases while outbreeding decreases the breeding value.

**Q.4 Answer in brief**

1. Differentiate between close breeding and line breeding.
2. Define inbreeding and give its effect.
3. Distinguish between *In-situ* and *Ex-situ* methods of conservation.
4. Enlist the causes of genetic erosion/ losses in indigenous cattle breeds.
5. Give the systems of breeding in flow chart.
6. Write in brief about tandem selection method.

**Q.5 Answer the following questions:**

1. Explain the rotational crossing with suitable flow chart.
2. Complete the given table

Male		Female		Progeny (F <sub>1</sub> )
Jack	×	.....	→	Mule
Stallion	×	Jennet	→	.....
..... cattle	×	American Buffalo	→	Cattalo
Stallion	×	.....	→	Zebroid

3. Explain the triple crossing method with suitable flow chart.
4. What do you mean by independent culling method and give its advantages.
5. Give advantages and disadvantages of progeny testing method.

**Q.6 Answer the following questions in detail**

1. Explain methods of crossbreeding with its advantages and disadvantages.
2. Discuss in details about the conservation strategies for indigenous livestock.
3. Enlist different methods of selection and explain in detail selection index method or total score method.
4. Define grading-up and explain it with suitable example.
5. Define selection and explain individual selection with its advantages and disadvantages.



## 12. REPRODUCTIVE TECHNOLOGIES

### Can you recall ?

- The terms sperm, ovum, estrous, fertilization and parturition.
- How the reproduction takes place in animals?



### 12.1 BASICS OF REPRODUCTION

#### 12.1.1 Estrous Cycle

Estrous cycle is the chain of physiological events that begins at one estrous period and ends at the next.

The estrous cycle consist of a long luteal phase (days, 1-17) where the cycle is under the influence of progesterone and shorter follicular phase (days, 18-21) where the cycle is under the influence of estrogen and can be completed in four stages.

#### 1. Follicular Phase (Days, 18-21)

- i) Proestrus stage.      ii) Estrus stage.

#### 2. Luteal Phase (Days, 1-17)

- i) Metestrus stage.      ii) Diestrus stage.

The details of various stages of estrous cycle are as follows.

- Proestrus :** It is the initial stage of estrous cycle. It usually lasts for 2 to 3 days in cow. It is characterized by follicular growth in ovaries and production of estrogen.
- Estrus :** It is the period of sexual desire. The duration of this stage in cows is around 24 hours. The ovary presents mature *graffian follicle*. There is high level of *estrogen* in blood. The animal exhibits signs of heat during this stage.

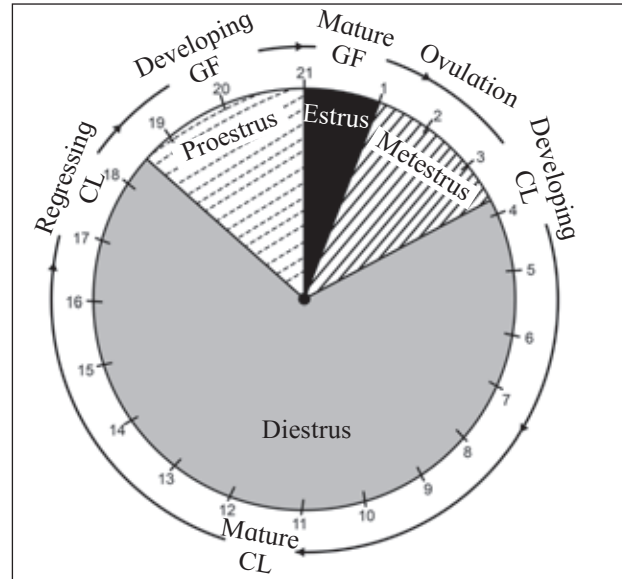


Fig 12.1 Estrous Cycle

- Metestrus :** It is the period after estrus. It lasts for 2-3 days in cows. It is characterised by cessation of visible signs of heat. The Graffian follicle ruptures and ovulation takes place during this period in cows and buffaloes. The ruptured follicle in the ovary is replaced by small, soft, developing corpus luteum which secretes a hormone called as *progesterone*.
- Diestrus :** It is the longest stage of estrous cycle. It usually lasts for 15 days in cow. The corpus luteum fully develops. This stage is followed by either pregnancy or next estrous cycle or anestrous in animals.

### Remember...

Heat/estrus is the period of intense sexual desire or sexual excitement experienced by females.



**Table 12.1 : Reproductive cycle of domestic animals**

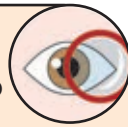
<i>Particulars</i>	<i>Cow</i>	<i>Buffalo</i>	<i>Ewe</i>	<i>Doe</i>
Age of Puberty	24-30 months	36-42 months	6-12 months	6-12 months
Length of estrous cycle	21 days	21 days	17 days	20 days
Duration of heat	12-24 hrs	12-24 hrs	24-36 hrs	24-36 hrs
Time of ovulation	10-14 hrs after end of estrous	10-14 hrs after end of estrous	Towards end of estrous	Towards end of estrous
Period of Maximum fertility	Last 8 hrs of estrous	Last 8 hrs of estrous	2 <sup>nd</sup> half of estrous	2 <sup>nd</sup> half of estrous
Gestation period	280 days	310 days	150 days	150 days
Breeding Season	Throughout Year	Sept. - Feb.	June-Aug. Jan - Feb.	June-Aug Jan.-Feb.

### Symptoms of heat/estrus

The cows in heat exhibit signs of excitement, restlessness, reduced appetite and rumination, frequent bellowing, drop in milk production, swollen and congested vulval lips, licking other animals, frequent urination with raised tail, peculiar movement of back and clear, shiny, stringy vaginal mucous discharge. Cows in heat attempts to mount other cows and also stands to be mounted when other cow/animal mounts.

#### Observe and record...

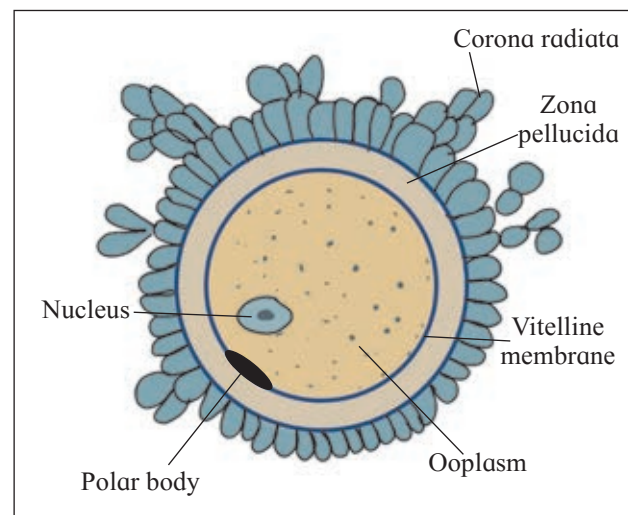
The behaviour of cow and buffalo during heat/estrus.



### 12.1.2 Fertilization

Fertilization is the union of male and female gametes.

**Ovum :** Ovum is a female gamete. It is produced in the ovary by oogenesis. It is roughly spherical, non-motile structure. It is covered by vitelline membrane, zona pellucida and cells of *cumulus oophorus* / *corona radiata*.



**Fig. 12.2 Structure of ovum**

**Sperm :** Sperm is a male gamete. It is produced in the testis by spermatogenesis. It is microscopic, motile structure. It consist of head, neck, middle piece and elongated tail.

#### Process of fertilization

The process of fertilization involves following steps.

1. **Transport of sperm** : Sperms deposited in the female genital organ either by natural service or artificial insemination are transported to the site of fertilization (ampulla) by both sperm motility and contractions of female genital tract.

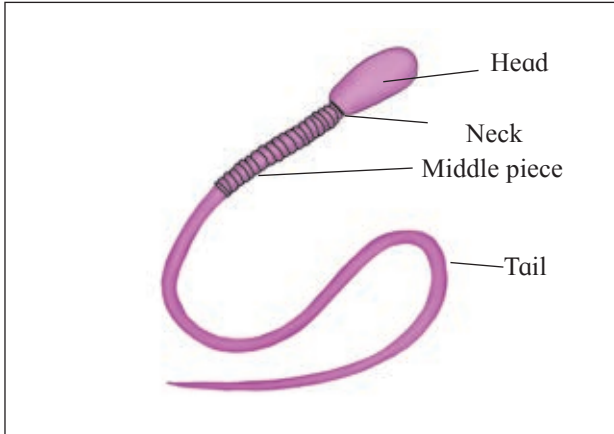


Fig. 12.3 Structure of sperm

2. **Capacitation** : When the sperms are exposed to female reproductive tract for 4-6 hours, they attain the capacity to penetrate and fertilize the ovum. This process of preparing the sperms for fertilization is known as **capacitation**.
3. **Ovulation** : Under the effect of LH, the matured Graffian follicle from ovary ruptures and the ovum is released. This process of release of ova is called as **ovulation**. Ovulation usually takes place about 8 hours after the end of estrus in cows. The released ovum is immediately picked up by infundibulum and reaches the ampulla in another 6 hours.

**Do you know ?**

The sperm remains viable for 24 hours in female genital tract whereas, ovum remains fertile for only 10 hours after ovulation.



4. **Penetration of the ovum by a sperm** : The sperm head contains **hyaluronidase** enzyme that breaks the **cumulus oophorus** of ovum and the sperm reaches the zona pellucida. The sperm also carries an enzyme called **zonolysin or acrosin** which breaks the zona pellucida, and allows sperm to reach perivitelline space. After entry of first sperm, zona pellucida becomes unresponsive to other sperm, called as **zona reaction**. The sperm head then passes through vitellus and loses its tail. When sperm contacts with vitelline membrane, there is reaction in the membrane which makes it unresponsive to other sperm, called as **vitelline block**.
5. **Formation of pronuclei** : The penetration of the ovum by sperm activates the egg/ova to complete its second reduction division. This results in formation of second polar body and female pronucleus. The sperm head consisting of nucleus is considered as male pronucleus.
6. **Syngamy** : The male and the female pronuclei fuse together to form one cell. This process of fusion of male and female pronuclei is called as **syngamy**.

**12.1.3 Pregnancy**

**Can you recall ?**

The terms pregnancy, gestation, embryo and foetus.



**Pregnancy** is the condition of female characterized by presence of developing young in the uterus.

**Remember...**

Gestation period is the period from fertilization/conception to parturition.



## Stages of pregnancy

The gestation period is divided into following three parts based on the developmental stages of the conceptus in cattle.

1. **The period of ovum/zygote :** It is the period up to 10-12 days after fertilization. The zygote reaches uterus on 3<sup>rd</sup> - 4<sup>th</sup> day of fertilization where the zygote is nourished by the secretions of uterine glands i.e. uterine milk.
2. **The period of embryo :** It extends from (implantation) 13<sup>th</sup> to 45<sup>th</sup> day of pregnancy in cow. It is characterized by formation of germ layers which gives rise to different body parts/organs. The digestive system, lungs, liver and circulatory system develops. The nervous, musculoskeletal and urogenital systems begins to develop. The extra embryonic membranes (placenta) usually formed in 20-30 days.

### Remember...

The heart of embryo starts beating by 21<sup>st</sup> to 22<sup>nd</sup> day.



3. **The period of foetus :** It extends from 46<sup>th</sup> day of pregnancy till the day of parturition. It is characterised by progressive increase in size and weight of foetus. There is development of bones and cartilages in different body parts. The different body systems progressively develop to the fully functional form. There is growth of placenta and accumulation of fluids.

### Do you know ?

Hairs appear around the muzzle and eyes at 150 days and hair coat covers the body at about 230 days of pregnancy.



## Symptoms / Signs of pregnancy

Cessation of estrous cycle after artificial insemination or natural service, gradual drop in milk production, sluggish, docile behavior, glossy hair coat, fattening tendency, gradual increase in the size of the abdomen and increase in the size of mammary glands/udder.

### 12.1.4 Parturition

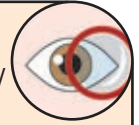
Parturition is the act of giving birth to fully developed and viable young one.

### Signs of Approaching Parturition

The animals about to parturite exhibit reduced appetite, irregular rumination, sluggish movements, hollow flanks with pendulous abdomen, elevated tail base and sunken rump, enlargement/distension of udder, engorgement of teats with colostrum, loose, soft and swollen vulva, strings of thick mucus hangs from vulva, rapid pulse and respiratory rate and decrease in body temperature by 1 to 2<sup>o</sup> F.

### Observe and record :

The signs of parturition in cow/ buffalo/goat.



### Causes of initiation of parturition

The exact cause of initiation of parturition is still not known. However, the following factors may be responsible for initiation of parturition.

1. Increase in the irritability of the uterus due to increase in the size of foetus at the end of pregnancy.
2. Excessive distension of uterus gives equal and opposite reaction by means of straining/contraction.
3. Degenerative changes in placenta towards the end of gestation resulting into separation of foetus from maternal tissues.

4. Decreased blood supply to foetus due to compression of arteries by distended uterus.
5. Accumulation of waste products and increased CO<sub>2</sub> tension in blood enhances foetal movements which in turn stimulates uterine contractions.
6. Increased secretion of corticosteroids by foetal adrenals.
7. Gradual fall in progesterone level removes/decreases inhibitory action on uterine musculature.
8. Rise in estrogen level towards the end of gestation sensitizes the uterus for the action of oxytocin and prostaglandins (PGF<sub>2</sub>α).
9. Release of oxytocin at the time of parturition produces strong uterine contractions leading to expulsion of foetus.
10. Relaxin hormone secreted at term causes relaxation of cervix, vagina and pelvic ligaments and thereby helps in expulsion of foetus.

### Stages of parturition

The process of parturition is divided into three stages -

1. **First stage** : It is also called as *stage of dilatation of cervix*. It is the period between onset of uterine contractions and

dilatation of cervix. It lasts for 2 to 6 hours in cow. It is characterized by restlessness, mild labour pain, rapid pulse, rapid and distressed breathing, appearance and rupture of allantoic bag (first water bag).

2. **Second stage** : It is also called as *stage of expulsion of foetus*. It lasts from complete dilatation of cervix to expulsion of foetus. It usually lasts for ½ to 1 hour in cow. This stage is characterized by recumbency, severe straining, entry of foetus in birth canal, appearance and rupture of amnion (second water bag) and expulsion of foetus.

3. **Third stage** : It is also called as *stage of expulsion of placenta*. It consists of the period between the birth of calf and expulsion of placenta. It lasts for ½ to 8 hours in cow. It is characterized by separation of placenta from cotyledons and its expulsion from vagina.

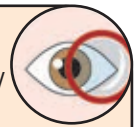
#### Remember...

- Allantoic bag is also called first or false water bag.
- Amnion bag is also known true water bag.



#### Observe and record...

The act of parturition in cow/ buffalo



**Table 12.2 : Common names for the sex, young one and parturition of Animals**

Species	Male	Female	Young one	Act of parturition
Cattle	Bull	Cow	Calf	Calving
Buffalo	Buffalo bull	She Buffalo	Buffalo Calf	Calving
Goat	Buck	Doe	Kid	Kidding
Sheep	Ram	Ewe	Lamb	Lambing

## 12.2 ESTROUS SYNCHRONIZATION

Estrus synchronization (ES) programs are available for the past 25 years and used as a tool to make artificial insemination more practical. At present number of products and protocols are available and all have its advantages and disadvantages. All synchronization programs require good management, cows having regular estrous cycles, and in good body condition

Estrus synchronization involves the use of one or more hormones to bring cows into heat within a short time period (36 to 96 hours).

### Remember...

**Estrus synchronization is the manipulation of the reproductive process so that females can be bred with normal fertility during a short, predefined interval.**



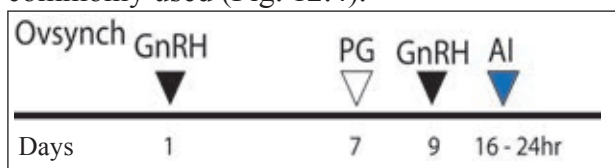
### Hormones used in estrus synchronization

The following two hormones are usually used for estrus synchronization

1. **Prostaglandins (PG)** are produced naturally in the animal's body and function, in part, to affect the estrous cycle. In cyclic females, estrus occurs within 2 to 6 days after they are given intramuscular injections of prostaglandin  $F_2\alpha$
2. **GnRH or gonadotropin-releasing hormone** is a naturally occurring hormone that causes the release of other required hormones.

### Protocols used in estrus synchronization

The "Synch" protocols viz. Select Synch, Ov Synch, Co Synch, and Modified Select Synch are currently used to synchronize estrus and ovulation in postpartum cow using GnRH – Prostaglandin  $F_2\alpha$  (PG) protocol. Among all these synch protocols Ovsynch protocol is commonly used (Fig. 12.4).



**Fig. 12.4. Ovsynch Protocol for estrous synchronization**

### Advantages

1. Maintain the milk production round the year in organized dairy farm
2. The time required for detection of estrus is reduced
3. Uniformity of calves at weaning is possible
4. Management of calves and cows during gestation and calving period becomes easier
5. Calf crop will be more uniform in age and size which can lead to an advantage in the market.
6. Cow nutrition can be improved by grouping cows according to stage of gestation and feeding each group accordingly.

### Disadvantages

1. Requires skilled management
2. Cows will respond poorly if not fed properly or if body condition is poor/weak.
3. More expenses on hormones/drugs and labour
4. High level of management is required

## 12.3 ARTIFICIAL INSEMINATION

Artificial Insemination (AI) is the most popular technique used in veterinary practice for genetic improvement of the animals. This technique is now days widely used in cattle and buffaloes and to some extent in other species of animals.

**Artificial insemination (AI) is defined as the process in which semen is collected from genetically superior male animal and introduced into the female genital tract by an artificial means.**

### Advantages of AI

1. It increases the use of superior/ outstanding sires for genetic improvement.

**Table 12.3 : Comparison between AI and Natural service**

No.	Parameter	AI	Natural Service
1.	Bulls required for breeding	Very less	More
2.	Use of proven sire	More / Extensive	Less / limited
3.	Progeny testing of sire	Easy	Difficult
4.	Intensity of spread of venereal diseases	Very less	More
5.	Special equipments	Required	Not required
6.	Trained/skilled persons	Required	Not required
7.	Expenditure on maintaining breeding bulls by farmer	Nil	Heavy
8.	Periodical change of breeding bull	Not needed	Essential
9.	Mating of animals having physical disparity/ disability	Possible	Not possible
10	Semen evaluation and examination of female in estrous	Strictly carried out	Not carried out

2. It reduces the number of bulls required for breeding purpose.
3. It solves the problem of searching and purchasing a new bull every two years to avoid inbreeding.
4. It helps in early and more rapid progeny testing of bulls.
5. It reduces the chances of spread of venereal diseases like brucellosis, trichomoniasis.
6. It saves labour and expenditure on maintaining breeding bulls on farm.
7. It encourages farmers to keep records and to adopt improved animal husbandry practices.
8. It eliminates difficulties in mating of animals having physical disparity due to differences in size and weight.
9. It enables use of injured or old but superior sires for breeding purpose.
10. It permits crossbreeding to improve the production performance.

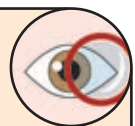
11. It improves the breeding efficiency and leads to improved performance.

**Disadvantages of AI**

1. It requires well trained persons for operations like semen collection, semen evaluation, insemination etc.
2. It needs special facilities like laboratory and equipments.
3. It reduces the market value of bulls.
4. Its use is limited in rural areas due to illiteracy and religious taboos.
5. It involves very strict hygienic precautions at every step.

**Observe and record :**

**The process of artificial insemination in cow/buffaloes.**



**12.3.1 Semen Collection**

The objective of semen collection is to collect the adequate quantity of semen with maximum number of viable spermatozoa per ejaculation.

The different methods of semen collection are artificial vagina method, electro-ejaculation method and massage method.

The details of each method are as given below.

### 1. Artificial vagina method :

- It is the most commonly used method of semen collection in which Artificial Vagina (AV) is used for collection of semen.
- The different kinds of AV are used for various types and species of animals.

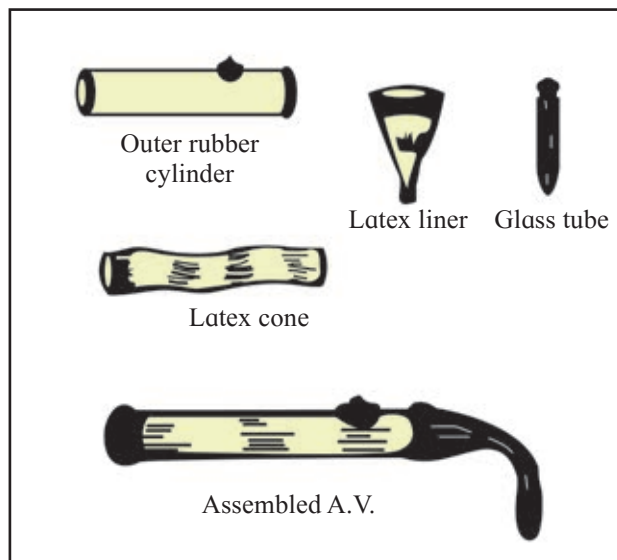


Fig. 12.5. Different parts of artificial vagina

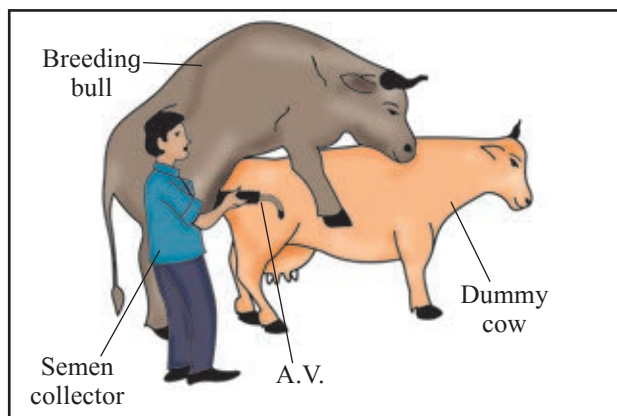


Fig. 12.6. Semen collection by AV method

### Advantages

1. Semen is collected in uncontaminated and natural state.
2. Semen collected is usually with better sperm concentration .
3. The semen is clear and free from other secretions viz. urine after collection of semen.
4. The volume, color and consistency of the semen is readily seen in the graduated tube.
5. Semen can be collected successfully by using a dummy / teaser cow.

### Disadvantages

1. The use of AV requires technical skill.
2. Semen collection is difficult from injured and old males.
3. Some males may refuse to serve the AV due to variation in temperature, pressure and lubrication.

### Do you know ?

The best time of semen collection is early morning before feeding.



### 2. Electro - ejaculation method

This technique is rarely used for semen collection in bulls.

This method involves electrical stimulation to the ampulla and seminal vesicles of bulls through rectum.

The different types of electro ejaculators with rectal probes specially designed for individual species are used.

### Advantages

1. Semen can be collected from bulls having low sex libido or leg injury or paralysis.
2. Semen can be collected from young and untrained / ferocious bulls.
3. Teaser or dummy cow is not required.



### Disadvantages

1. Semen gets contaminated with urine.
2. Semen collected by this method is usually with poor sperm concentration.
3. Few males may refuse to donate semen and sometimes exhibits muscle tremors.
4. The sperms are more susceptible to cold shock and less likely to survive during freezing and thawing.

### 3. Massage method

This method involves semen collection by massaging the seminal vesicles and ampullae of breeding bull per-rectally.

### Advantages

1. This method is useful for semen collection in bulls having low sex libido and leg injuries.
2. Semen can be collected from bulls untrained for AV.

### Disadvantages

1. The semen collected is usually with poor sperm concentration and poor keeping quality.
2. The chances of contamination with urine are more.

#### Can you tell ?

Which is the best method of semen collection ?



### 12.3.2 Semen composition and properties

Semen is a suspension of spermatozoa in seminal fluid.

#### Semen composition

- Semen is composed of sperms and seminal plasma.

- Sperms are produced in testes and stored in epididymis.
- Seminal plasma comprises secretory fluids of accessory organs like seminal vesicles, prostate gland, Cowper's gland, epididymis and vas deferens
- Seminal plasma contains fructose, citric acid, minerals, proteins and vitamins.

### Properties of semen

1. The normal colour of bull semen is milky white to creamy.
2. The consistency of bull semen varies from thick milky to thick creamy.
3. The normal volume of semen per ejaculate is 5-8 ml in cow bull and 3-4 ml in buffalo bull.
4. The specific gravity of semen is 1.035 in bull.
5. The normal semen pH is 6.4 – 6.8.
6. The sperm concentration ranges between 800 to 2000 million per ml of semen in bull.

#### Internet my friend

Normal quantity of semen ejaculated by different adult livestock species.



### 12.3.3 Semen preservation

#### Purpose of semen preservation

1. It helps to store semen for long period and transport of semen for long distance.
2. It helps to retain fertility potential of spermatozoa for long period. It helps to inhibit growth of bacteria and prevents death of sperms in semen.
4. It helps to use maximum semen from proven sire

## Methods of semen preservation

### 1. Storage at room/ambient temperature

1. Semen can be preserved for 4 to 7 days at 25 - 30 °C by this method.
2. Illini Variable Temperature (IVT), Millovanov's dilutors and Coconut Milk Extenders (CME) are commonly used semen extenders for preservation of semen at room temperature.

#### Remember...

**Semen dilutor or extender is an agent or a medium which increases the volume and keeping quality of collected semen and retains fertility potential of sperm cells in semen.**



### 2. Storage at refrigeration temperature

1. Semen preserved at 4 to 5°C in refrigerator is called as **liquid semen**.
2. Semen can be preserved for 4 days at 4 to 5°C.
3. Egg Yolk Citrate (EYC) and Egg Yolk Phosphate (EYP) dilutors are commonly used diluents for preservation of semen at refrigeration temperature.

### 3. Storage at sub-zero temperature (cryopreservation)

1. Semen preserved at -196 °C in liquid nitrogen is called as **frozen semen**.
2. Semen is preserved for years together at -196 °C.
3. The commonly used extenders for frozen semen are Glycerol-Egg-Yolk-Citrate dilutor, Milk-Glycerol diluter and Glycerolated Egg Yolk Tris dilutor.
4. This method is commonly used because of its advantages over other methods.

#### Do you know ?

**The frozen semen is the best method of semen preservation.**



#### Advantages of frozen semen

1. Semen can be stored/preserved for very long time i.e. for years together.
2. Semen retains its viability and fertility as good as fresh semen.
3. Semen from proven but injured sires can be used efficiently.
4. Semen can be transported any time and any where in the world.
5. This technique enhances efficiency and accuracy of progeny testing programmes.

#### Disadvantages of frozen semen

1. Freezing, packaging and storage equipments are very costly.
2. Frozen semen increases chances of spread of contagious diseases if bulls used are infected or strict hygienic measures are not followed during processing and storage of semen.
3. Semen of some bulls may not withstand freezing.
4. The more number of spermatozoa per insemination are required because freezing process kills about 50% spermatozoa.

#### Internet my friend

**Collect information on storage of semen in livestock species.**



#### 12.3.4 Insemination

**Insemination means introduction of semen into female reproductive tract by natural or artificial means.**

### Methods of insemination

**1. Vaginal speculum method :** This method is used in case of sheep and goat.

#### Method

1. Take clean and sterilized vaginal speculum and lubricate it with liquid paraffin.
2. Introduce the speculum into vagina and view the cervix.
3. Take the semen straw into insemination gun.
4. Introduce the insemination gun into vagina and place it in cervix and push the semen.
5. Remove the insemination gun and vaginal speculum.

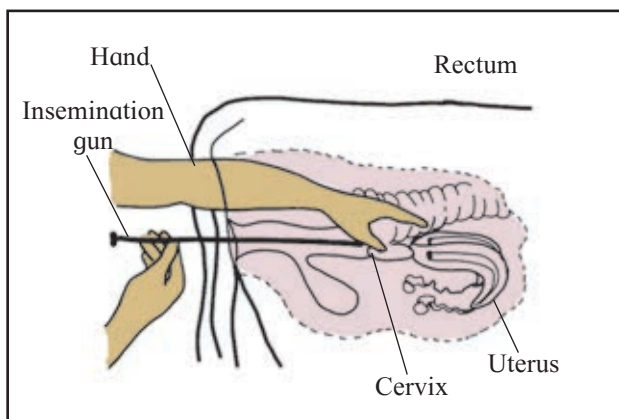
#### Disadvantages

1. Introduction of speculum into vagina is painful.
2. Requires frequent cleaning and disinfection of speculum.
3. Abnormalities of uterus and ovary can not be ascertained.

**2. Recto-vaginal method :** This method is commonly used in cows and buffaloes

#### Method

1. Secure the cow/buffalo in heat in service crate.
2. Put the polythene gloves/ rubber sleeves in left hand and lubricate it with soap water.



**Fig. 12.7 : Recto - vaginal method of insemination**

3. Insert the left hand into rectum, remove the dung and grasp the cervix.
4. Wash the vulva with clean water and then wipe it dry with the help of clean absorbent cotton or towel.
5. While grasping the cervix with palm and fingers inserted in rectum, pull apart vulval lips and pass the AI gun at an angle of 45° through vagina with other hand.
6. Pass the AI gun by manipulation up to mid cervix and deposit the semen.
7. Remove the AI gun as well as left hand from the rectum.

#### Advantages

1. Abnormalities of genital organs can be ascertained.
2. Chances of spread of infection are very less.

#### Remember...



- The proper time of insemination in cattle and buffaloes is mid to late estrus.
- Mid-cervix is the most ideal site for semen deposition.
- Dose of frozen semen is 0.25 ml diluted semen
- Number of sperms required is 12 million motile sperms per insemination for frozen semen.

### 12.4 : EMBRYO TRANSFER TECHNOLOGY

Embryo transfer (ET) is a technique by which embryos are collected from donor female and transferred to recipient female which serve as surrogate mother for remaining period of pregnancy.

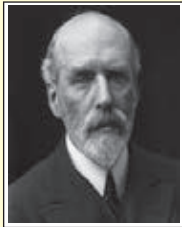
**Remember...**



**Artificial insemination technique allows greater use of superior sires; however ET technique allows the best use of superior / elite females for genetic improvement.**

Embryo transfer (ET) was first performed and recorded in rabbits by Walter Heap in 1891. Embryo transfer in animals began in the 1949 with sheep and goats. In our country first

**Introduction to scientist**



Walter Heape (1855 - 1929) was a British zoologist and embryologist famous for the first successful mammalian embryo transfer.

embryo transfer cattle calf was born in 1986 in Andhra Pradesh Agricultural University, Tirupati, whereas first embryo transfer buffalo calf was born in 1987 at Sabarmati Ashram, Gaushala, Bidaj. In recent years the technology has become fairly well established in cattle and many institutions have adopted ET technique successfully in cattle resulting in several pregnancies and birth of genetically superior calves.

**Advantages**

1. The technique makes it possible to produce many off springs / calves from genetically superior / elite cows.
2. It is the quickest and most efficient method of increasing, the rate of genetic improvement within the herd.

3. It is economic to import and export embryos with desirable genetic traits as compared to export and import of pride animals.
4. It helps in conservation of endangered animals species and breeds.

**Limitations**

1. The cost of embryo transfer technology is high
2. It requires highly sophisticated and well equipped laboratory.
3. The success rate is low.

**Technique**

1. The highly fertile cow having desirable traits is selected as donor cow for retrieval of embryo.
2. The Follicle Stimulating Hormone (FSH) is injected to donor cow twice daily for 4 days from day 11 of estrous / heat for induction of super ovulation.
3. Following prostaglandin therapy on day 14 of estrous, the donor cow comes in heat in 48 hours and releases more number of ova (10-15) i.e. superovulation.
4. The donor cow in heat is then inseminated with high quality semen of the outstanding bull 3 times at an interval of 12 hours.
5. The ova are naturally fertilized within the donor's womb and then zygote reaches uterus for implantation.

**Remember...**



**It is necessary that both donor and recipient cow should be in heat on the same day.**

6. About 7 days after insemination the embryos which are freely floating within the uterus are flushed out carefully with Foley's catheter in suitable biological medium in graduated cylinder.
7. The flushed out embryos are then isolated, classified and good embryos are transferred within 4 to 5 hours of collection to the recipient cows or they may be frozen for later use.
8. The embryo develops to foetus in the womb of recipient cow i.e. surrogate mother. However the offspring born derives its genes from donor cow and from male to which the donor was bred.

**Do you know ?**

The embryo's can be stored for indefinite period in liquid nitrogen

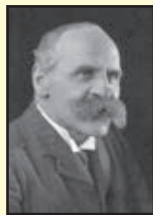


**12.5 CLONING TECHNIQUE**

**Cloning :** It is the process of making identical genomic copies of an original animal.

**Clone :** It can be defined as a group of two or more individuals with identical genetic make up, derived by asexual reproduction, from a single common parent or ancestor.

**Introduction to scientist**



J. B. S. Haldane (1892 – 1964) was a British-Indian scientist. He is remembered for coining the words “clone” and “cloning” in human biology and “ectogenesis”. He willed his body for medical studies, as he wanted to remain useful even after death.

The word clone refers to creation of a precise copy of a gene (gene cloning), production of therapeutically relevant embryonic stem cells (therapeutic cloning) and production of genetically alike animals (reproductive cloning). In 1963, J.B.S. Haldane coined the term clone. Nuclear transfer technique was used in 1980's to clone cattle and sheep from cells taken directly from early embryos of respective species. In 1995, live limbs namely Megan and Morag were born from embryo derived cells which were cultured in the laboratory for several weeks. For the first time in 1996 Ian Willmut at the Roslin Institute, Scotland, cloned a sheep Dolly from mature mammary gland cell of six year old Dorset sheep.

**Remember...**



- **Dolly was the first cloned mammal.**
- **Pratham is the world's first IVF buffalo calf born through ET technique at NDRI Karnal in 1990.**
- **Garima is the first live cloned buffalo calf born on June 6, 2009 at NDRI, Karnal.**

**Advantages**

1. Animal cloning could enable the rapid dissemination of superior genotypes from nucleus breeding farm and herds directly to commercial farmers. Thus technique could provide genotypes / animals suited for high milk yield, disease resistance or extreme environmental conditions.
2. Cloning can be used for conservation of indigenous livestock breeds especially threatened or endangered animals. Somatic cells obtained from endangered animals can be propagated and maintained in vitro

for use as nuclear donor to produce animal clones.

3. Animal models can be developed to study the genetic basis of several human diseases.
4. The cloned animals that are capable of producing recombinant proteins can provide an economic and safe system for production of pharmaceutical proteins for prevention and treatment of animal diseases.
5. Stem cell therapy can be used for treatment of various diseases.
6. Cloning can create organ transplants that would never be rejected by a recipient.

#### Limitations

1. The current cloning technique is not efficient and is more expensive.
2. Development abnormalities, illness and premature deaths are common in cloned animals.
3. The ethical issues related to cloning are unresolved.
4. The safety of cloned animals as food source has not been well established.

### 12.6 TRANSGENIC ANIMALS

Transgenic animals are defined as animals whose genetic make up has been improved by introducing DNA from other source than parental germplasm by using reconstruction DNA technology.

**Technique :** Transgenic animals can be produced as follows :

1. The desired gene is identified, isolated and prepared for insertion into a fertilized egg.
2. The host embryo is obtained for insertion of gene.

3. The desired gene is then transferred to host cell.
4. The recombinant embryo is duplicated and then embryo is transferred to recipient cow that has earlier been synchronized.

#### Advantages

1. It is possible to produce animal that possess trait of economic importance viz. growth, reproduction and production.
2. It provides base for human organ transplant (xenotransplantation).

### 12.7 SEXED SEMEN/EMBRYO

**Sexed semen :** Semen having X or Y bearing sperm to produce progenies of a desired sex either female or male with 80-90% accuracy is known as sexed semen.

Sex sorting technology was developed by the USDA (United States Department of Agriculture) researchers in Livermore, California, and Beltsville, Maryland. The technology was patented as “Beltsville Sperm sexing technology”. The commercialization of sexed semen started in United States in the year 2001. At present, commercially sex sorted semen is available in many countries of Europe, USA, Canada, Mexico, Brazil, India, China, Japan etc.

#### Do you know ?

**Sexed semen gives 80-90% accuracy to get female progenies as compared to conventional semen straws where male : female ratio is about 50:50.**



#### How sexed semen is produced?

1. Sperms are sorted by identifying differences between the X- and Y-bearing sperm.

2. The X-chromosome (female) contains 3.8 per cent more DNA than the Y-chromosome (male) in cattle. This difference in DNA content is used to sort the X from the Y bearing sperm.
3. The flow cytometry based sorting method is mainly used as a most efficient technique with more than 90 per cent purity.

**Can you imagine ?**

The sperm concentration of sexed semen ranges between 2 and 4 million/dose whereas, it is 20 million/dose in conventional semen.



**Advantages**

1. It produces maximum female calves which help the farmers to save resources shared with unwanted males.

2. It speeds up genetic improvement by increasing efficiency of Progeny Testing (PT), Embryo Transfer (ET) and In-vitro Fertilization (IVF) programme.
3. It is an economic way to increase herd strength with no risk of introducing diseases by purchasing heifers from outside.
4. It is more successful even at a low sperm concentration in semen than conventional semen as dead, dying or damaged sperm cells are removed during the sorting process.

**Disadvantages/Limitations**

1. It requires highly skilled person to operate sex sorting machines.
2. The cost of sexed semen is high.
3. The efficiency and speed of sex sorting machine is generally low.
4. Approximately 50 per cent sperms are lost during sorting and hence having less conception rate.

**EXERCISES**

**Q.1 Fill in the blanks.**

1. The best site for semen deposition is .....
2. Embryo can be preserved in liquid nitrogen at .....°C.
3. Artificial insemination technique makes better use of ..... for genetic improvement.
4. .... is the most commonly used method of semen collection.
5. The sperm concentration of bull semen is ..... millions/ml.
6. The process of preparing the sperms for fertilization is known as .....
7. The young one in goat is termed as.....
8. The conception rate with sex sorted semen is .....percent less than the conventional semen.

**Q.2 Make the pairs**

Group A	Group B
1. Goat	a. Process of preparation the sperms for fertilization
2. Sheep	b. Kidding
3. Capacitation	c. Lambing
4. Ovulation	d. Process of fusion of male and female pronuclei
5. Syngamy	e. Process of release of ova
	f. Calving

**Q.3 State true or false**

1. Diestrus is the longest stage of estrous cycle.
2. Gestation period in ewe is 165 days.
3. The best time of semen collection is early morning before feeding.
4. Embryo transfer was first performed and recorded in sheep.
5. Act of giving birth is called as parturition.
6. Estrous in cattle usually occurs every 60 days.
7. Dolly the famous animal was a cloned sheep.
8. Fertilization result into formation of eggs.
9. The normal semen pH ranges from 6.4 – 6.8.

**Q.4 Answer in brief**

1. Define the term artificial insemination.
2. Mention the different parts of AV.
3. Enlist the methods of insemination.
4. What do you mean by cloning?
5. Name the hormone used for induction of super ovulation.
6. Enlist the steps involved in the process of fertilization.

7. Give the signs/symptoms of pregnancy.
8. Enlist the signs of heat in cattle.
9. What are the different methods of pregnancy diagnosis?

**Q.5 Answer the following questions**

1. Write advantages of AV method of semen collection.
2. Define semen, give its properties.
3. Write the advantages of frozen semen over liquid semen.
4. Enlist the benefits of embryo transfer technology.
5. What are the limitations of cloning technique?
6. Give the advantages and disadvantages of estrous synchronization.
7. Compare the AI and Natural service.

**Q.6 Answer the following questions in detail**

1. Define artificial insemination and give its advantages and disadvantages.
2. Enlist different methods of semen collection and describe in brief artificial vagina method.
3. Elaborate the concepts of sexed semen along with its advantages and disadvantages.
4. Define estrous synchronization along with its procedure.
5. Describe the estrous cycle in detail.



### Practicals (XI)

1. Study of external body parts of livestock and poultry.
2. Demonstration of morphological features of various breeds of cattle.
3. Demonstration of morphological features of various breeds of buffalo.
4. Demonstration of morphological features of various breeds of sheep and goat.
5. Demonstration of morphological features of various breeds of poultry.
6. Identification of commonly used feeds and fodder crops.
7. Study of unconventional feed and fodder resources.
8. Study of azolla fodder Production
9. Demonstration of chaffing of fodder and hay making
10. Different methods of silage making
11. Study of hydroponic fodder production system
12. Study of various body systems of ruminants.
13. Study of various body systems of poultry and structure of egg.
14. Study of different breeding systems adopted in cattle improvement programme.
15. Signs and symptoms for heat detection in livestock.
16. Study of methods of pregnancy diagnosis in livestock.
17. Signs and stages of parturition.
18. Study of equipments required for collection of semen.
19. Visit to local veterinary dispensary to demonstrate A.I. technique.

### Project Work (XI)

1. Collect the information and photographs of cattle breeds from your locality.
2. Collect the information and photographs of buffalo breeds from your locality.
3. Collect the information and photographs of sheep breeds from your locality.
4. Collect the information and photograph of goat breeds from your locality.
5. Collect the information of and photographs of poultry breeds from your locality.
6. Collect the specimens of common fodder crops cultivated in your area.
7. Collect the samples of different feeds/concentrates fed to livestock in your locality
8. Visit the different livestock improvement projects and record their objectives and breeding programme.
9. Visit and collect the information on modern dairy farm.
10. Visit to feed manufacturing company and record different types of feed manufactured.

Note : Teachers can allot any one above project work.

**Specimen question paper (Practical)**

**30 Marks**

**Q.1 Identification**

**6 Marks**

- A. Identify
- B. Sub question

**Note : Total 6 specimens should be kept, each carrying 1 Marks (½ mark for identification and ½ mark for sub question)**

**Q.2 Solve any two of the followings (Each 3 marks).**

**6 Marks**

- A. Draw a neat Diagram/sketch and label it correctly.  
e.g. Draw a neat sketch of cow and buffalo and label the body parts.
- B. Calculation from practical syllabus.  
e.g. Calculate feed and fodder requirements of lactating crossbred cow weighing 500 kg as per thumb rule.
- C. Theoretical question from practical syllabus.  
e.g. What is the importance of pregnancy diagnosis ? What are the external signs of pregnancy in the farm animals.

**Q.3 Practical exercise (any one)**

**6 Marks**

- 1. Hay making
- 2. Silage making
- 3. Chaffing of fodder
- 4. Azolla production
- 5. Urea molasses treatment

**Q.4 A. Vivavoce**

**2 Marks**

**b. Journal**

**4 Marks**

**Q.5 Project or visit report**

**6 Marks**

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