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Introduction to Livestock Breeding Management



12

Technical and Vocational Stream

Learning Resource Material

**Introduction to Livestock Breeding
Management
(Grade 12)**

Secondary Level

Animal Science



Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

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Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline and self-reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills. It is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This Learning Resource Material for Animal Science has been developed in line with the Secondary Level Animal Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops and seminars, interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Prof. Dr. D.K. Singh, Dr. Shambhu Sah, Dr. Yam Bahadur Gurung, Dr. Ganesh Gautam, Dr. Shishir Bhandari, Dr. Hari prasad panta, Dr. Milan Paudel, Dr. Bhumika Paudel, Dr. Garima Thapa is highly acknowledged. The book is written by Dr. Shushila Shrestha and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book in this form.

This book is a supplementary learning resource material for students and teachers. In addition they have to make use of other relevant materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.

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UNIT 1

INTRODUCTION

Objectives

On completion of this chapter, the students will be able to know about:

- Terms and Definition
- History of animal Breeding in Nepal
- Importance of Breeding

Contents

1.1 Terms and Definition

A.I (Artificial Insemination): when animal breeders place semen of a male animal into reproductive tract of a female animal. The sperm from the semen meets with the female (ova) egg and a baby (foetus) begins to develop. This makes it possible for breeders throughout the world to introduce the best traits into their herds even though males with those traits might not live nearby.

Allele: A variant of a specific gene.

Breeding: The process of mating and producing young animals.

Breeding Value: The estimated genetic value of an individual. The part of an individual's genotypic value that is due to independent and therefore transmittable gene effects.

Chromosome: a piece of DNA that contains gene which determine what characteristics the animal will have.

Cloning: It is another form of biotechnology used in animal production. Identical twins are an example of naturally occurring cloning. It is the process which creates genetic copies of individual.

Courtship: The behaviour of animals who are trying to attract a sexual partners.

Environment: The surroundings and management of a farmed animals.

Estrus: The period when a female animal can produce young one if she mates with

male.

Estrus induction: Hormonal stimulation of estrus at desired moment to ensure a better control and care of reproducers and offspring.

Farm Animal Breeding: Strategies applied by specialized farmers to increase desirable traits selecting the appropriate animals as ancestors of the new generations.

Gene: a section of genetic material or DNA of a living organism which affects a particular aspect or characteristic of the organism's phenotypic traits, its morphology or metabolism.

Genetic diversity: High variety of alleles of genes within a population.

Grade up: process of converting from a non pedigree to a pedigree herd or animal.

Heritability: how much of a particular trait can be expected to be passed from one generation to the next, on average.

Inbreeding: Genes that two animals have in common due to common ancestors. Inbreeding can be used to increase genetic variation between families in order to increase response to selection.

Mass Selection: A form of selection in which only individuals with phenotypic values greater or less than a threshold level are used for breeding. It involves no use of family information.

On heat: A female animal that is on heat is ready to mate with a male.

Pedigree: An animal's ancestry

Phenotype: A physical characteristic, observable or measurable in the real world.

Sire: to become the father of an animal such as a cow or a horse.

1.2 History of animal breeding in Nepal

Livestock development in Nepal is considered to have been initiated, with import of cows from UK, way back in 1917 BS, by Jung Bahadur Rana, Prime Minister. Then ruling elites gradually started bringing exotic cows from India, and number of exotic cows in Kathmandu valley increased, as people close to ruling families

followed them.

Livestock improvement Section, with main objective of increasing genetic potentialities of indigenous cows was officially established in 2008 BS (1952 AD), and exotic breeds such as Red Sindhi, Sahiwal, Jersey and Brown Swiss were used for "grading-up" of native cattle. As there were only small number of crossbred cows in Kathmandu valley, artificial insemination (AI) program with liquid semen was started in 2017/2018 B.S. (1961/62 A.D.). Thus, use of Red Sindhi, Sahiwal, Jersey, Holstein and Brown Swiss liquid semen to upgrade native cattle came into practice, in the year 2018/2019 B.S. (1962/63 A.D.).

An artificial Insemination Project was started at Tripureshwor, Kathmandu in 2025/26 B.S. (1969/70 A.D.), and AI program received further momentum after establishment of Liquid Nitrogen (LN₂) plant in the year 2037/38 B.S. (1980/81 A.D.). The project was renamed as Animal Breeding Division (ABD) and was shifted to Khumaltar in the year 2041/42 B.S. (1985/86 A.D.). The ABD initiated breeding activities in cattle, buffalo, sheep, goat, pig, and poultry with main emphasis on Ai in cattle and buffaloes. In 2046 B.S., when ABD became a part Nepal Agriculture Research and Services Center (NARSC), the Department of Livestock services (DLS) started AI program naming it Artificial insemination services. The artificial insemination services was renamed animal breeding and Artificial insemination program in 2048/49 B.S. (1991/92 A.D.) and was made a part of the Department of agriculture Department (DoAD). With restructuring of the Agriculture Ministry and re-establishment of DLS in 2052/53 B.S. (1995/96 A.D.), the program was named as Animal Breeding and Artificial Insemination Section and renamed National Livestock Breeding Center in 2061/62 BS (2004/05 AD).

National Livestock Breeding Center (NLBC), located in Khumaltar, Lalitpur since last 18 years was relocated to Lampatan, Pokhara in the year 2058/59 BS (2001/02 AD), and has been functioning to achieve and meet its vision, goal and objectives.

1.3 Importance of Breeding Management

Animal breeding is the branch of veterinary science concerned with maximizing

desirable traits. Animals and livestock contribute 40% of the global value of agricultural output and contribute to the livelihoods and food security of almost a billion people worldwide. Reproduction is an important consideration in the economics of animal production. In the absence of regular breeding and calving at the appropriate time, animal rearing will not be profitable.

- Improving livestock production and lowering costs for producers
- To avoid the introduction and development of characteristics harmful to well being
- To manage genetic resources and diversity between and within populations.
- Improving livestock breeds to allow greater feed efficiency and other desirable traits
- Improving adaptability of animals to climate change and resistibility to various diseases.
- Sequencing animal genomes to improve health, adaptability, and production

UNIT 2

PRINCIPLES OF SELECTION

Objectives

On completion of this chapter, the students will be able to know about:

- Natural and artificial selection
- Basis of selection
- Methods of selection

Contents

2.1 Natural and Artificial Selection

Selection is defined as a process in which certain individuals in a population are preferred over others for producing next generation. Selection is the tool used by the breeders to improve the performance of the animal. It does not create new genes, but it only increases frequency of desirable genes. Selection may be natural or artificial. Natural selection occurs naturally with time based on the organism which is best suited for environment. Man, aimed at improved genetic potential of farm animals, controls artificial selection.

Artificial selection is the method of making varieties with desirable traits. Here the individuals with desirable character is selected and it is used as parent for the next generation. Artificial selection has played a crucial role in livestock for production of high yielding and disease resistance animals.

In natural selection, nature selects the individuals with favorable variations that help them to adapt better to an environment.

Natural selection	Artificial selection
In natural selection, nature selects the individuals with favorable variations for better survival in an environment.	It is the selective breeding of domesticated animals to produce offspring's with characters desirable to humans.
The nature selects the best or the most favorable variation.	Man selects the desirable characteristics that are to be passed onto the next

	generation.
Selection pressure is exerted by environmental factors.	Selection pressure is exerted by humans.
It always increases the species chance for survival in its natural environment.	It may not always increase in the species chance for survival in its natural environment.
It takes about hundreds of years for new species to emerge.	It leads to the formation of new species in a much shorter time, may be in a few years.
It operates on a wide scale in natural populations.	It involves selective breeding of economically important plant and animal populations only.
It leads to great diversity in nature.	It promotes evolution of a few economically important plants and animals only.
Genetic diversity remains high.	Genetic diversity is lowered.
Out breeding is common leading to hybrid vigor.	Inbreeding is common ensuring preservation of desired trait, leading to loss of vigor in offspring.
Proportion of heterozygous in the population remains high.	Proportion of heterozygous in the population is reduced as inbreeding increases homozygosity.
e.g. giraffes long neck, beaks of Darwin's Finches	Breeding of cows, sheep and other domesticated animals

2.2 Basis of Selection

There is only one way to select and that is to "keep the best and cull the poorest. The various selection methods are techniques for identifying or estimating the genetic values of individual candidates for selection.

Selection based on Individual's performance

Selection on the basis of individual phenotypic performance is called individual selection. Since the phenotypic value is determined by both genetic and environmental influences, the performance test is an estimate, not a measure of the

genetic value. The occurrence of this estimate depends upon the heritability of the trait i.e. on the degree to which the genetic value is modified by the environmental influences. It is the commonly used basis for improvement in livestock, characters like body type, growth rate are evaluated directly from the individual animal performance.

Advantages

- It is the most accurate procedure.
- Environmental influences can be minimized by testing candidates for selection in the same pen or in similar environmental conditions.
- The measure is direct, not on a relative basis.
- Generation intervals are usually short.
- Testing can usually be done on the farm under normal management conditions.

Disadvantages of Individual's Performance

- Accuracy become low when heritability is low
- Some important traits like milk production, maternal abilities in cows are expressed only in females.
- Some of the traits like performance records for milk and other maternal qualities are available only after sexual maturity is reached, which may become expensive or difficult to manage by performance test since most selection decisions must be made before maturity.
- When the heritability of a trait is high, individual merit is a poor indicator of breeding value.

Selection Based on Progeny Testing

Selection of the individuals on the basis of average performance of their progeny is called progeny testing. It is the estimation of an individual by evaluating its offspring. It is very useful tool in evaluating breeding worth of dairy cattle. It offers best means of achieving genetic improvement in traits of moderate to low heritability. The rate of progress achieved by this method is double to that of phenotypic selection. Progeny testing is generally used for selecting males as large

number of progeny can be obtained for each male, while the number of progeny produced by a female is limited.

Advantages:

- High accuracy when many progeny are obtained.

Disadvantages

- Long generation interval (as individuals are to be selected only after their progeny performance test is evaluated)
- Requires high reproductive rate
- Low selection intensity
- Very expensive (since large number of animal's performance should be recorded)

Selection based on Pedigree Performance

Selection on the basis of performance of ancestors is called pedigree selection. A pedigree is a record of an individual's ancestors including its parents. If a performance record of individual is available, the addition of pedigree information usually adds little to accuracy of estimates of breeding value of individual. Pedigree selection is very useful when the traits selected are highly heritable and when we do not have sufficient accurate records of production of the individual. Pedigree selection is especially useful for early selection of individuals in case of selection of young bulls for progeny testing.

Advantages:

- It provides information when performance tests are not available for the candidates.
- It provides information to support performance test information.
- It allows selection to be completed at a young age. Pedigree records may be used to select animals for performance or progeny testing in multi-stage selection scheme.
- It allows selection of bulls that can be selected based on the milk records of their female relatives.

Disadvantages

- Accuracy is usually low.
- Too much emphasis on relatives, especially remote relatives, greatly reduces genetic progress.
- Progeny of favoured parents are often environmentally favoured.
- Relatives often make records under quite different environments, thus introducing non random bases into the selection system.

Selection Based on Collateral Relatives

Selection based on the collateral relatives is another form of sib selection. In this case the source of information is the production of the full or half sibs. Its main advantage is that it can be used on traits which are expressed only in one sex as well as on those which can be measured only after slaughtering. Again, effectiveness depends on the number of individuals providing information, their genetic distance and the heritability of the trait.

2.3 Methods of Selection

Tandem Selection

It is a method of artificial selection in which useful traits are selected sequentially. Selection for one trait for a given period of time until desired change is achieved followed by selection for a second trait and continuing in this way until all important traits are selected is known as tandem selection. For instances, one could select for both increased milk yield and increased milk fat content in cows via tandem selection. At first selecting those with the best of one trait, say those that produce highest milk yield. And then when that trait is at a satisfactory level, then starting to select for those cows that produce milk with the greatest milk fat content.

Advantages

- Simple strategy to apply because selection is really for one trait

Disadvantages

- The correlation between traits is not being used to advantage

If the traits are unfavorably correlated, progress achieved in one will be lost once

selection begins for the other.

Independent culling level

Independent culling is a selection strategy whereby a genotype is culled if it does not meet the requirement for a single trait, regardless of its levels on other traits. It is a method by which the producer sets a minimum value for each trait in the selection program. This strategy guarantees that a genotype that is selected as a new variety has no major defects. A minimum standard is set for each trait of interest and those individuals that exceed that standard for all traits are selected done in same generation.

Advantages

- This is the simplest method to identify bulls that meet the goals of a selection program.
- More common and practical method of selecting breeding stocks.
- Simple way to select for more than one trait simultaneously.
- Convenient when selection done at different points.

Disadvantages

- Difficult to set the (minimum) standards
- Needs to update the standards periodically
- Superiority in one trait allowed to offset lower merit in another

Selection Index

It is a method of artificial selection in which several useful traits are selected simultaneously.

Advantages

- Several traits can be selected simultaneously rather than sequentially.
- Allows superiority of one or more traits to compensate for inferiority in a single trait.
- Includes emphasis based on the economic value of traits so that selection of those animals with the highest index values will result in the highest economic returns.

Disadvantages

- It requires considerable genetic, economic and computational expertise to calculate the b-values, (the regression or weighting coefficients).
- All traits in the index must be measured before any animal are culled.

Learning Process and Support Material:

- a. Guided by teaching material

Assessment

1. Define selection.(1)
2. Differentiate between natural and artificial selection. (4)
3. Write down the basis of selection with its advantages and disadvantages. (8)

Glossary

- **Resistance:** the ability not to be affected by something, especially adversely
- **Genetic:** relating to genes or heredity
- **Diversity:** a range of different things
- **Vigor:** physical strength and good health
- **Hybrid:** the offspring of two animals of different species, such as a mule
- **Heritability:** is a statistic used in the fields of breeding and genetics that estimates the degree of variation in a phenotypic trait in a population that is due to genetic variation between individuals in that population.
- **Heterozygous:** having two different alleles of a particular gene or genes.
- **Homozygous:** having two identical alleles of a particular gene or genes.

UNIT 3

LIVESTOCK BREEDING SYSTEMS

Objectives

On completion of this chapter, the students will be able to know about:

- Random mating system
- Assortative mating system
- Inbreeding
- Out breeding

Contents

3.1 Random Mating System

Random mating or Panmixia is the ability of any individual in a population to move freely about its habitat in order to breed with any other member of that population.

3.2 Assortative Mating System

It is a mating pattern and a form of sexual selection in which individuals with similar phenotypes mate with one another more frequently than expected under a random mating pattern. Some examples of similar phenotypes are body size, skin color/pigmentation and age.

Positive Assortative Mating (Homogamy)

It increases genetic similarities within the family. It occurs more frequently than negative assortative mating.

Negative Assortative Mating (Heterogamy)

In which individuals with dissimilar genotypes and /or phenotypes mate with one another more frequently than expected under random mating. It reduces the genetic similarities within the family.

3.3 Inbreeding

Mating of closely related individuals is known as inbreeding. Inbreeding can again be divided into following groups.

- a. Close breeding: Mating with sire to daughter, son to dam, full brother and sister.
- b. Line breeding: Mating with half brother and sister or mating of animals more distantly related individuals, e.g., cousin mating.

Advantages of Inbreeding

- It increases homozygosity and decreases heterozygosity and hence favours the development of genetic uniformity amongst the animal.
- Increased prepotency (ability to pass on traits to offspring).
- Fixing of desired traits and breed type.

Disadvantages of Inbreeding

- Effect on reproductive performances or Lower fertility
- Lower vigor
- Birth defects
- Smaller size
- Fewer offspring
- Slower growth
- Higher offspring mortality
- Shorter life span
- Increase in genetic diseases
- Reduced genetic potential
- Effect on production
- Appearance of lethal and abnormalities

a. Close breeding

The mating of full sister to full brother or sire to his daughter or dam to her son is known as close breeding. These types of mating should be used only when both parents are outstanding individuals, and then only at increased risk of bringing undesirable recessive genes into homozygous form in the progeny.

Advantages of Close breeding

- Undesirable recessive genes may be discovered and eliminated by further

testing in this line

- The progeny are more uniform than out bred progeny

Disadvantages of Close Breeding

- The undesirable characteristics are intensified in the progeny if unfavourable gene segregation occurs
- Progeny becomes more susceptible to diseases
- Breeding problems and reproductive failure usually increase

b. Line Breeding

The mating of animals of wider degrees of relationship than those selected for close breeding is known as line breeding. It promotes uniformity in the character. Homozygosity is not reached so quickly as in close breeding. Neither desirable nor harmful characters are developed so quickly.

Advantages of line Breeding

- Increased uniformity
- The dangers involved in close breeding can be reduced

Disadvantages of Line Breeding

- The main danger in line breeding is that the breeder will select the animal for pedigree giving no consideration to real individual merit.

3.4 Out Breeding

Breeding of unrelated animals is known as out breeding. It is generally of following types:

- a. Out Crossing
- b. Cross Breeding
 - Criss-crossing
 - Triple crossing
 - Back crossing
- c. Species Hybridization
- d. Grading up

a. Out Crossing

Mating of unrelated pure bred animals within the same breed. The animals mated have no common ancestors on either side of their pedigree upto 4-6 generations and the offspring of such a mating is known as the Out Cross.

Advantages of Out Crossing

- Highly effective for characters that are largely under the control of genes with additive effects, e.g., milk production, growth rate in beef cattle, etc.
- It is an effective system for genetic improvement.
- It is the best method for the most herds.

Disadvantages of Out Crossing

Outcrossed individuals are less likely to transmit their own type because of their more varied genetic background.

b. Cross Breeding

It is the mating of animals of different breeds. It is generally used where the crossed progeny is directly marketed and are not needed for breeding and further multiplications. It has become common in pigs and in the production of hybrid chickens.

Methods of Cross Breeding

1. Criss- Crossing

When the two breeds are crossed alternatively, the method is known as criss-Crossing. This method is proposed for utilizing heterosis in both dams and progeny. Breed A females are crossed with breed B sires. The cross-breed females are mated back to sires of breed A and so on. In this system the cross breeds soon come to have about 2/3 of their inheritance from the breed of their immediate sire with 1/3 from the breed being used.

2. Triple Crossing

In this system three breeds are crossed in a rotational manner. It is also known as rotational crossing

Three breeds are used in this system. The females of crosses are used on a sire of pure breeds in rotation.

3. Back Crossing

Mating of a crossbred animal back to one of the pure parent races which are used to produce it. It is commonly used in genetic studies.

Advantages of Cross Breeding

- It is valuable as a means of introducing desirable characters into a breed in which they have not existed formerly.
- It serves a good purpose in evolving a new breed.
- It is an extremely handy tool to study the behavior of characteristics in hereditary transmission.
- The cross breed animals grow rapidly with high vigour, producing more milk, wool, eggs, etc.

Disadvantages of Cross Breeding

- It requires maintenance of two or more pure breeds in order to produce the cross breeds which cause investment to become high.

c. Species Hybridization

Species hybridization: Species hybridization is a process where hybridization between two different species leads to a new species. It is least common form of out breeding, mainly because animals from different species do not often interbreed. The basic example of a species cross is mule, cross between a stallion and a jenny.

d. Upgrading/Grading Up

It is mating of pure bred males of a established breed with non descript females successively over several generations to produce a progeny that resembles and performs similar to the pure breed. Grading up is the system of breeding mostly adopted for genetic improvement of the buffaloes.

It is to be taken up in areas having more number of the non descriptive female population. After seven generations of crossing, the non-descriptive females acquire the characters of a pure breed.

Advantages of Upgrading

- Pure breeds can be obtained just after a few generations (after 7th to 8th generation).
- The start can be made with a little money in comparison to the purchase of an entire herd of pure breeds.
- It helps to prove the potentialities of the sire and adds to its market value.
- It is good start for a new breeder who can slowly change over to pure breed systems.

Disadvantages of Upgrading

- Pure breed are not always better than grade or country animals for the use to be made.
- Pure breed stocks which give good results in one set of environmental conditions do not always give favourable results in some different environmental set-up. The pure breed dairy cattle from temperate zone often degenerate when used in tropical areas. Moreover, their offspring fails to show vigor and constitution for high reproduction. To make grading successful, the pure breed must have the ability to perform under the environmental set-up where their offspring is going to perform.

UNIT 4

REPRODUCTIVE ANATOMY

Objectives

On completion of this chapter, the students will be able to know about:

- Male and female reproductive system of cattle and buffalo
- Male and female reproductive system of sheep and goat
- Male and female reproductive system of Pig
- Male and female reproductive system of poultry

Contents

4.1 Male Reproductive system of cattle and buffalo

The reproductive tract of the bull consists of:

- testicles,
- secondary sex organs (epididymis, vas deferens and penis)
- accessory sex glands (seminal vesicles, prostate and bulbourethral gland (cowper's gland))

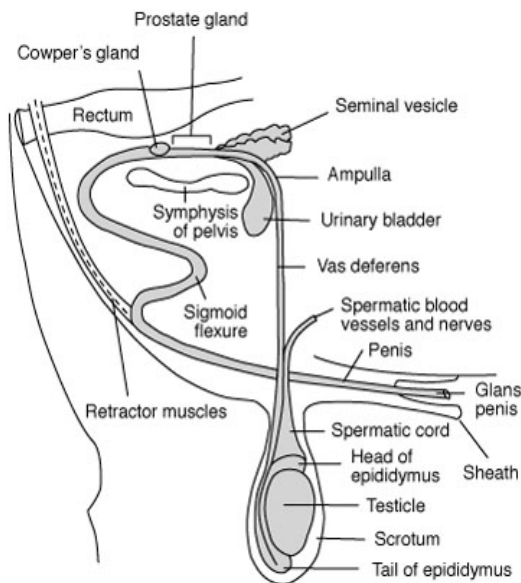


Fig4.1: Male reproductive system of cattle

Testicle

It is located outside the body cavity in the scrotum and has two vital functions: producing spermatozoa, and producing the male hormone, testosterone. Testicles are located at the exterior to the body cavity which is essential for normal sperm formation, which occurs only at 4 to 5 degrees below body temperature. The scrotum provides physical protection to the testicles and helps to regulate the temperature for optimum spermatozoa development.

The testicle contains many long, tiny, coiled tubes known as *seminiferous tubules*, within which the sperm are formed and begin to mature. Scattered throughout the loose connective tissue surrounding the seminiferous tubules are many highly specialized cells, the *interstitial cells of Leydig*, that produce testosterone. There are hundreds of individual seminiferous tubules in the body of the testicle which unite with one another to form a few dozen tubules that exit from the testicle and pass into the *epididymis*.

Epididymis

The epididymis is a compact, flat, elongated structure closely attached to one side of the testicle which serve as an outlet for all the sperm produced in the testicle. It is divided into three regions, the head, body and tail. Many tubules enter the head of epididymis from the testicle that unite to form a single tubule some 130 to 160 feet in length. This tubule is convoluted and packed into the 6- to 8-inch epididymis.

Functions of the epididymis are:

- transportation of the developing sperm cells from the testicle to the *vas deferens*
- the concentration of the sperm by absorption of surplus fluids
- maturation of the developing spermatozoa
- Storage of viable sperm cells in the epididymis tail. If sexual activity is slowed, resorption of sperm cells from the epididymis tail occurs.

Vas deferens

The vas deferens, also known as ductus deferens, emerges from the tail of the

epididymis as a straight tubule and passes as a part of the spermatic cord through the *inguinal ring* into the body cavity. Spermatozoa are transported further along the reproductive tract to the pelvic region through the vas deferens by contraction of the smooth muscle tissue surrounding this tubule during ejaculation.

Urethra

The two vas deferens eventually unite into a single tube, the urethra, which is the channel passing through the penis. The urethra in the male serves as a common passage way for semen from the reproductive tract and urine from the urinary tract.

Accessory glands

Two of the accessory glands are found in the general region where the vas deferens unite to become the urethra. Secretions from these glands make up most of the liquid portion of the semen. In addition, the secretions activate the sperm to become motile. The seminal vesicles consist of two lobes about 4 to 5 inches long, each connected to the urethra by a duct.

The *prostate gland* is located at the neck of the urinary bladder where it empties into the urethra. The prostate is relatively small in the bull, as compared to other species, and does not produce a very large volume secretion.

Cowper's glands are small, firm glands located on either side of the urethra. The clear secretion that often drips from the penis during sexual excitement prior to service is largely produced by these glands and serves to flush and cleanse the urethra of any urine residue that may be harmful to spermatozoa.

Penis

The *penis* is the organ of insemination. Spongy-type material within the penis is filled with blood during sexual arousal, resulting in erection of the organ. The end of the penis is the glans penis and is richly supplied nerves, which are stimulated during copulation to induce ejaculation.

The *sigmoid flexure* is an anatomical structure that provides a means by which the penis is held inside the sheath except during time of service. Strong retractor muscles hold the penis in the "S" shaped configuration.

4.2 Male Reproductive System of Sheep and Goat

The male reproductive system of sheep and goat consists of testicles, which produce sperm and sex hormones, a duct system for sperm transport, accessory sex glands, and the penis.

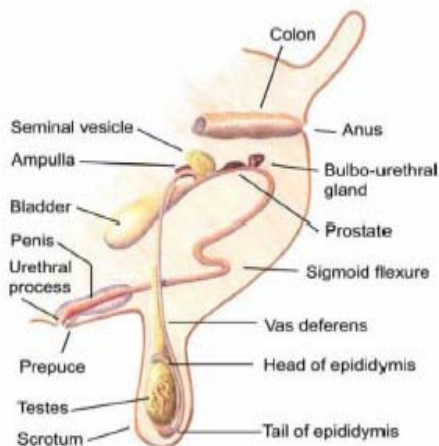


Fig4.2: Male reproductive system of goat

The system consists of following parts:

1. Testes:

The testes are paired organs which descend from the abdominal cavity during fetal development to lie in the scrotum. The testes hang between the hind legs. They produce the male gametes (spermatozoa) and secrete the male sex hormone, testosterone. Testosterone is essential for the development of male characteristics, maintaining normal sexual behavior and sperm production. The testes are located in the scrotum, which support and protect the testes and aids in the temperature regulation, and maintain the testes at 3-5°C below body temperature for optimal function. The testicle contains many long, tiny, coiled tubes known as *seminiferous tubules*, within which the sperm are formed and begin to mature.

2. Epididymis

The epididymis is a compact, flat, elongated structure closely attached to one side of the testicle which serve as an outlet for all the sperm produced in the

testicle. It serves as the site of sperm maturation (sperm acquire motility and fertilizing capacity), and storage prior to ejaculation. The length of the epididymis tube is about 50 meter.

3. Vas deferens

The vas deferens, also known as ductus deferens connects the epididymis to the ampulla and accessory sex glands. These glands are located in the pelvic region and provide the spermatozoa with fluids that make up the ejaculation.

4. Accessory sex glands:

The accessory sex glands include the bulbo-urethral, prostate, and seminal vesicle glands and the ampulla. Accessory glands secrete additional fluids, which when combined with the sperm and other secretions from the epididymis, form the semen. Some of the secretions contain nutrients like fructose while others produce alkali secretion to raise the pH of the ejaculate. These secretions are added quickly and forcibly during the mating to propel sperm into the urethra.

5. Penis

This is the final part of the male reproductive tract, and its function is to deposit semen into the vaginal tract of the female. The preputial sheath protects the penis, except during mating. It is about 30 cm in length and 1.5 to 2.0 cm in diameter.

4.3 Male Reproductive system of Pig

The reproductive system of the male pig is located in the abdomen and extends outside the abdominal cavity in the area of the groin. Its main function is to produce and maintain a sperm supply.

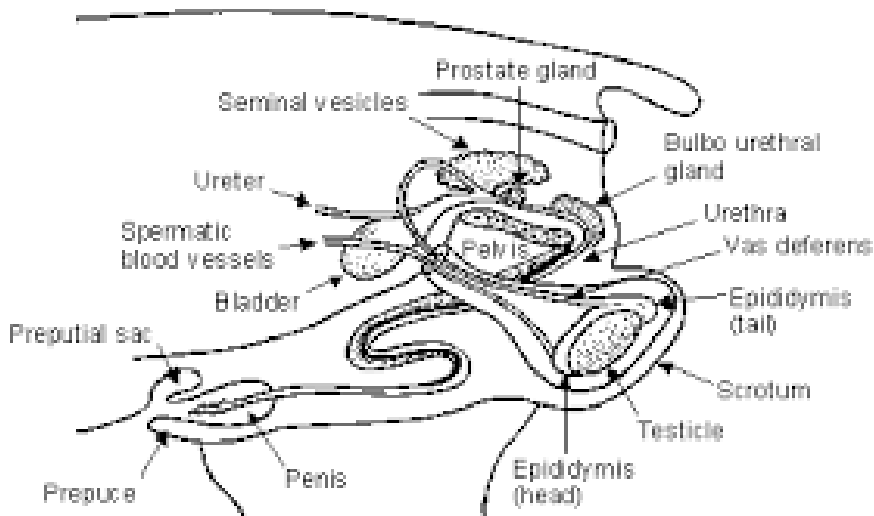


Fig 4.3: Male reproductive system of boar

Anatomy

The male pig's reproductive system is comprised of the testes, the epididymis, the ampullae and the seminal vesicles, all of which are paired. In addition there is the prostate gland, the bulbo-urethral glands and the penis.

Testes

The testes of the boar are paired and unlike most other species, the boar testes are anatomically upside down. The testes are the primary organs of reproduction in the male pig and they are responsible for producing hormones and sperm. They are contained within a pouch called the scrotum and hang outside the abdominal cavity in the region of the groin. Scrotum serves the important functions of protection and temperature regulation. Unlike most other species, the boar testes are anatomically upside down. Sperm that is produced leave the testes from the bottom, move up, and are stored near the top of the testicle. Seminiferous tubules are highly convoluted and densely packed tubes within the testes. Sperm cells are produced only within the seminiferous tubules of the testes.

Epididymis

All of the separate sperm producing tubes however, eventually converge into a

single collection tube in the center of the testicle. The central sperm collection tube (rete testes) exits the boar testicle at the bottom and enters into the epididymis. The epididymis is highly coiled, long tube that rests on the backside of each testicles and when laid out end to end is over 189 ft in length where maturation and storage of sperm takes place.

Vas Deferens

It is a long, muscular tube that travels from the epididymis into the pelvic cavity, to just behind the bladder. It transports mature sperm to the urethra in preparation for ejaculation.

Urethra

The two vas deferens connect with each other and merge into a single tube called the urethra that runs from the bladder to the end of the penis. The urethra continues forward and passes through the center of the penis where it is known as the penile urethra. The urethra is responsible for transport of both semen and urine. Urine enters the urethra by relaxation of a muscle under voluntary control. Relaxation of this muscle is prevented during erection and ejaculation by the nervous system in order to prevent urine entering into the semen. Fluids are added to sperm in the pelvic urethra during the process of ejaculation.

Various accessory gland fluids are added to sperm beginning with the prostate fluids, the vesicular gland fluids and then the bulbourethral gland fluids. All of these glands add substances to the ejaculate that serve to increase volume, protect sperm cells, and provide nutrients needed for ensuring sperm fertility.

Penis

The final structure for transfer of sperm into the female is the penis. The penis consists of the root, shaft and glans. The boar penis is composed of tough fibro elastic tissue supplied with blood and nerves. To deliver semen into the female when erect, the boar penis is extended through an opening called the prepuce located on the abdomen. In the pig, the average number of sperm per ejaculation is about 8,000 million.

Notable Fact

The male pig's testes are unusual in that they are anatomically upside down, which means that sperm is stored near the top of the testicle.

4.4 Male Reproductive System of Poultry

The male reproductive system produces male reproductive cells (spermatozoa), which is introduced into the oviduct of the female for fertilization of the egg and secondly for producing a hormone which influences sex characters.

The male reproductive system consists of the testes, vas deferens, and papillae or rudimentary copulatory organs.

Male Poultry Reproductive Tract

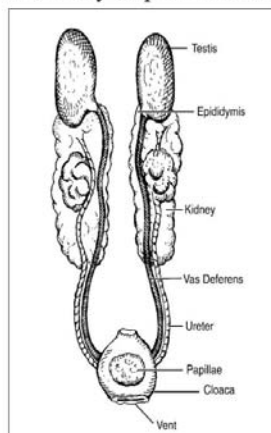


Fig4.4: Male reproductive system of poultry

Testes

The testes are two small ovoid organs situated at the anterior end of the kidneys in the dorsal body wall. The left testis is usually larger than the right one. Each testis consists of a larger number of slender tubes, called seminiferous tubules, from the linings of which the reproductive cells are given off. The spermatozoa are then carried out of the testes by the seminal fluid, which is also produced in the testes. Millions of these are produced and expelled.

Vas Deferens

The vas deferens are the two tubes pursuing a wavy course from the testes to the cloaca. They convey the spermatozoa and seminal fluid from the testis to the cloaca.

Papillae

The rudimentary copulatory organ of the male is located on the median ventral portions of one of the transverse folds of the cloaca. At the time of mating sperms are introduced by the papillae into the oviduct in the cloacal wall of the female.

Cloaca

The enlarged section of the alimentary canal that connects the large intestine and vent is called the cloaca. The vent is the external opening of the cloaca. Sperms from the testes, faecal material from the large intestine and the urine from the kidneys all pass through the cloaca and are eliminated through the vent.

4.5 Female Reproductive system of cattle and buffalo

The female reproductive system of a cow is composed of;

- i) Ovary
- ii) Uterus
- iii) Cervix
- iv) Vagina
- v) Vulva

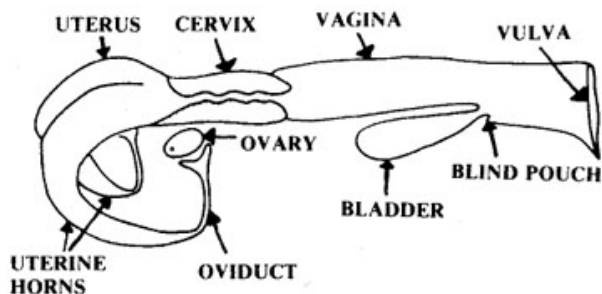


Fig4.5: Diagrammatic sketch of the reproductive tract of the cow.

A cow has two bean-shaped ovaries located within the abdominal cavity. Size of the ovaries varies with stage of the reproductive cycle and age of the female, but generally are 1 to 1-1/2 inches long.

The **ovary**, or female gonad, is responsible for two basic functions

- Production of the female gamete, the egg or ovum
- Production of two primary reproductive hormones, estrogen and

progesterone. Estrogen produced by graffian follicle inside ovary induces oestrus i.e. Heat period so that the cow shows signs of heat. The hormone estrogen is produced under the influence of other hormone called the Follicle Stimulating Hormone (FSH).

The **oviduct** begins as a funnel-shaped tube that engulfs the ovary. This funnel portion of the oviduct is called the **infundibulum**. When ovulation occurs, the ovum is picked up by the infundibulum and channeled into the oviduct (also known as the **Fallopian tube**), where fertilization takes place if viable sperm are present. Here the ovum remains capable of fertilization for only a short time. Thus sperm must be present in the oviduct near the time of ovulation. The ovum moves through the oviduct into the uterine horn within the next 3 to 4 days. If the ovum is fertilized, it then begins embryological development; if not, it degenerates and disappears and the next estrous cycle ensues.

Uterus

The body of the **uterus** of the cow is short and poorly developed, while the **uterine horns** are relatively long and well developed. The fertilized embryo moves from the oviduct into the uterine horn, where fetal and maternal membrane development begins. This newly developing fetus grows within a layer of membranes called the placenta, through which nourishment from the dam diffuses. There is no direct blood connection between the fetus and the dam, but rather a complex system that selectively allows certain molecules to pass from the maternal side of the placenta to the fetal side and vice versa. It also provides nutrients and carries waste products from the fetus.

Cervix

The **cervix** is located near the neck of the uterus. It has thick walls and a small opening which softens and relaxes to allow a passage way for sperm at mating and expulsion of the fetus at the time of birth. During pregnancy, the cervix is filled with a thick mucus secretion known as the cervical plug, which protects the uterus from infections entering from the vagina. The cervical plug is expelled and the cervical opening begins to dilate in the days prior to calving.

Vagina

The **vagina** serves as a receptacle for the male's penis during service. In the cow, the semen is deposited in the vagina near the cervix during natural mating with the bull. When artificial insemination is used, an insemination instrument is threaded through the vagina and cervix and semen is deposited at the uterine side of the cervix. Urine is discharged from the urinary bladder through the urethra, which opens into the base of the vagina. The region behind the urethral opening is called the vestibule and is a common passageway for both the urinary and reproductive systems.

Vulva

The external opening of the vagina is called the vulva.

4.6 Female Reproductive System of Sheep and Goat

The reproductive tract of ewes and does is similar. The female reproductive tract consists of the ovary, oviduct (also called Fallopian tube), uterus (body of the uterus, uterine horns), cervix, vagina (copulatory organ) and vulva.

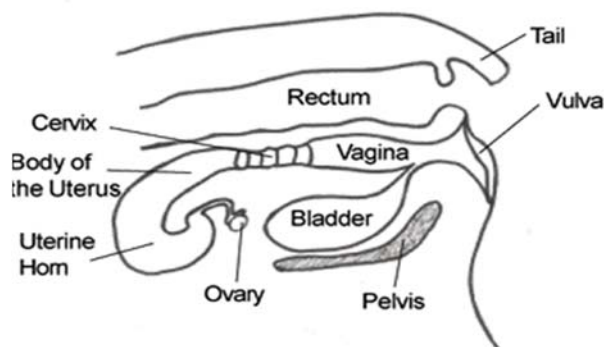


Fig 4.6: Female reproductive system of goat

1. **Ovaries:** The ovaries contain the ova (eggs), and secrete female reproductive hormones (progesterone and estrogen).
2. **Oviduct:** The oviduct opens like a funnel (infundibulum) near the ovary. The infundibulum receives ova released from the ovary and transports them to the site of fertilization in the oviduct. The oviduct is involved in sperm transport to the site of fertilization, provides a proper environment for ova and sperm

fertilization, and transports the subsequent embryo to the uterus.

3. **Uterus:** The uterus consists of two separate horns (corona). In animals with multiple births, each horn can contain one or more fetuses. The uterus provides a proper environment for embryo development, supports development of the fetus (supplying nutrients, removing waste, and protecting the fetus), and transports the fetus out of the maternal body during birth.
4. **Cervix:** The cervix is the gateway to the uterus and is a muscular canal consisting of several folds of tissue referred to as “rings.” The cervix has relatively little smooth musculature. It participates in sperm transport, and during pregnancy, blocks bacterial invasion. The mucus produced during pregnancy (also during the luteal phase) forms a plug that makes the opening through the cervix impermeable for micro-organisms and spermatozoa.
5. **Vagina:** This is the exterior portion of the female reproductive tract and is the site of semen deposition during natural mating.
6. **Vulva:** barrier for preventing external contamination of the female reproductive tract.

4.7 Female Reproductive System of Pig and Poultry

The female reproductive system of pig consists of:

- | | | | |
|-----------|------------|-----------|-----------|
| a. Ovary | b. Oviduct | c. Uterus | d. Cervix |
| e. Vagina | f. Vulva | | |

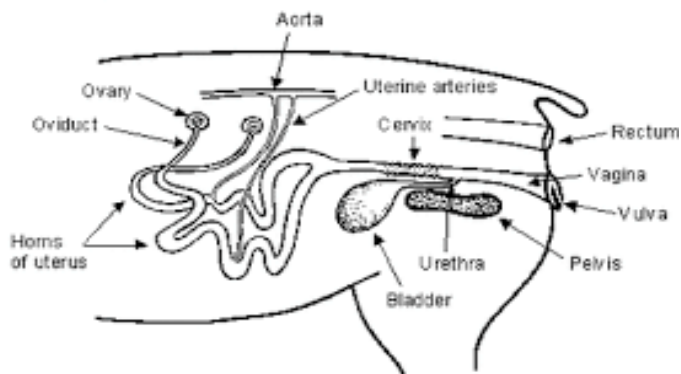


Fig 4.7: Female Reproductive tract of Sow

Ovary

The primary structures of the female reproductive tract are the ovaries. There are two ovaries i.e left and right ovary. They have two major functions:

- to produce ova, the female germ cells and
- to produce the hormones progesterone and estrogen

Oviduct

Each ovary is surrounded by a thin membrane called the infundibulum which act as a funnel to collect ova and divert them to the oviduct. The oviduct is about 6-10 inches long and acts as the site of fertilization. It is short convoluted tube that connects ovary to the uterus. Fertilization takes place in the mid portion of the tube, called the ampulla. Most of the eggs reach the site of fertilization within 30 minute to 1 hour after ovulation. The eggs will remain viable and fertilizable in the tube for approximately 8-12 hours after ovulation. Therefore it is important that insemination occur prior to ovulation so that sperm are waiting for the egg.

Uterus

There are two uterine horns with the cervix at one end and the oviducts at the other. Each is 2-3 feet in length in the non pregnant sow. They act as a passage way for sperm to reach the oviduct and are the site for fetal development. The uterine body, which is small compared to some other species, is located at the junction of the two uterine horns.

Cervix

The cervix is a muscular junction between the vagina and the uterus which is approximately one inch in diameter and about 6-8 inches in length. It is made of tough connective tissue and contains limited amounts of glandular and muscular tissue. It contains a series of five inter digitating pads which provide pressure points for locking of the penis. Its primary functions are to serve as a locking mechanism for the penis. The cervix is important for protecting the fetuses and will remain tightly closed except at estrus and at farrowing, when it will dilate to accommodate the boar's penis and to allow passage of the piglets through the birth canal. The

cervix is also the primary source of mucus. Under estrogen stimulation, such as that which occurs at estrus, the mucus becomes watery and can sometimes be seen seeping from the vulva. The mucus serves as a lubricant for the penis of the boar. Under progesterone stimulation during pregnancy, the cervical mucus will thicken and form plug to prevent any contaminants from entering the sterile uterine environment. This cervical plug will dissolve just prior to farrowing.

Vagina

The vagina extends from the cervix to the vulva and serves as a passage way for urine and the piglets at birth. It is approximately 12-18 inches long and connects the cervix to the external genitalia of the pig. It serves primarily as a copulatory organ for the boar and as a passageway from the uterus to the outside. The bladder is connected to the vagina by the urethra.

Vulva

The vulva is the external portion of the reproductive tract. The vulva is endowed with blood vessels and in gilts the vulva is often observed to swell and change color near the time of estrus.

Female Reproductive System of Poultry

The female reproductive system differs greatly from that of mammals. The reproductive cell, also known as a gamete, ovum or egg, is an article of food. It is large and enclosed with a food supply for embryo development.

The reproductive system of the female consists of primary and accessory sexual organs, the ovary and the oviduct with its five part: infundibulum, magnum, isthmus, uterus and vagina.

Ovary

The reproductive system has the following parts;

- i) Ovary
- ii) Oviduct (Funnel(infundibulum), Magnum and Isthmus)
- iii) Uterus/ shell gland
- iv) Vagina

V) Cloaca

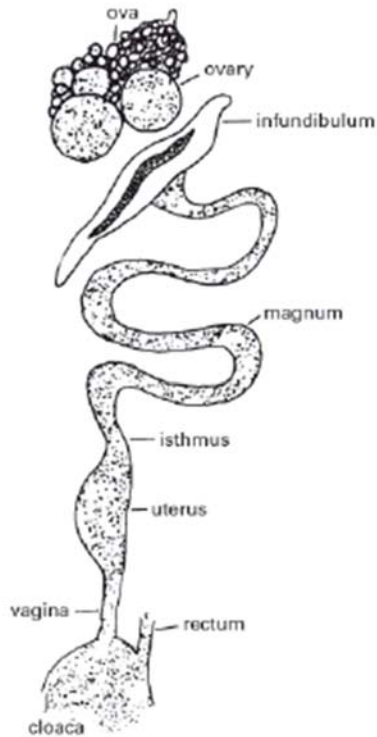


Fig 4.8: Female Reproductive System of Poultry

Ovary

Hen has two ovaries but one functional. Normally, only the left one develops. The right persisting if at all, only as a function less rudiment. Ova are formed in ovaries. About 3500-4000 ova present inside ovary held by follicle. Mature ovum released via rupture of follicle. It moves into oviduct received by the funnel.

Oviduct

The oviduct is a twisted tube that is 25-27 inches long when fully developed and divided into 3 sections i.e. infundibulum, magnum and isthmus.

Infundibulum

It is 3-4 inches long and engulfs the ovum released from the ovary. The yolk remains in the infundibulum for 15 to 17 minutes. Fertilization, if it is going to occur, takes place in the infundibulum.

Magnum

It is 13 inches long and the largest section of the oviduct. The yolk remains here for 3 hours during which thick albumen forms.

Isthmus

It is 4 inches long where the inner and outer shell membranes are form. The developing egg remains here for 75 minutes.

Uterus (shell gland)

It is 4 to 5 inches long. In this section, the shell forms on the egg. The shell largely is made of calcium carbonate. Addition of albumin finished and stays here for 18-22 hours. Pigment deposition, if there is any, occurs in the shell gland. The egg remains here for 20 or more hours.

Vagina

It is made of muscle and about 4 to 5 inches long. The vagina does not really play a part in egg formation but is important in the laying of the egg. It is short, 6.9cm long and for temporal storage of egg before laying.

Near the junction of the shell gland and the vagina are deep glands known as sperm host glands that can store sperm for long periods of time, typically 10 days to 2 weeks. (One of the unique things about birds is that the sperm remain viable at body temperature). When a hen lays an egg, sperm can be squeezed out of these glands into the oviduct and then can migrate to the infundibulum to fertilize an ovum.

Cloaca

Egg moves out of cloaca through the vent and the cloaca extends out to prevent the egg from breaking.

UNIT 5

REPRODUCTIVE PHYSIOLOGY

Objectives

On completion of this chapter, the students will be able to know about:

- Puberty and sexual maturity
- Factors affecting puberty and sexual maturity
- Spermatogenesis and Oogenesis
- Control mechanism of reproduction (neuro-endocrinal)
- Estrus cycle, ovulation and fertilization)
- Gestation and Parturition

Contents

5.1 Puberty and Sexual Maturity

Puberty

Puberty is the period of growing young one, when a male or female is the first time able to release gametes. At this stage the animals become typical in nature and their physiological development (age and body weight) show complete sexual behavior, which shows that the animal has attained puberty. Apart from environmental and nutritional factors, gonadotropic hormones play the most important role (FSH and LH) and simultaneous response from gonads increases the steroidogenesis (secretion of estrogen and progesterone) and gametogenesis.

The onset of puberty occurs when animals reach at a set proportion of their adult size at a particular phase of their growth curve called “pubertal inflexion”. In heifers, dairy heifers reach puberty at a younger age than beef breeds.

In case of male, it is hard to determine the exact time of puberty as release of spermatozoa from seminiferous tubules takes month or more, sperm transport from testes to vas deference needs at least two weeks.

In cases of female the first ovulation and the ability to produce off spring, the

puberty is converted into sexual maturity. At this stage some physical changes take place like mammary development, change in voice, fatty deposition of muscles on hip joints.

Age of puberty differs with breed, climate, social factor, nutrition. High level of nutrition, presence of opposite sex hastens puberty where as low level of nutrition and presence of same sex delays puberty. In female, at puberty blood supply to the ovaries increases, the external genitalia, vagina, uterus and oviducts enlarges, hormonal action increases and thus increases the growth of genitalia.

Cattle:	12-18 months
Horse:	12-24 months
Sheep:	6-12 months
Dog:	6-12 months
Swine:	5-8 months

Sexual Maturity

Onset of puberty does not determine sexual maturity. Sexual maturity refers to the attainment of full capacity of reproduction, where all related organs of reproductive system should discharge their physiological functions for successful reproduction. There is some time span between puberty and sexual maturity, first few cycles are unovulatory in animals as the number of G.F don't develop properly and rupture.

5.2 Factors affecting Puberty and Sexual Maturity

Onset of puberty and sexual maturity are the gradual processes which are influenced by plane of nutrition and management, cross breeding, chronic diseases, individual differences and other factors.

Nutrition and management

- Poor somatic growth and emaciation which ultimately delays the onset of puberty due to the deficient feeding of protein, iodine, phosphorus, copper, iron, cobalt.
- Lack of TDN in the feed or starvated animal prevents the secretion of

gonadotrophic hormones by the anterior-pituitary which results in failure of early puberty.

Body size and weight

- Body weight plays more important role than the age for attaining puberty and sexual maturity.
- If the individual animal gains less weight according to age the puberty and ultimately sexual maturity will be delayed.

Gonadal growth

- The scrotal circumference is directly proportional to the intensity of sex desire and spermatozoa production.
- Sex desire: depending on the available testicular surface area containing number of leydig cells- site of androgen secretion.
- Spermatozoa production: depending on the available testicular surface area containing number of seminiferous tubule-site for spermatogenesis.
- At the age of puberty the diameter of seminiferous tubules is less than the diameter of the seminiferous tubules at the age of sexual maturity.
- Genetic factors
- The genetic components of young bulls affect the onset of puberty and maturity.
- The large breeds of cattle and horses have a late onset of puberty than the smaller breeds.
- The buffalo male calves appear to attain sexual maturity later than the cattle-bull calves even with good nutrition and management; probably due to genetic difference (testicular surface area of buffalo is lesser than cattle)
- The cross breeding causes early puberty and maturity.

Species

Onset of puberty varies with species.

Species	Age of Puberty
Bull	9-12 months
Stallion	18 months
Boar	5-7 months

Ram and Buck	7-8 month
Dog	7-10 months
Cat	8-10 months

Geographical Location

- The geographical location for rearing of young animals affects the onset of puberty and maturity.
- If individual animal of one geographical area is raised in another geographical area, the puberty will be affected adversely.
- Animals located in tropical regions are late in attaining puberty and sexual maturity.

Season

- There is a close relationship among season of birth, body weight and onset of puberty.
- Winter is favourable for sexual maturity in young bulls, used in AI.
- Seasonal influences are there in sheep and buffaloes- hot season delays the onset of puberty.

Hormones

- If hormones (FSH and ICSH/LH) release occurs at earlier age, the puberty and sexual maturity comes earlier.
- If delay the release of hormones leads to delay in the puberty and sexual maturity.

Chronic disease and debility

- Any disease which causes emaciation of individual, delay the onset of puberty and sexual maturity. E.g. FMD, Johne's diseases, TB, Mange.
- Chronic diseases indirectly due to elevation of body temperature, disturbance of basal metabolism, thermal stress, anorexia, indigestion, stunted growth, emaciation, debility, weakness and endocrinological dysfunction affects the onset of puberty.

Sexual stimulation

- The stimulation of sensory apparatus through CNS by hearing, seeing, smelling of opposite sex, causes early puberty.

- Lack of these stimulation leads to delay in the onset of puberty.
- If the male and female are kept together, they mature earlier.

5.3 Spermatogenesis and Oogenesis

Spermatogenesis

It is the process by which haploid spermatozoa develop from germ cell in seminiferous tubules of the testis. The testes are composed of numerous thin, tightly coiled tubules known as the seminiferous tubules; the sperm cells are produced within the walls of the tubules. Within the walls of the tubules, also, are many randomly scattered cells, called Sertoli cells, that function to support and nourish the immature sperm cells by giving them nutrients and blood products. As the young germ cells grow, the Sertoli cells help to transport them from the outer surface of the seminiferous tubule to the central channel of the tubule.

Sperm cells are continuously being produced by the testes, but not all areas of the seminiferous tubules produce sperm cells at the same time. One immature germ cell takes as long as 74 days to reach final maturation, and during this growth process there are intermittent resting phases.

The immature cells (called spermatogonia) are all derived from cells called stem cells in the outer wall of the seminiferous tubules. The stem cells are composed almost entirely of nuclear material. (The nucleus of the cell is the portion containing the chromosomes.) The stem cells begin to multiply in the process of cell duplication known as mitosis. Half of the new cells from this initial crop go on to become the future sperm cells, and the other half remain as stem cells so that there is a constant source of additional germ cells. Spermatogonia destined to develop into mature sperm cells are known as primary sperm cells.

These move from the outer portion of the seminiferous tubule to a more central location and attach themselves around the Sertoli cells. The primary sperm cells then develop somewhat by increasing the amount of cytoplasm (substances outside of the nucleus) and structures called organelles within the cytoplasm. After a resting phase the primary cells divide meiotically (Meiosis I) into two secondary sperm cells (spermatocyte); each secondary spermatocyte divides into two equal

haploid spermatids by Meiosis II. During this cell division there is a splitting of the nuclear material. In the nucleus of the primary sperm cells there are 46 chromosomes; in each of the secondary sperm cells there are only 23 chromosomes, as there are in the egg. Thus, the primary spermatocyte gives rise to two cells, the secondary spermatocytes, and the two secondary spermatocytes by their sub division produce four spermatozoa and four haploid cells.

The secondary sperm cell still must mature before it can fertilize an egg; maturation entails certain changes in the shape and form of the sperm cell. The nuclear material becomes more condensed and oval in shape; this area develops as the head of the sperm. The head is covered partially by a cap, called the acrosome, which is important in helping the sperm to gain entry into the egg. Attached to the opposite end of the head is the tailpiece. The tail is derived from the secondary sperm cell's cytoplasm. In the mature sperm, it consists of a long, slender bundle of filaments that propel the sperm by their undulating movement. Once the sperm has matured, it is transported through the long seminiferous tubules and stored in the epididymis of the testes until it is ready to leave the male body.

Oogenesis

It is the process of producing the female gametes, the ovum, from the primordial germ cells. The majority of the steps in oogenesis, up to the point of producing primary oocytes, occur prenatally. Therefore, females are born with all of the primary oocytes that they will ever have as primary oocytes that they will ever have as primary oocytes do not divide further. These primary oocytes are committed to a gamete fate and either become secondary oocytes or degenerate. Oocyte development occurs within follicles and so oogenesis and folliculogenesis occur in conjunction with each other, interacting via reciprocal induction. The follicular granulose cells produce important growth factors and supporting substances to facilitate oocyte development and vise-versa.

Stages of Oogenesis

Stage 1

- Primordial germ cell undergoes mitosis to produce two oogonia. These cells

are all diploid.

- Occurs pre-natally.

Stage 2

- Each oogonia also undergoes mitosis to produce two diploid primary oocytes.
- Occurs pre-natally.

Stage 3

- Each primary oocyte starts to undergo meiosis I replicating their DNA, but they are arrested at the first meiotic Prophase
- Occurs Pre-natally

Stage 4

- The meiotic block is removed by the onset of puberty and the first Luteinising Hormone surge. The primary oocyte completes its first meiotic division producing a secondary oocyte and the first polar body. The secondary oocyte enters Meiosis II and is arrested at metaphase II. The secondary oocyte is diploid.
- The oocyte enlarges due to a increase ($\times 50$) in cytoplasmic volume. The oocyte is now 100-150 μ
- Ovulation occurs at this stage once the first meiotic division has been completed and secondary oocyte formed within the dominant follicle. The exception in this case is of the Bitch where ovulation occurs after stage 3 with the primary oocyte arrested in prophase I.
- Occurs after puberty is reached.

Stage 5

- The secondary oocyte completes meiosis II producing the mature gamete, the ova, which is haploid.
- This stage occurs once fertilization of the secondary oocyte by the sperm has occurred.

5.4 Control mechanism of reproduction (neuro-endocrinal)

The male and female reproductive cycles are controlled by the interaction of hormones from the hypothalamus and anterior pituitary with hormones from

reproductive tissues and organs. In both male and female, the hypothalamus monitors and causes the release of hormones from the pituitary gland. When the reproductive hormone is required, the hypothalamus sends a gonadotropin-releasing hormone (GnRH) to the anterior pituitary. This causes the release of follicle stimulating hormone (FSH) and luteinizing hormone (LH) from the anterior pituitary into the blood. Although FSH and LH are named after their functions in female reproduction, they are produced in both sexes and play important roles in controlling reproduction.

Male hormones

At the onset of puberty, the hypothalamus causes the release of FSH and LH into the male reproductive system for the first time. FSH enters the testes and stimulates the sertoli cells to begin facilitating spermatogenesis.

LH also enters the testes and stimulates the interstitial cells of Leydig to make and release testosterone into the testes and the blood.

Testosterone: It is the hormone responsible for the development of accessory reproductive organs and secondary sexual characteristics. It stimulates sexual desire in male animals and also stimulates spermatogenesis.

Note: the body must reach puberty in order for the adrenals to release the hormones that must be present for GnRH to produce them.

Female Hormones

The control of reproduction in females is more complex. As with the male, the anterior pituitary hormones cause the release of the hormones FSH and LH. In addition, estrogen and progesterone are released from the developing follicles.

Estrogen is the reproductive hormone in females that is produced in ovary which assists in endometrial regrowth, ovulation, and calcium absorption; it is also responsible for growth of accessory reproductive organs, secondary sexual characteristics of females. These include development of mammary gland. It stimulates development of the duct system in mammary gland. Estrogen induces estrus in animals.

Progesterone assists in endometrial re-growth and inhibition of FSH and LH release. Progesterone is steroid hormones that prepare the uterus for implantation and maintain pregnancy. It develops alveolar system in mammary gland.

FSH: It stimulates development of egg cells, called ova, which develop in structures called follicle. Follicle cells produce the hormone inhibin, which inhibits FSH production.

LH also plays a role in the development of ova, induction of ovulation, and stimulation of estradiol and progesterone production by the ovaries. It help in the formation of corpus luteum.

Prolactin: It is secreted by anterior pituitary gland. In ovary it maintains functional capacity of the corpus luteum. It stimulates formation of milk in alveoli of mammary gland. It also causes broodiness in birds.

Oxytocin: It is secreted by posterior pituitary gland. It stimulates contraction in uterus during birth in animal and during laying in birds. It initiates let-down of milk into ducts and cisterns in mammary gland.

Relaxin: It is produced from cervix which relaxes pubis bones and cervix during birth.

Prostaglandin F2 alpha: It is secreted from Uterus and causes regression of corpus luteum in sheep, cattle and swine.

5.5 Estrus Cycle. Ovulation and Fertilization

Estrus Cycle

The chain of physiological events or changes in the reproductive organs of female animals from one estrous period to other after onset of puberty, except during pregnancy is called estrous cycle. Estrus is the stage of the estrous cycle when female expresses sexual desire and accept male. With references to bovine, there are four stages in one estrous cycle. These are proestrous, estrous, metestrous and diestrous.

Proestrus

This is the period immediately proceeding (before) estrous characterized by rapid

growth and maturation of the graffian follicle in the ovary under the influence of FSH and producing increasing amounts of estradiol. The stage is not precisely defined but begins from day 17-18 of the estrous cycle once the regression of the corpus luteum begins. Thus the period lasts for about 3 days (in bovines) until the apparent estrous is evident. There is increased in activity of all the organs of the reproductive tract.

Estrus

Estrous is fairly defined period of the estrous cycle characterized by expression of sexual desire and acceptance of the male by a female domesticate animal. This period begins with the time of the first acceptance and ends with the last acceptance of the male. The graffian follicle in the ovary is large and mature. The ovum undergoes some maturational changes approaching ovulation.

Metestrus

Also called post estrus, this stage is again poorly defined period after estrus during which the corpus luteum grows rapidly from granulose cells of the ruptured follicle under the influence of luteinizing hormones of the anterior pituitary gland. Metestrus is the phase under the influence of drastic withdrawal of estrogen, therefore is largely under the influence of progesterone produced by the corpus luteum. The stage lasts for about 3-4 days post estrous. The presence of progesterone inhibits secretion of FSH by the pituitary gland and thus prevents the development of more graffian follicles and initiate development of another estrus until progesterone with drawl is reached (effect of $\text{PGF}2\alpha$ after day 16-17).

Diestrus

This phase is the longest phase or period of the estrous cycle in domestic animals. The corpus luteum is matured and the effects of progesterone on the reproductive tract are most pronounced. This phase occurs between day 4 or day 5 to day 16 or 17 of the estrous cycle in bovines. If the animal got pregnant, the CL continues and implantation proceeds as trophoblastic cells of the developing conceptus secrete a specific protein called interferon which informs mother about the pregnancy, otherwise CL has to regress under the influence of $\text{PGF}2\alpha$ secreted by endometrium

due to the absence of viable embryo in the uterus.

Anoestrus

This is the period (when referred to physiologic estrous cycle) of ovaries being inactive, quiescent, function less and occurs for a few days to few months after parturition and during off-season in seasonally breeding animals (for example mare and ewe). Anoestrus (nonfunctional or noncyclic ovaries) during other times is generally pathological (infertility).

Behavioral signs of Estrus

The acceptance of male during estrus is due to the effect of estradiol on the central nervous system producing species specific characteristic or behavioral patterns of receptivity in various female animals.

With reference to bovines, some of the prominent signs of estrus include:

- Bellowing
- Restlessness, however, standing still when approached by other animals
- Separation from the rest of the herd and search for a male
- Accepting mounting by other animals
- Frequent urination
- Vaginal mucus discharge- transparent and string like
- Pink vulva (hyperemia)
- Reduced feed and water intake
- Slight rise in body temperature

Factors affecting the estrus cycle

Several factors affect the onset of estrus and its interval between the estrus periods: some of the important factors are:

- Nutritive state of the animal
- Seasonal influences and light. Sheep and horse tend to follow seasonal pattern in heat expression.
- Age: younger animals specially swine and cattle species tend to show shorter estrum and estrus cycle than their older members.

- Temperature: excessive heat and cold may produce adverse hormonal situations and affect the heat pattern.
- Character of the work animal performs: mares heavily put on draught work may not show estrum regularly. So is the case in heavily lactating cows.
- Systemic diseases: any period of suffering from systemic disease produces adverse effect on regularity of the estrous cycle in all species.
- Pathology of the uterus and the cervix
- Endocrine disturbances
- Other miscellaneous causes include: variation among individuals within same species and also noticed.

Ovulation

Ovulation is defined as the process of release of ovum from the graffian follicle of the ovary. A prior surge of luteinizing hormone is absolutely necessary for the final follicular growth and ovulation. Without LH, even though the quantities of FSH are available the follicle will not progress to the stage of ovulation.

There are several layers of tissues of the ovary that have to be dissolved for ovulation to take place. These layers include:

- Surface of the epithelium
- Collagen rich tunica albuginea
- The theca externa layer
- Thin basement lamina
- Capillary network within membrane granulose
- Membrane granulose

Within a few hours of ovulation two events occur

1. The theca externa (the capsule of the follicle) begins to form proteolytic enzymes that cause the dissolution of the capsular wall and consequent weakening of the wall resulting in further swelling of the entire follicle and degeneration of the stigma.
2. Simultaneously there is rapid growth of new blood vessels into the follicle wall and at the same time there is production of prostaglandin (local hormone

that cause vasodilation) are secreted in the follicular tissue.

These two effects are responsible for sufficient plasma transudation into the follicle.

In the process of ovulation, the vascularity of the follicular surface increases in other areas except at the center (which seems to be devoid of blood vessels). At this central point develops a stigma, the point where the rupture of the follicle begins.

Several mechanisms in the process of ovulation have been described. Some of them are:

- **Biochemical mechanism:** The most important change is the switch of estradiol and progesterone ratio following the gonadotropin surge (LH). The increased progesterone concentration following the LH surge stimulates the collagenase activity in the follicular wall. The explanation of biochemical basis of ovulation is the neuroendocrine and enzymatic interactions taking place in the event. Moreover, prostaglandins of the ovarian origin probably are involved in the process that initiates smooth muscle contractions.
- **Neuromuscular and vascular mechanism:** Ovarian stroma and concentric layers of the theca externa of the preovulatory follicles contain smooth muscle fibers with autonomic nervous innervation. Once stigma is formed (the area devoid of blood vessels) the smooth muscle fibers contract and the thin follicular wall ruptures squeezing the ovum from the follicle into the fimbriated end of the oviduct (fallopian tube).

Cytoplasmic and nuclear maturation of the ovum is necessary for ovulation to occur. In cattle, when ovulation takes place the ovum is at the metaphase II of the second meiotic division.

When the ovulation occurs, the ovum along with its attached granulosa cells, the corona radiata is expelled into the peritoneal cavity and must then enter one of the fallopian tubes. The fimbriated end of each fallopian tube approaches close enough to receive the ovum. The inner surfaces of the fimbriated tentacles are lined with ciliated epithelium and the cilia continuously beat toward the abdominal ostium of the fallopian tube. On the basis of conception studies in human beings, it is believed that more than 98% of the ovulated ovum are received by the fimbria of

the oviduct though rare misses are possible (ovum being released in the peritoneal cavity).

5.6 Gestation and parturition

Gestation

Gestation is the period between conception to the birth.

Gestation period of different farm animals.

SN	Species	Gestation period (days)
1.	Cattle	280
2.	Buffalo	310
3.	Sheep and goat	150
4.	Horse	336

Parturition

Parturition is the physiological process by which the pregnant uterus delivers the fetus and placenta from maternal origin.

Sign of approaching parturition

Sign of approaching parturition vary from species to species. The most common signs are as follows:

- Females usually seeks solitude from the herd for parturition
- The female of all species begins to show inappetance distress and anxiety and withdraws from the useful environment as much as possible.
- Mammary glands become developed in the preparation for lactation and there may be considerable secretion of milk in the udder. In some species, distention of udder may be so great that there may be some dripping of secretion from that teat, especially in dairy cows.
- In monotocous animals, the movement of the fetus often can be seen through the abdominal wall.
- Slight drop in body temperature in cow, bitch and ewes.
- Relaxation of muscles surrounding the pelvis, sacro-ischiatic and sacroiliac ligament.

- The soft tissue of the perineal region, the vulva and vagina become relaxed, enlarged and flabby.

Initiation of parturition

Parturition is triggered by foetus and is completed by complex interaction of endocrine, neural and mechanical factors. Both fetal and maternal mechanisms play roles in initiating parturition. The fetal endocrine system dominates in ruminants (cattle, sheep and goat) whereas it plays minor role in other species (horse, man).

Fetal mechanism

- Fetal dominates the mechanism stimulating the onset of parturition in most mammalian species. A significant increase in fetal concentration of cortisol occurs during the final stage of gestation. During the last trimester, fetus grows rapidly and placental $\text{PGF2}\alpha$ increases and in turn activates fetal hypothalamic-pituitary-adrenal axis leading to increase concentration of fetal cortisol. Cortisol stimulates the placenta to convert progesterone to estrogen. The elevated estrogen stimulates secretion of $\text{PGF2}\alpha$ and development of endometrial oxytocin receptors. (Cortisol). In addition, synthesis of estrogen also releases $\text{PGF2}\alpha$ from uterine endometrium which in turn leads to regression of corpus luteum.

- **Maternal mechanism**

Maternal mechanism is event at the timing of birth, for example foaling during mid night in undisturbed condition. Anxiety, fear stress prolong the act of parturition by decreasing myometrial contraction and induced by epinephrine as well as oxytocin blocked upon posterior pituitary. Thus it is reasonable to conclude that the fetus determines the day of parturition whereas the mother decides the hour of parturition.

- **Labor**

Labour starts with the onset of regular, peristaltic uterine contraction accompanied by progressive dilation of cervix.

Stages of labour

There are 3 stages of labour that may be recognized as:

- a. **First stage:** dilation of cervix
- b. **Second stage:** expulsion of fetus
- c. **Third stage:** expulsion of placenta

Dilation of cervix

Uterine muscle contract rhythmically with great force by the action of estrogen. Oxytocin from posterior pituitary stimulates more forceful contraction. Typical labour pain starts and relaxin relaxes the pubis symphysis. Amniotic sac protrudes through the canal ruptured. Released fluid but becomes slippery.

Expulsion of fetus

The opening of the uterus is now well dilated and head of the body begins to descend through it. The fetus movement through vagina creates considerable pressure. Mother straining increases intra-abdominal pressure and the fetus moves alone. After the birth, the second stage ends and dam is very tired.

Expulsion of placenta (fetal membrane)

After delivery, mother rests a while and the uterus contracts rhythmically and vigorously again. The placenta comes out itself. Contraction of the uterine muscle also constricts various blood vessels ruptured during parturition and reduces hemorrhage.

Learning Process and Support Material:

- a. Guided by teaching material
- b. by poster method

Assessment

1. Define Ovulation. (1)
2. Factors affecting puberty and sexual maturity. (4)
3. Write down the stages of estrus cycle and behavioral signs of estrus. (8)

Glossary

- Meiosis: two successive nuclear divisions of reproductive cells in the course of which the diploid chromosome number is reduced to the haploid.
- Mitosis: a type of cell division that results in two daughter cells each having

the same number and kind of chromosomes as the parent nucleus, typically of ordinary tissue growth.

- steroidogenesis: the formation of steroids, as by the adrenal cortex, testes, and ovaries.
- gametogenesis: the process in which cells undergo meiosis to form gametes.

UNIT 6

HEAT DETECTION AND SYNCHRONIZATION

Objectives

On completion of this chapter, the students will be able to know about:

- Induction and synchronization of ovulation/estrus
- Advantages and disadvantages of estrus synchronization
- Heat detection
- pregnancy diagnosis

Contents

6.1 Induction and Synchronization of estrus cycle

Bringing a group of females into estrous through extraneous hormonal intervention in the estrous cycle is termed as heat synchronization. Synchronization of estrous and ovulation in a group of females allows one to predict the time of estrous with a reasonable accuracy. This reduces the time required for the detection of estrous thus making livestock management an easier task.

In farm species there are two approaches to achieving synchronized estrous. The methods depend on either extending the luteal phase through exogenous progesterone administration for the inhibition of LH secretion or shortening of the life span of the CL and subsequent onset of estrous and ovulation.

Onset of heat is achieved after the CL lysis irrespective of the methods and drugs deployed. When progesterone is used LH is inhibited due to negative feed back of the progesterone injected extraneously. When PGF is used it causes lysis of the CL.

Techniques for synchronizing estrus in cyclic farm animals

Species	Method	Treatment regimen	Time from treatment to appearance of estrus
Cattle and buffalos	Prostaglandin (PGF) administration	Two injection(11 days apart	3-5days

Cattle	GnRH +PGF ₂ α	Injection GnRH on day 0 and PGF on day 6	2-4 days
	Estrogen+progest erone	Estrogen inj. On day 1 and CIDR (for day 1-9)	3-5 days
	Progesterone+PG F ₂ α	Progesterone(day 1-7) and PGF on day 6	2-3 days
Sheep	Progesterone (pessary +ECG)	Progesterone for 12-14 days,ECG on day of pessary removal	2 days
	PGF ₂ α	Two injections nine days apart	2-3 days
Goat	Progesterone +ECG	Progesterone for 18-21 days and ECG on the day of pessary removal	2-3 days
	PGF ₂ α	Two injections 11 days apart	2-3 days
Swine	Progesterone in feed	Altrenogest for 14-18days	4-7 days
Mare	Progesterone in feed	Altrenogest for 15days3-5 days	4-7 days
	PGF ₂ α	One dose during Diestrus	3-5 days
	PGF +HCG	PGF (day 1), HCG (day7-8), PGF(day 5) and HCG (day 21-22)	2-4 days

CIDR= Controlled internal drug release implants

6.2 Advantages and Disadvantages of estrus synchronization

Advantages of estrus synchronization

- Earlier and more concentrated calving.
- Uniformity of calves at weaning.
- Uniformity of calves in age and size which can lead to an advantage in the market place.

- Use of improved genetics for producing a value added product.
- Less time for estrous detection.
- Cow nutrition can be improved by grouping cows according to stage of gestation and feeding each group accordingly.
- Shortened calving periods also facilitates improvements in herd health and management such as uniformity in timing of vaccinations and routine management practices resulting in decreased labor requirements.
- A shortened calving season provides producers a better opportunity to offer improved management and observation of the cow herd, which should result in fewer losses at calving.

Disadvantages

- It requires a high level of management and skills to be able to manage numerous calving operations at a synchronized time
- Drug expenses and labor
- An existing high level of management is required
- Good handling facilities are required
- Cows must be cycling and in good body condition
- You can only synchronize the number of cows you can inseminate at onetime

6.3 Heat detection and pregnancy diagnosis

Heat in animals can be detected by following sign and symptoms:

- Mounting other cows
- Mucus discharge
- Swelling and reddening of the vulva
- Bellowing, restlessness and trailing
- Rubbed tail head hairy and dirty flanks
- Chin resting and back rubbing
- Sniffing genitalia
- Decreased feed intake and milk yield
- Metestrous bleeding

Pregnancy Detection

The objective of pregnancy diagnosis (cyesiognosis) is to know if the animal is pregnant or not as early as possible for successful breeding program. The accurate and early diagnosis helps in the management of infertility in farm animal. A variety of methods are now available for diagnosis of pregnancy in animals.

Pregnancy in animals can be detected by following methods:

1. Management method (Signs and symptoms of pregnancy)

- The failure to return to estrous cycle

This is a positive and good sign for the diagnosis of pregnancy. The farmer has to observe the animal for estrus symptoms in the subsequent estrus cycle. A failure to exhibit the symptoms of heat indicates a positive sign of pregnancy. The situation when false positive sign may occur are:

1. When the animal has a silent heat
2. If the animal is anestrous due to lactation and some other environmental factors.
3. If the animal has prolonged diestrus and has not conceived.
4. Prolonged luteal phase associated with embryonic death.

- Mammary glands

The teats of the pregnant heifer begin to enlarge about the fourth month. After the fourth month a honey like secretion may be withdrawn from the teats of pregnant heifer. From the sixth month the mammary glands become more firm to the touch and their enlargement can be seen.

- Abdominal ballottement

This is possible as early as 7 months of gestation in some small breeds such as the jersey. The method involves fairly vigorous pummeling of the ventral abdomen and flank with clenched fists. The object is to push the fetus, which is floating in the fetal fluid, away from the body wall and then identify it as it swings back against the fist which is kept pressed against the abdominal wall.

- Tendency to fatten

- Gradual dropping milk yield
- Gradual increase in weight
- Drooping quarters
- Increase in size of udder
- Waxy appearance of teats in last month of pregnancy

2. **Clinical method**

Vaginal method

It can be done by following methods

- Manual method and
- By use of vaginal speculum

In both the cases the positive signs of pregnancy are:

- Pale and pink vaginal mucous
- Sticky and scanty mucus
- Cervix tightly closed
- External orifice is filled with tacky mucus forming incomplete vaginal plug which points eccentrically. In early pregnancy the vaginal signs are indistinguishable from that seen in diestrus. Thus there is chance of error in prolonged diestrus and pseudo pregnancy.

Rectal palpation

Palpation of the amniotic vesicle

It involves the palpation of the amnion towards the end of the first month of pregnancy. The bifurcation of the uterine horn is located, then the horns are uncoiled and gently palpated along their entire length. The amniotic sac can be felt as a distinct, round, turgid object 1-2 cm in diameter floating in the allantoic fluid.

Palpation of the allantochorion (membrane slip)

The method could be used from the fifth week of gestation. Identify the bifurcation of the uterine horns, pick up the enlarged, gravid horn just cranial to the bifurcation and gently squeeze and roll the whole thickness of the horn. The allantochorion will eventually be identified as a very fine structure as it slips between the thumb and

finger before the uterine and rectal walls are lost from the grasp.

Unilateral corneal enlargement

Unless there are twin conceptuses, one in each horn, it is possible to detect a difference in the size of the two horns. This is largely due to the presence of fetal fluids, in particular allantoic fluid, which gives the uterine horn a fluctuating feel with good tones.

Palpation of the early fetus

At about 45-50 days of gestation the amniotic sac becomes less turgid, and it is sometimes possible to palpate directly the small developing fetus.

Palpation of caruncles/cotyledons

Caruncles/cotyledons first become recognizable by rectal palpation at 10-11 weeks as roughened elevations when the fingers are passed back and forth over the surface of the enlarged gravid horn. From about 3 month they can be identified as discrete structures in the mid line, about 8-10cm in front of and over the pelvic brim, by pressing down up on the uterine body and base of the horns.

Palpation of cervix

Evidence of pregnancy can be assumed when there is tension on the cervix. In the non pregnant or early pregnant cow or heifer the cervix is freely movable from side to side. However, as pregnancy advances the cervix becomes less mobile and it is pulled forwards and downwards over the pelvic brim.

Hypertrophy of the middle uterine artery and development of fremitus

At some stage during pregnancy the middle uterine artery will cease to have the usual pulse, and instead it will become a 'thrill' or tremor, which is called fremitus. The earliest the fremitus can be detected is at 86 days. During the terminal stages of gestation the uterine arteries become greatly hypertrophied and tortuous; they can be distinctly felt, with the thickness of a pencil, with a continuous, tremor-like pulse.

Palpation of the late fetus

Palpation of the fetus, either per rectum or by abdominal ballotment, is diagnostic of pregnancy. The ease of palpation depends upon the size of the cow, the degree of stretching of the suspension of the uterus, and the degree of relaxation of the rectum and uterine wall.

Observation of genital organs of cow by rectal palpation

S. No.	Reproductive organs	45 days	60 days	90 days	120 days	150 days
1.	Vagina	Dry	Dry, wrinkled	Dry, wrinkled	Dry, wrinkled	Dry, wrinkled
2.	Os-cervix	Closed and plugged with gelatinous seal	Closed with gelatinous light brown seal	Closed tenacious brown seal, slightly pulled	Closed tenacious brown seal and pulled forward	Closed tightly, difficult to pick up
3	Uterus	Amniotic membrane slips when horn is rubbed between fingers	Amniotic membrane slip when horn is rubbed between fingers	Embryonic mass conveniently palpable	Foetal mass distends down in abdominal cavity	Foetus in larger volume, cotyledons large
4	Ovary	Corpus luteum present, ovary size and position on 10 th , 22 nd and 45 th day same	Corpus luteum present, ovary size and position on 10 th , 22 nd and 45 th day same	Corpus luteum present, ovary pulled forward	Ovaries out of reach, pulled ahead and downward	Ovaries distend down and out of reach
5	Uterine horn	Slightly enlarged (5 cm)	Ballonous feeling bulged (8 cm)	More enlarged (15 cm)	More enlarged cotyledons, palpable (35 cm)	More enlarged down in abdominal cavity
6	Foetus size	3 cm	5 cm	13 cm	25-30 cm	40 cm

3. Laboratory method of pregnancy diagnosis

Identification of early pregnancy factor/early conception factor

Early pregnancy factor (EPF) is an immunosuppressive glycoprotein associated with pregnancy. Commercially available test kits are available which use the 'dipstick' principle and can detect early conception factor (ECF) in serum and milk from as early as 3 days after artificial insemination, although more accurate results are obtained if samples are taken later at 7 to 8 days.

Assay of pregnancy-specific protein B (PSP-B)

This protein has been identified in the maternal serum of cows from 24 days of gestation, the concentration is measured by radio immunoassay. It is secreted by the binucleate cells of the trophoblastic epiderm, and thus its presence can be used to confirm pregnancy. Since it has a long biological half life it can also be identified in serum for many weeks post partum: therefore, false positive can occur after embryonic or fetal death.

Progesterone concentration in plasma and milk

Since the CL persists as a result of the pregnancy, if a blood sample is taken at about 21 days after the previous oestrus, progesterone levels remain elevated. If the cow is not pregnant and is close to or at estrus then the progesterone levels will be low. Progesterone concentration in plasma and milk can be determined by radio-immunoassay or enzyme-linked immunosorbent assay (ELISA) methods. These days, test-kits are also available for the field use.

Estrone sulphate in plasma and milk

Estrone sulfate secreted by the feto-placental unit, is quantitatively one of the major estrogens in plasma and milk of pregnant cows. During gestation, the concentration increases gradually so that after 105 days. it is present in the plasma or milk of all pregnant animals, whereas in non-pregnant animals it is undetectable. The identification of estrone sulfate in plasma or milk of a cow at 105 days of gestation, or later, is a very reliable method of pregnancy diagnosis.

S. No.	Test Name	Test ingredients mixed	P= pregnant NP= nonpregnant
1.	Copper sulphate test	0.25 ml cervical mucus placed in CuSo4 solution	Mucus sinks= pregnant (90 %) Mucus float= NP
2.	Sodium hydro-oxide test	0.25 ml cervical mucus + 5ml NaOH solution. Heat to boil	Orange color pregnant (80-90 %) Pale (NP)
3.	Barium chloride test	5ml of urine + 5ml barium chloride	Turbidity due to precipitation NP Clear (pregnant)
4.	Sodium benzoate test	3ml urine +0.6ml sodium benzoate and mix to get green color	Green color reduced in 30 seconds (NP) Not reduced upto 8-10 minute (P)

4. Ultrasound examination of the uterus

Different types of ultrasound are in use for diagnosis of pregnancy

1. Ultrasonic fetal pulse recorder

It is based on the principle that a high frequency sound is emitted from a probe placed on the rectum of the animal. This high frequency sound wave is reflected back in the same probe when the sound wave strikes a moving object or particle like fetal heart movement, flow of blood. The difference in the frequency is then converted into audible sound in an amplified form. It is possible to identify the fetal heart from 6-7 weeks using a rectal probe.

- i. Ultrasonic amplitude depth analyzer (A-mode)

It has been used to detect pregnancy as early as 40 days.

Realtime B-mode grey scale ultrasound scanning

- ii. It is the method of choice for the early diagnosis of pregnancy in the cow. The uterus is imaged transrectally with transducer. After insertion of the transducer, both ovaries should be examined to determine the presence of a CL, followed by the right and left horns.

5. Radiography

This method of pregnancy diagnosis is based on the identification of fetal skeleton on an x-ray plate. The method can be used for the diagnosis of pregnancy in sheep, goat, swine and bitches. The method poses radiation hazards to the animal, operator and the fetus.

It can be applied only in the last third of gestation. It is costly and necessitates restraint of the animal. This method is not used frequently because of availability of some easier and most reliable methods.

Learning Process and Support Material:

- a. Guided by teaching material

Assessment

1. Define heat synchronization.(1)
2. Write down about advantages of estrus synchronisation. (4)
3. Write down about methods of pregnancy diagnosis in animals. (8)

Glossary

- Synchronization: the operation or activity of two or more things at the same time or rate
- Ovulation: discharge of ova from the ovary
- Hypertrophy: the enlargement of an organ or tissue from the increase in size of its cells.

UNIT 7

SEMEN COLLECTION AND PROCESSING

Objectives

On completion of this chapter, the students will be able to know;

- Methods of semen collection
- Evaluation and examination of semen quality
- Dilution of semen
- Preservation of semen
- Transportation, handling and distribution of semen
- Natural and artificial selection
- Basis of selection
- Methods of selection

Contents

7.1 Methods of Semen Collection

Hygienic collection of semen is an integral part of an artificial insemination programme. The following are the different methods of semen collection:

1. Directly from vagina after natural service
2. By rectal massage of the ampullae of vas deferens and seminal vesicles per rectum
3. By electro-ejaculation
4. Using artificial vagina (A.V)

Directly from vagina after natural service

This is the simplest and oldest method of semen collection. After a natural service of the cow, the semen is collected from vagina using either a long spoon or a syringe with long nozzle. Good quality semen cannot be obtained by this method, since the semen is always mixed with large volume of mucus.

By rectal massage of the ampullae of vas deferens and seminal vesicles per rectum

It is an useful method for bulls which are lame or are unwilling or are unable to copulate. The bull is securely restrained in a service crate. Hand with full arm obstetrical rubber sleeve after lubrication is inserted in the rectum and a feces is evacuated. The seminal vesicles are massaged pressing towards urthera for few minutes. Simultaneously an assistant is kept ready to collect semen as it drips. Then the ampullae are massaged and milked one by one and are stripped off by pressing against the floor of the pelvis. The pelvic urethra may also be massaged. Prior stimulation with a cow may be of great help in collecting semen through massage technique. After the massageof the ampullae the S-curve of the penis should be straightened to allow escape of semen, if retained in sigmoid flexure. There are chances that if massaged regularly the bulls may become accustomed with this technique within 3-4 weeks.

Disadvantages of this method are:

- Skill and experiences necessary to massage ampullae and the seminal vesicles per rectum
- Some bulls respond poorly to this method of semen collection
- Because the semen dribbles through preputial hairs, semen collection is not clean
- The massage of ampullae sometimes stimulates urination

Electro-ejaculation

The electro-ejaculation method is rarely used for semen collection in bulls. The method is painful to bulls. The electro-ejaculation method of semen collection may be used in valuable and crippled bulls that cannot mount and also in old bulls which have no desire to mount. In this method weak and alternating current is provided to sacral and pelvic nerves with the electrode placed in the rectum. Depending upon the size of the bull various size of electrodes (diameter ranging from 4-8cm and length ranging from 35-60 cm) are available. The preputial hairs may be clipped and the adjacent area was, rinsed and properly dried. Sexual stimulation with a cow

or rectal manipulation of the ampullae and seminal vesicle prior to electro ejaculation would greatly help in collecting good semen samples. The bulls should be fastened in strong stanchion. The footing should be non slippery. The probe after being lubricated with non insulating lubricant is inserted about 30-45 cm into the rectum and is held from outside anus on the middle against the ventral floor of the pelvic. A gradually increasing alternating current (0-5 volts) is passed which is later gradually reduced (5 volts to 0) in 5-10 seconds. Current frequency may range from 15-90 cycles per seconds. Subsequent stimulation are slowly increased. Erection and ejaculation occur 10-15 volts when 0.5-1.0 ampere current is flowing. Excessive stimulation at higher voltage may cause a degree of ataxia or the bull may fall down. With electro ejaculation, it takes about 3-5 minute for semen collection. There is no difference in percentage of motile, live or abnormal spermatozoa. The concentration and the total number of sperms per ejaculate are low with electro ejaculation compared to collection with artificial vagina.

The Artificial Vagina Method

This is the most widely accepted method of semen collection and used in various animals like ram, buck, bulls, dog, stallion, boars etc. Through A.V. a complete and clean ejaculation is promptly obtained. The best time of semen collection is early morning before feeding. In the morning hours, the bulls are fresh and alert. Bulls may become reluctant to donate semen in full belly after feeding. The bull, prior to semen collection should be properly cleaned. Clipping of preputial hairs should be done occasionally. Preputial region may be thoroughly washed and dried. The dummy should also be well clean and dry. It should be strong enough to sustain the weight and thrust of the bull. The dummy should be of docile nature and appropriate size. The tail of dummy should be tied to one side. All the parts of A.V must be thoroughly clean, dry and sterile before being assembled.

Steps in semen collection

- Secure dummy in a service crate and tie its tail to one side
- Collector should stand on right side of the dummy
- Prior teasing of bulls e.g. showing to other mounting bulls, restraining for few

minutes prior to collection and allowing mounting and then forcing to dismount helps in obtaining complete ejaculate.

- Again allow the bull to mount. Direct the penis in the A.V. Left hand of the collector may be used to direct the penis in A.V. by putting the left palm under the sheath.
- The bull donates semen with a thrust. The A.V. is kept on the penis while the bull is dismounting after thrust.
- After semen collection, the A.V. is held vertically to allow the semen to drain completely into the semen collection tube.
- The semen collection tube is withdrawn from A.V. This is kept well protected from light and temperature. It is marked for identification, corked or covered and is put in a water bath at 35-37 °C.

For proper thrust and ejaculatory reflex, it is important that the proper temperature and pressure should be maintained in the artificial vagina along with proper lubrication. The bulls may refuse semen ejaculation in an A.V which is either too hot or too cold. The bulls donate semen at 39-41 °C depending upon the liking of the bull. Temperature above 45° C may kill sperms and also the bulls may refuse to serve at higher temperatures. Very low temperatures may also fail to induce ejaculatory response. Sterilized and neutral Vaseline is nontoxic to spermatozoa and is used for lubrications. Care should be taken to use lubrication to its minimum so as to avoid trickling down of the lubricants in the semen collection tube. The first 7-8cm opening of the A.V. should be lightly lubricated for easy introduction of the penis. Proper pressure of the A.V is also important to stimulate ejaculatory response.

7.2 Evaluation and Examination Of Semen Quality

The semen examination is of great diagnostic value in determining the cause, severity and the degree of the pathological conditions of the testes and other genital organs. The quality of semen is also value in predicting fertility of the male. Semen quality remains almost constant for different ejaculates over months or even years in bulls. There are several parameters to evaluate the semen quality. A single test is never sufficient to assess the semen quality and the examiner should be acquainted

with several tests to evaluate the semen. The semen should be examined within a shortest possible period after ejaculation and the ejaculate must be properly protected and handled until examination.

The different tests for semen quality are:

1. Appearance
2. Color
3. Volume
4. Mass motility
5. Individual motility
6. Hydrogen ion concentration (pH)
7. Concentration or density of spermatozoa
8. Live spermatozoa percentage
9. Sperm abnormalities
10. Other tests e.g. Catalase test, Resistance to cold shock, Millovanov's resistance test (R-test), Methylene blue reduction test, Resazurin reduction test, fructolysis index and Oxygen utilization test etc.

Appearance

Translucent samples contain few spermatozoa. Uniform and opaque appearance of the ejaculate is indicative of high spermatozoa. Semen with curdy appearance indicates reproductive infections.

Color

The color of the bull semen is milky or creamy white. In some bulls the color of semen may be light yellow owing to the presence of a harmless pigment "Riboflavin" secreted by the accessory glands and it is of no significance. The appearance and color of the semen have correlation with spermatozoa concentration in the semen samples.

S.No.	appearance and Color	Sperm density
1.	Creamy	1.0-1.2 millions/mm ³
2.	thin milky	0.5-0.6 millions/mm ³

3.	Watery	< 0.3 millions/mm ³
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Bull with orchitis may donate semen of brownish color because of blood pigment. Dark red or bloody semen is indicative of blood which may come from tubular genital tract. The presence of *Pseudomonas aeruginosa* organisms may change the semen color from normal to yellowish green especially if the samples are left at room temperature. Clots or flakes in the semen may be due to the pus that may come from tubular tract or accessory glands.

Volume

Under usual breeding conditions (without any stress) the semen volume in bull does not change much. The semen volume is generally less in young and small size bulls, excessively used bulls, during incomplete ejaculation and in bulls with seminal vesiculitis. Teasing increases the ejaculate volume. If the low ejaculate volume is accompanied by low spermatozoa concentration, the number of the sperm available would also be low and hence would minimize the use of semen. In bulls the average ejaculate volume is 3-5 ml.

Mass motility

The sperm motility at the time of collection is used as a measure to assess the fertilizing capacity of the semen. It indicates both the sperm concentration and their viability. The epididymal spermatozoa gain motility during the course of ejaculation when they come in contact with the secretions of accessory sex glands. All the motile spermatozoa are live but all the immotile spermatozoa are not dead. The first ejaculate after a period of long sexual rest has poor motility as well as high percentage of dead spermatozoa. The mass motility is influenced by season also. Spring is supposed to be the best season for motility followed by summer. Care should be taken to protect the semen sample from cold shock that markedly depresses the spermatozoa motility. Excessive heat, contamination with chemicals, uncleaned and dirty glass wares and contamination with dust etc. also reduce the motility. As a result of sperm motility the whole mass of semen is brought under movement and waves/swirls are created which are readily observed under the microscope. For judging mass motility of the spermatozoa, a drop of freshly collected semen is spread uniformly over clean grease free and dry slide maintained

at 30-35⁰ C and is examined under low power of the microscope with facility of electrically heated stage to maintain the temperature.

The following descriptive quality and numerical scales are assigned to different waves/swirls motion as observed under the microscope.

S. No.	Findings under microscope	descriptive value	numerical scale
1.	Extremely rapid waves and eddies. it is difficult to trace the origin and disappearance of the waves. This indicates that nearly 100% of the spermatozoa are motile.	excellent	5
2.	The waves and eddies are comparatively not so rapid. The swirls are observed to move towards the extremities. This indicates that about 90% of the spermatozoa are motile.	Good	4
3.	The waves and eddies are slowly moving and are scattered in the field. This indicates that 50-80% of the spermatozoa are progressively motile.	fair	3
4.	The waves and eddies are absent. Movement of spermatozoa is observed. This indicates that nearly 40% of the spermatozoa are in progressive motion. Other sperms may have oscillating or circular movements.	poor	2
5.	No waves and eddies are observed. Only stationary and throbbing movements are observed. This indicates that only upto 20% of the spermatozoa may have progressive movements.	very poor	1
6.	spermatozoa are non motile	all dead	0

Individual motility

The estimate of initial mass motility is not a very precise method. So, the individual spermatozoa are observed under the microscope to estimate the total percentage of

motile sperm cells in the ejaculate. For the estimation of individual spermatozoa motility, the semen is diluted (about 1:100 dilution) in normal saline solution or Ringer's solution. One drop of the diluted semen is put on a clean and dry slide and is covered by cover slip. The slide is examined under high power in a microscope having warm stage facility. The following types of motility may be observed in the spermatozoa.

- spermatozoa moving very rapidly in the straight forward direction,
- spermatozoa moving in forward circular motion because of defects of middle piece and tail.
- spermatozoa moving in reverse circling motion.
- spermatozoa showing oscillatory movements and jerks without change of place.

The individual motility rating is done as below:

S.No.	Progressive motility	Descriptive value
1.	80-100%	excellent
2.	60-80%	Good
3.	40-60%	Fair
4.	20-40%	poor
5.	0-20%	very poor

Hydrogen ion concentration (pH)

The pH value of the semen changes depending upon the concentration and the activity of the spermatozoa. The pH of the bull semen is 6.9 (range 6.4 to 7.5). The pH of the semen is generally 7.0 or higher in excessively used bulls, incomplete ejaculates and in pathological conditions of testes, epididymis, ampullae and the seminal vesicles.

Concentration or density of spermatozoa

The spermatozoa concentration in the bull semen may vary from 0.3 to 2.5 millions/mm³ (average 1.2 millions/mm³). The ejaculates collected by electro-ejaculation have more volume and less density because of excess fluid secreted by accessory sex glands. A rapid decrease in spermatozoa concentration following

successive ejaculates is indicative of poor spermatozoa reserve. The bull having spermatozoa concentration below 0.1 million/mm³ are generally infertile/sterile. The concentration of the spermatozoa may be determined by the following methods:

- a. Macroscopic examination using appearance of color and consistency
- b. Haemocytometer method
- c. Photoelectric colorimeter method

Macroscopic examination

By visual examination, the estimation of the sperm concentration may be done fairly satisfactorily in samples of high sperm density but in low sperm density semen samples, this method may lead to serious errors. The visual characteristics of bull semen corresponding to spermatozoa density are as below:

visual characteristics	sperm concentration
Creamy	2.0 millions/mm ³ and above
light creamy	1.0 millions/mm ³
Milky	0.5 millions/mm ³
cloudy-watery	0.1 millions/mm ³
almost clear and watery	<0.1 millions/mm ³

Haemocytometer method

For measuring the concentration (density) of spermatozoa in the semen sample, haemocytometer may be used in a manner similar to that used for making red blood cell count in blood. The Neubauer's slide of the haemocytometer has two counting chambers. Each RBC chamber (primary square) is divided into 25 (5×5) secondary squares. Each secondary square is further divided into 16(4×4) tertiary squares. thus each primary square is into 400 (25×16) tertiary squares. These total 400 tertiary squares measures a total area of 1mm². When a drop is placed under the cover slip in a Neubauer blood cell counting chamber, the thickness of the film is 0.1 mm. thus the total volume of the semen covering 400 tertiary square of 0.1mm³. The semen is diluted at the rate of 1:200 in RBC pipette in the diluting medium. However for convenience a higher dilution rate (1:1000) is generally preferred.

Methods

Preparation of diluting fluid

Dissolve 0.05 gm of Eosin-y (water soluble) and 1.0 gm of Sodium Chloride in 100 ml distilled water. Eosin may also be dissolved in 100 ml formal saline (1 ml of formalin added to 99 ml of normal saline). Formalin kills the spermatozoa and thus the counting is done conveniently.

The diluting fluid of following composition may also be used:

Eosine y solution	4ml
Distilled water	100 ml
Saturated NaCl solution	2ml

Steps

- take 0.1 ml of the well mixed semen
- add to it 9.9 ml of the diluting fluid and mix well (now the dilution is 1:100)
- take 1 ml of the above diluted semen and add to it 9 ml of diluting fluid (now the dilution is 1:1000)
- Place a drop of diluted semen (1:1000 dilution) under the coverslip in a Neubauer blood cell counting chamber. Avoid over flowing. Allow it to settle.
- Examine under high power objective of the microscope.
- Count spermatozoa in 80 tertiary squares.

Calculation

Let no. of sperms counted in 80 tertiary squares	= 20
No. of sperms in 80 tertiary squares	= 20
No. of sperms in 400 tertiary squares	= 100
No. of sperms in 0.1 mm ³ of diluted semen	= 100

Dilution rate is (1:1000)

No. of sperms in 0.1 mm³ of undiluted semen = 100,000

No. of sperms in 1 mm³ of undiluted semen = 1,000,000

So concentration is 1,000,000/mm³ or 1,000,000,000/ml or 1000 × 10⁶/ml

The same results would be obtained using the formula

$$\text{Sperm concentration} = \frac{N \times D \times 4000}{n} \text{ per mm}^3$$

where N= number of spermatozoa counted (here 20)

D= dilution rate (here 1000)

n= number of tertiary squares counted (here 80)

$$\text{Sperm concentration} = \frac{N \times D \times 4000}{n} \text{ per mm}^3 = \frac{20 \times 1000 \times 4000}{80} = 1,000,000/\text{mm}^3$$

Photoelectric colorimeter method

It is a rapid method for the estimation of sperm concentration in semen sample. The method is based on principle that semen samples with varying spermatozoa concentration absorb varying amount of light. The estimation of spermatozoa concentration using colorimetric method is likely to be erroneous when the semen samples have epithelial cells and other particles in higher concentration.

Various dilutions of the semen are prepared in 3% Sodium Citrate dihydrate solution and the number of spermatozoa are standardized in varying dilutions with the help of haemocytometer

Method

- check the instrument.
- use preferably red filter (light wave length of 625 nm)
- adjust zero using blank solution (3 % Sod. citrate dihydrate solution)
- take reading using 0.1 ml of semen of various dilutions (of which the sperm concentration has been assessed with haemocytometer) and 9.9 ml of 3% Sod. citrate dihydrate solution.
- plot a graph between photoelectric colorimeter reading and the spermatozoa concentrations. With the help of the graph so prepared, further samples are very easily and rapidly estimated for the concentrations of the spermatozoa.
- for unknown sample 0.1 ml of semen is added to 9.9 ml of 3% Sod. citrate dihydrate solution and reading of the colorimeter is recorded after adjusting

zero with blank solution.

- record concentrations with the help of the graph already prepared.

Live spermatozoa

Differential staining techniques is used for counting live and dead spermatozoa in the semen smears. The Eosin-Nigrosin stain is prepared as below:

Eosin-y (water soluble)	1.67 gm
Nigrosin (water soluble)	10.00 gm
Glass dist. water	100 ml

Eosin stains the dead spermatozoa as pink or red. The live spermatozoa which are alive at the time of staining remain colorless. Live spermatozoa are impermeable to the Eosin stain. Nigrosin provides a blue-black background.

Method

- put 5-6 drops of Eosin-Nigrosin stain on a clean slide.
- add a drop of semen to the stain and mix gently with the help of a glass rod or platinum loop.
- after a rest of about 1 min., draw a smear on a clean, grease free slide.
- dry in air and examine under microscope.

Sperm abnormalities

The recognition of defective spermatozoa in stained smears provides useful information. The bulls fertility depends upon morphologically normal spermatozoa present in the ejaculate. The fertility is hardly affected if the abnormal spermatozoa do not exceed 15-20%. However above 30-35% of total abnormalities are not suited to achieve good fertility. The normal spermatozoa consist of head, neck, middle piece and tail.

The spermatozoa have mainly three types of abnormalities. They are:

- a. Primary abnormalities: are those that occur due to disorders of the seminiferous or germinal epithelium. These include microcephalic head, macrocephalic head, elongated narrow head, short broad head, pyriform head, double head, double middle piece and tail, abnormalities of the form of

middle piece (e.g. swelling), abaxially attached middle piece, highly coiled middle piece and tail.

- b. Secondary abnormalities: are those that occur after the sperms have left the germinal epithelium during their passage through the efferent ducts, epididymis and vas deferens. These include detached normal heads, proximal and distal protoplasmic droplets, spermatozoa with bent tail, detached and loosened galea tail.
- c. Tertiary abnormalities are due to damage to the spermatozoa during or after ejaculation or during handling because of excessive agitation, overheating, too rapid cooling, presence of water and urine etc.

In general, when in the semen sample, the percentage of primary and secondary abnormalities are high, the bulls fertility potential is low.

Other tests for semen

1. Catalase test: the test is not routinely carried out. This test may be carried out to detect increase in the catalase enzyme in the presence of pus and blood and the bacterial contamination in the semen.
2. Resistance to cold shock
This test is useful to test semen samples for varying degree of resistance of spermatozoa against cold shock. It may be likely that the semen having more spermatozoa with resistance against cold shock live longer when preserved and may predict high fertility.

Method

- take small quantity (0.25 to 0.5 ml) of undiluted semen in a small tube.
- immerse the tube in crushed ice (sudden change of temperature from 37⁰C to 0⁰C) and keep it for 10 minutes.
- remove the tube and thaw at 30⁰C.
- prepare slide

Milovanov's Resistance Test (R-Test)

This test shows the ability of the spermatozoa to withstand 1% sodium chloride solution.

Method:

- take 0.02ml of freshly collected semen in 200 ml capacity flask.
- add 10 ml of 1% sodium chloride solution in several steps and after each addition examine a drop of mixture under microscope till progressive motility of all the spermatozoa is ceased.
- calculate R-value (Resistance) as below:

$$\text{R-value} = \frac{\text{ml. of sod. chloride solution required to cease the progressive motility}}{0.02}$$

good quality semen would have R-value not less than 5000 i.e progressive motility would cease after adding more than 100 ml of 1% sodium chloride solution.

methylene blue reduction test

It is a very simple test to study the metabolic activity of the spermatozoa. As a result of metabolic activity of the spermatozoa in the semen, hydrogen ions are liberated under anaerobic condition. These hydrogen ions are transferred to methylene blue and the methylene blue is reduced to leuco methylene blue which is colorless. More are the number of the hydrogen ions liberated, less is the time taken by methylene blue for reduction and to change its blue color. The reduction time is directly related to the motility and the concentration of the spermatozoa in the semen sample.

Method:

- Add 0.2 ml of freshly collected semen in a small test tube containing 0.8 ml EYC (Egg Yolk Citrate) dilutor.
- add 0.1 ml of methylene blue solution in the above diluted semen and mix the contents (to prepare methylene blue solution, 50 mg of methylene blue is dissolved in 100 ml of 3% Sod. citrate dihydrate solution).
- Seal the mixture by covering it with a 1 to 1.5 cm. thick layer of liquid paraffin or mineral oil to ensure anaerobic condition.
- Place the tube containing the mixture in a water bath at 46.5⁰ C.
- Note the time taken for the disappearance of the blue color.

A good quality semen would reduce the methylene blue in only 3-5 minutes. Average samples, would require about 9 minutes and poor samples would require > 9 minutes.

Resazurin Reduction Test

Like methylene blue reduction test, Resazurin reduction test is also employed to evaluate the metabolic activity of semen based on the dehydrogenase activity of the spermatozoa. As a result of dehydrogenase enzyme activity in the sperm cells hydrogen ions are liberated which reduces Resazurin. Resazurin upon reduction undergoes a series of colour changes. Resazurin (blue) is first reduced to resurufin (pink) and finally to hydroresurufin (colorless).

Method:

- Add 0.2 ml of freshly collected undiluted semen in a small test tube.
- Add 0.1 ml of Resazurin solution in the above undiluted semen and mix the contents (to prepare resazurin solution 5.5 mg of resazurin is dissolved in 100 ml distilled water).
- Cover the mixture with 1 cm thick layer of liquid paraffin or mineral oil to ensure anaerobic condition.
- Incubate the contents at 45⁰ C.
- Look for change in color i.e. blue to purple and from purple to colorless.

In good samples colour changes from:

blue to pink or purple 1 minute

pink to colourless 3-4 minute

The average samples would take a time of about 5 minutes for second end point.

Fructolysis Index

It is described as the amount of fructose (mg) utilized by 10⁹ spermatozoa in 1 hour at 37⁰ C. Fructolysis has a direct correlation with the metabolic activity of the spermatozoa. This test is not a rapid test and is not of much practical value in routine semen evaluation work.

Oxygen utilization test

Oxygen is utilized for the oxidation of substrates outside the cell wall (exogenous respiration) and also for the oxidation of intracellular material (endogenous respiration). The measurement of oxygen uptake is related to the biochemical changes taking place in whole semen. If the spermatozoa are very active, they utilize more oxygen per unit of time, this test alone is not a dependable test for fertility and is not a test of routine practical value.

Tests for the examination of specific infectious diseases

The venereal or semen borne diseases has a special concern in the examination for breeding soundness of bulls. The bulls should be tested periodically against Brucellosis, Campylobacteriosis, Leptospirosis, Trichomoniasis, Tuberculosis and Johne's disease (Paratuberculosis).

7.3 DILUTION OF SEMEN

The semen dilution is done basically with the following objectives:

- To increase number of services of the female from one ejaculate of the male
- To maintain the viability of the sperms during storage period

The semen is extended to such an appropriate volume so that each inseminating dose of semen contains sufficient number of motile spermatozoa needed for optimum fertility. The volume and the number of the spermatozoa needed per dose of insemination in different species are given below:

Dose	Frozen semen	Liquid Semen	Dose	Frozen semen	Liquid Semen	Dose
	Ampoules (cattle)	Straws (Cattle)	Cattle	Sheep	Swine	Horse
Volume (ml)	1	0.25-0.5	1	0.2	50	30-50
No. of motile Spermatozoa(millions)	15	15	10	50	2000	500

The following should be ensured before dilution

- All glasswares and other articles used for working should be sterilized.
- Semen and the dilutor are maintained at equal temperature

Example for semen dilution for EYC dilutor (liquid Semen)

Let

Volume of ejaculate= 4 ml

Density/ml= 1200×10^6

Motile spermatozoa 70%

Calculation for dilution

1ml of semen contains $\frac{1200 \times 10^6 \times 70}{100} = 840 \times 10^6$ motile sperms

The required dose of liquid semen as 1 ml and the number of the motile sperms required is 10×10^6 per insemination

Hence, the dilution rate is $\frac{840 \times 10^6}{10 \times 10^6} = 84$

Hence 4ml of the semen may be diluted to $(4 \times 84 \text{ml}) = 336 \text{ml}$

When such a high number of doses are not required for inseminating the cows, the dilution rate may be reduced.

The liquid semen should be stored in sterilized glass vials or tubes. The vials/tubes should be filled completely to leave minimum possible space for air. The presence of air causes more jolts during transportation. The processed semen should be protected from sudden cooling and cold shocks. The semen vials/tubes should be labeled properly for identity e.g.

- Name, number and breed of the bull
- Dilutor and dilution rate
- Date of semen collection

7.4 Preservation of Semen

For diluting semen, the following precautions should be taken

- Dilutors should be prepared aseptically with analytical grade chemicals
- Pure substances and clean and sterilized equipments should be used
- Handling of semen should be done carefully to avoid cold shock, overheating

and contamination with urine, dust and water, exposure to direct sunlight and excessive agitation etc.

The basic pre-requisites of satisfactory diluents for semen preservation are

- Maintaining proper osmotic pressure of approximately 300 milli-osmoles (which is equivalent to blood, semen and milk)
- Provision for buffering substances to maintain a nearly neutral pH.
- Provision for nutrients for both aerobic and anaerobic metabolic processes.
- Provision for protection against cold shock (e.g. Lecithinin egg yolk, phospholipids in milk and glycerol in deep freezing).
- Antibiotics to cover broad range of bacteria.

7.5 Transportation, Handling and Distribution Of Semen

Storage

Some common precautions in the storage of diluted semen are:

1. Protection from cold shock
2. Protection from contamination by water, urine and chemicals
3. Protection from excessive jerks and agitation
4. Protection from exposure to air
5. Protection from exposure to direct sunlight

Storage of semen at room temperature (ambient temperature)

The semen at ambient temperature should be stored in 1ml ampoules or vials i.e. each ampoule/vial should contain only one insemination dose. The ampoule/vial should be completely filled with semen and as little air space as possible should be left in ampoule/vial. The ampoule/vial should be wrapped in cotton and then put in paper bag. Exposure to light should be avoided. The semen packets may be put in wooden boxes for transportation.

Storage of semen at refrigeration temperature (5°C)

The glassware containing semen should be well cleaned and sterilized. The tube containing extended semen should be put in a beaker or jar containing clean water at room temperature and both should be kept at the bottom (not top) of the

refrigerator to cool slowly. The semen tube should be properly covered with aluminum foil or screw cap. During use, the extended semen should be taken out for minimum possible period and should always be protected from thermal shock, agitation and exposure to light.

Storage of deep freezed semen in liquid nitrogen

The frozen semen is stored always dipped in liquid nitrogen. It is also necessary that liquid nitrogen container should not be damaged. The room of storing liquid nitrogen containers (containing frozen semen) should be properly ventilated and cool. The liquid nitrogen containers should always remain loaded with cap except during taking out or putting in frozen semen or during pouring of liquid nitrogen. The number as well as length of exposure of frozen semen outside liquid nitrogen should be kept as minimum as possible. The level of the liquid nitrogen should be regularly checked.

Transportation

The semen in ambient temperature dilutors is generally packed in 1ml dose (single inseminating dose). The vials should be wrapped in cotton and then put in a paper bag. Such paper bag may be put in wooden box having inner layer made up of thermocol. In this container the semen may be dispatched to places of need. The containers may be labeled as:

- Living biological products
- Rush it

The tube containing chilled diluted semen may be transported through cycle, motorcycle, bus or train. Whatever may be the mode of transportation, it should always be kept in mind that:

- Moisture should not enter the tube.
- Semen tube/vial should be prevented from breaking
- Jerks should be minimized to their maximum.
- The semen tube should not come in close contact with ice.

The transportation of the chilled liquid semen may be done either in thermos flask or insulated cartons. In thermos, there should be a layer of crushed ice at the

bottom and then a good layer of cotton/wool. Then the tube containing chilled semen may be put. It should be noted that refrigeration temperature dilutors work well at 4-5⁰C. The ice (0⁰C temperature) would kill sperms in refrigeration temperature dilutors. Hence it is necessary to ensure that the semen tube does not come in direct contact with ice. Also, the semen tubes should be water tight. For shipping chilled liquid semen in cartons, the water tight semen tubes are wrapped in paper and are put in double insulating bag (may be rubber bag). The arrangement is such that moisture is absorbed by the paper, breaking of the semen tube is prevented and too close contact of semen with ice is avoided. Both the semen tube is insulated cover and ice bag in insulated cover is put in cartoons. The semen tubes are kept in cartoons in straight up right position. The shipping carton is labeled as:

- Living biological product.
- Handle with care
- this side up
- Rush it.

The frozen semen is transported capped in liquid nitrogen. The main precautions in the transportation of frozen semen are:

- It should be ensured that the level of liquid nitrogen does not goes down and the semen straws/ampoules remain dipped in liquid nitrogen.
- Liquid nitrogen containers should also be protected from damage during transportation. For safety, liquid nitrogen containers may be put in tin boxes having hole at top. This would also protect the vacuum seal of the liquid nitrogen container. The use of rubber cotton pads and rubber belts greatly aid in preventing damage to the liquid nitrogen containers.
- Frictional damages to the liquid nitrogen containers should be avoided. Liquid nitrogen containers should either be lifted by attendants or trolley with wheels should be used. Liquid nitrogen containers should not be slipped against the ground with friction.
- Undesired material should not be put in the liquid nitrogen containers.
- Transportation with public vehicles should be avoided. It may lead to serious consequences

- The consignee should be well informed about details of semen, date of dispatch and mode of transportation etc.
- The container should be labeled as:
 - Living biological products.
 - Handle with care.
 - Rush it
 - This side up

Learning Process and Support Material

- a. Guided by teaching material
- b. Demonstration method
- c. Observation method

Allow the students to collect semen by using different methods and allow to perform evaluation, dilution, preservation of semen.

Materials Required

- Semen straw
- Microscope
- lubricants, gloves, cotton, Paper bag, syringe
- dummy animal
- Artificial Vagina
- Travis
- Semen collecting tube, Slide, Cover slip
- Haemocytometer
- Methylene blue, Sodium chloride, Ringer's solution, Eosine
- Distilled water, Saline
- Water bath
- Refreigerator

Assessment

1. Write down about objectives of semen dilution.(1)
2. List the name of different teste for semen quality and described about the

color of semen. (4)

3. Write down about methods of semen collection. (8)

Glossary

- Eddies: a circular movement of water causing a small whirlpool
- Stationary: not moving or not intended to be moved
- Colorimeter: an instrument for measuring the intensity of colour
- Haemocytometer: an instrument for visual counting of the number of cells in a blood sample or other fluid under a microscope
- Pyriform: pear shaped
- Microcephali: a medical condition in which the brain does not develop properly resulting in a smaller than normal head
- Macrocephalic: being or having a head with a large cranial capacity

UNIT: 8

ARTIFICIAL INSEMINATION (A.I)

Objectives

On completion of this chapter, the students will be able to know about:

- Techniques of A.I
- Time of insemination
- Advantages and disadvantages of A.I

8.1 Introduction

Artificial insemination is the technique of collection, evaluation and processing of semen of male animals, the transfer of semen at suitable time and appropriate site of female genitalia by artificial means with the objectives of successful fertilization, embryonic growth, fetal development and birth of viable offspring.

8.2 Techniques of AI

Per rectal method

- In cattle it is the safe and the best method of insemination.
- Cow which is in heat is well controlled placing it in a travis.
- The inseminator will get ready by wearing a plastic apron, gumboots and gloves.
- The semen straw after thawing (keeping the semen straw in warm water for a minute to convert the freezed semen into liquid and the sperms become motile) is loaded in a sterilized A.I gun covered with a plastic sheath.
- The inseminator will insert the gloved left hand into the rectum after applying the soap or other lubricant on the glove and the animal is back racked, and the hand is further inserted the cervix is held through rectal wall.
- The A.I gun loaded with semen straw is passed through the vulva to vagina and cervix and observed with the hand in rectum that the A.I gun reaches the cervix, then the semen is deposited by injecting the gun. After depositing the semen the gun is removed and the empty straw and sheath are discarded.

Vaginal Speculum Method

In this method, speculum is placed in the vagina of the cow, which provides passage outside to the site of insemination, then inseminating tube is passed through the speculum and semen is deposited at the cervix.

8.3 Time of Insemination

Ovulation occurs 25 to 32 hours after the onset of standing heat. Standing behavior is the only reliable symptom which determines the time of ovulation.

Sperm has to be in the female reproductive tract for approximately six hours before they are capable of fertilizing the egg. This process is termed capacitation. Although live sperm has been found in the female tract up to 48 hours after insemination, sperm viability usually is estimated to be 18 to 24 hours. Improper semen handling or poor insemination technique can dramatically reduce the number of sperm cells available for fertilization and thus can lower the conception rate.

The egg travels very rapidly from the ovulation site to the fertilization site in the oviduct. The fertile life of the egg is shorter than that of the sperm. Ovulated eggs remain fertilizable longer (10-20 hours) than they remain capable of being fertilized and developing into normal embryos (8-10 hours). The likelihood of embryonic death increases as the time beyond this interval increases. Thus viable sperm should be at the site of fertilization awaiting the arrival of the freshly ovulated egg. Breeding either too early or too late allows an aged sperm or an aged egg to interact at the site of fertilization and will result in poor conception. Events and time intervals associated with standing heat and insemination are summarized in Figure 3.

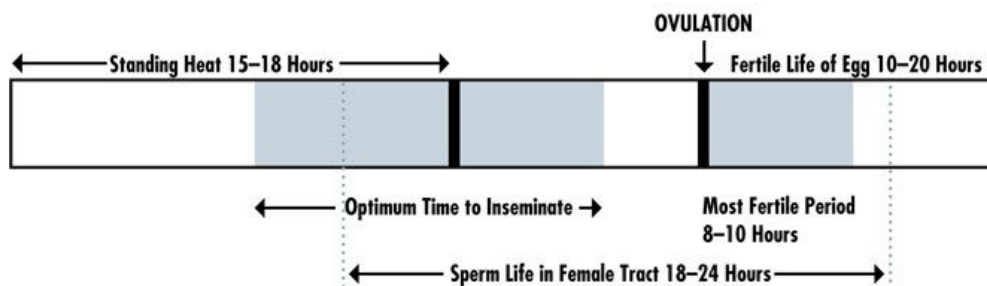


Figure 3. Average time relationships among reproductive events.

Cattle should be inseminated during the last half of standing heat. The a.m.-p.m. rule was developed as a guide. Cows first seen in standing heat in the morning (a.m.) would be inseminated in the afternoon (p.m.) and those observed standing in the evening would be bred the next morning. This system was based on research in which cows were observed frequently (4 to 12 times per day), allowed to interact, and exhibited mounting/standing behavior. Furthermore, insemination was based on standing heat, not secondary signs. Under such conditions, heat detection was very good. But herd managers may not be in a position to accurately predict the latter half of the heat period. Generally it is a challenge just to detect standing behavior. Knowing when to inseminate is another management challenge.

More recent studies conducted by artificial insemination organizations and universities reexamined timing of insemination. In a Virginia study with twice daily heat checks, cows were inseminated either at the end of the heat check period in which they were first observed in heat or at the end of the next heat check period. Using a routine 8:00 a.m. and 8:00 p.m. heat detection system, waiting 12 hours to inseminate resulted in a slight numerical advantage in pregnancy rate over inseminating immediately after heat was first observed (55% vs. 51%). However, this was not a significant difference. Thirty percent of the cows stood to be mounted at the 12-hour heat check after they were first observed in standing heat. These cows had higher pregnancy rates than their herdmates, whether they were inseminated immediately after being first observed in heat or 12 hours later.

Applying this information to a herd situation suggests the following guidelines:

- Best fertility is obtained when cattle are inseminated during the last half of standing heat.
- If a management schedule permits routine heat checks and if it can determine when a heat began and thus predict the latter portion of the heat, the A.M.-P.M. system should be used.
- If the conception rate is unsatisfactory or heat detection is not routine, cows should be inseminated soon after they are first detected in standing heat. Waiting 10 or 12 hours probably results in most of the cows being bred too late.

- Remember, factors other than timing of insemination can affect the conception rate.

8.4 Advantages and Disadvantages of A.I

Advantages of A.I.

1. Maximum utilization of Sire

Several insemination doses are prepared from one ejaculate and thus proven sires are utilized to their maximum. Through the use of A.I., a single bull in its life time may easily cover up to 1 lakh female cattle.

2. Economical technique for selecting sire for breeding purpose

In A.I programmes only selected bulls are kept for breeding purpose. This reduces work load and expenditure on bulls.

3. Genetic improvement in the herd

The use of selected proven sires through A.I brings about genetic improvement in the herd.

4. Better safety

Since only selected bulls are kept in A.I programmes, the dangers are minimized. Further since males are not brought to the farm or females, it further leads to better safety.

5. Reduced the risk of spreading sexually transmitted diseases

Bulls kept for A.I purpose are regularly examined for their general as well as reproductive health. Diseased bulls are either properly treated or culled. This reduces risk of spreading sexually transmitted diseases.

6. Overcoming the different size of two parents

Great variation in the size of male and female partners may prevent natural mating. Cow with either extremely large or extremely small size may be covered through A.I without any difficulty.

7. Overcoming the physical inability

The bulls which are unable to copulate due to physical inability may be utilized in A.I

8. Covering the cows that refuse to mount

Some female which are in good heat, but for some reason or the other refuse to be mounted, may be bred through A.I.

9. Early detection of diseases

Since during semen collection or artificial insemination, the genitalia of both males and females are closely inspected, the genital defects are easily noted, which otherwise may remain undetected for longer period of time.

10. Low transportation cost

Through the export/import of semen, international transportation cost is reduced which otherwise would greatly exceed to actual transportation of the animals.

11. Utilizing the germ plasma of dead cells

The deep freeze semen of the bull, which has died, may be utilized in A.I programme.

12. Essential after estrous synchronization

A.I. is almost essential for inseminating females after synchronization of estrous in large group of animals.

13. Better records

A.I. results in better record keeping.

14. Interesting techniques interests in livestock breeding and also in better livestock management.

A.I. stimulates greater

15. Valuable method for dog breeding under certain condition

In dog, when mating is not possible, either due to timid nature or due to premature erection or due to unacquaintance of partners, A.I techniques may be of great value.

16. Helps in selecting progeny tested proven sires

Because of wide use of extended semen/stored semen, the sire's daughters can be evaluated in more number and in maximum possible period. This is of great help in selecting progeny tested proven sires.

Disadvantages of A.I.

1. Fast spread of genetic abnormalities
2. Genetic abnormalities, if spread, spread at a very fast rate in A.I. programme e.g. cystic ovary, poor conformation and lack of libido etc.
3. Loss of embryo/fetus with improper A.I.
Intrauterine inseminations of pregnant females may result into abortion.
4. Required skilled persons
For operations like semen collection, semen examination, semen extension, semen freezing and insemination, trained persons are required. Inseminators if not, careful would spread infections from animal to animal and from herd to herd.
5. Requiring special facilities
6. Problems of prolapse and dystocia
7. Heavy investment in financial term is essential at very beginning.
8. Breeding efficiency might be compromised if high quality fertile semen is not produced.
9. Injuries at cervix and vagina while inseminating may cause many female infertile or sterile.
10. Chance of contaminating the semen at a number of stage right from collection to insemination.
11. Means of disease transmission

Learning Process and Support Material:

- a. Guided by teaching material
- b. Demonstration method
Demonstrate the A.I method to the students and allow them to perform by themselves.

Materials Required

- Animal to perform A.I
- A.I Gun
- Semen straw

- Liquid nitrogen
- Warm water
- Gloves, apron, gumboot
- Lubricants
- Scissor
- Soap

Assessment

1. Define A.I. (1)
2. Write down the per rectal method of A.I. (4)
3. Write down the advantages and disadvantages of A.I. (8)

Glossary

Conception: the action of conceiving a child or of one being conceived

Evaluation: the making of a judgment about the amount, number, or value of something: assessment

Thawing: the process of ice, snow, or another frozen substance becoming liquid or soft as a result of warming up

Insemination: the introduction of semen into a female animal by natural or artificial means

Libido: Sexual desire

UNIT: 9

BREEDING BEHAVIOUR OF DIFFERENT FARM ANIMALS

Objectives

On completion of this chapter, the students will be able to know about:

- Breeding behaviour of cattle and buffalo
- Breeding behaviour of sheep and goat
- Breeding behaviour of pig

Contents

9.1 Introduction

The animals are mostly social ones and prefer living in herds. In each species there are certain rules for group survival, cohesion, defense and also for propagation. The basic patterns of male sexual behaviour appear to be innate in nature. Calves of both sexes are very often seen exhibiting sexual display during play and mounting is seen most commonly. Bulls reared in complete isolation show normal mating behaviour when exposed to estrous cows. In females, the sexual receptivity is restricted to few hours or days near the estrus phase of the estrus cycle, while in males the sexual receptivity is grossly permanent. The physiological signal for arousal of sexual motivations originate from gonadal steroid balance. In males the androgen secretion is in the form of several peaks within 24 hours reflecting the pulsative release of pituitary gonadotropins. However, the total amount of androgen in males is most constraint practically for day to day. In females the secretions of estrogens are restricted only during few days (follicular phase) of the estrus cycle.

9.2 Breeding Behaviour of cattle and buffalo

The various components of copulatory patterns in male domestic animals are:

1. Sexual arousal
2. Courtship (sexual display)
3. Erection
4. Penile protrusion

5. Mounting
6. Intromission
7. Ejaculation
8. Dismounting
9. Refractoriness

Sexual arousal

The finding of the sexual partner is the first step for sexual arousal and in that all the senses like sight, hearing and collection are important. The senses of sight, hearing and olfaction help estrus females to be attracted towards the males. The stimuli from males greatly influence the females for exhibiting sexual responses.

Courtship (Sexual Display)

The patterns of courtship are simple in domestic animals but species differences do occur. Once attracted to a female partner, the bull tests her receptivity most oftenly by sniffing and licking around the perineal region. These actions indicate chemical communication in between the male and female partners. Sniffing to female's genitalia and urine is very commonly seen in cattle, sheep and goat. Following sniffing to female's genitalia and urine, the male stands rigidly, makes the head in horizontal position with neck extended and the upper lips are curled upward to perform the "Flehmen's reaction". Flehmen's reaction is seen in all species except in swine. Species specific patterns of urination during courtship are noticed in some species. Stallion marks with urine in the place where an estrous mare has urinated. There is rhythmic emission of urine during sexual activity. Urination during sexual excitement has not been observed in cattle and sheep.

Species specific vocalization patterns are also observed in male during courtship. In bulls no vocalization patterns are observed during sexual display.

Nudging (Nudge = to push gently specially to draw attention) and licking of the female external genitalia and perineal region are noticed in cattle, sheep and goat.

Erection and penile protrusion

The penis of bull, ram and boar is fibroelastic and the vascular tissue is much less

and there is varying amount of foreplay in these species. The erection process is predominantly under the control of parasympathetic system. Reflex stimulation from testicles, urethra, prostate or penis and specially the glans penis cause erection. The penis of the sexually active male may erects partially and there may be to and fro penile movements before mounting. During this process dribblings of accessory fluid derived from the cowper's gland may also been seen, especially in bulls. The male rests his chin on female's body and the receptive female respond by standing quietly in order to allow mounting by males.

Mounting

The sexually active male mounts the female. Some initial mounts may be unsuccessful with excretion of dribblings. During this process the movements of bull's hind limbs and contractions of the abdominal muscles align the glans penis both horizontally and vertically to see vulva for penetration. The male mounts, grasp the female by fixing fore legs around female's body. During this process rhythmic pelvic thrusts may be performed.

Intromission

In farm animals one intromission takes places per copulation. At mounting, the male's pelvic region is brought in close apposition to the female's genitalia. The movements of the male help the glans penis to seek vulva. The vulvar heat and moisture are detected by the superficial nerve endings of the glans penis and this sensation is the leading factor for proper intromission. The duration of the intromission varies greatly in between different species. The intromission is instant in bull, ram and goat.

Ejaculation

The process of ejaculation starts from epididymis, travel along ductus deferens and at the same time accessory sex glands contract and their contents are forced into urethra. At ejaculation there is maximum lengthening of the penis so that the semen is ejaculated near os-cervix in case of cattle, sheep and goat. At ejaculation the bull leaps and thrust is very strong. Bulls often coil the penis during ejaculation. The bull at ejaculation presses its head on female's back.

Dismounting

After the ejaculation takes place, the male dismounts and soon the penis is withdrawn into the prepuce. Postcoital reactions are generally not seen in cattle, swine and horse.

Refractoriness

Most of the males would not show sexual interest in females immediately following copulation and this is known as refractoriness. The period of refractoriness varies greatly in between individual males. Repeated and successive copulations greatly increase the period of refractoriness. The period of refractoriness is modified by environmental stimuli e.g. male to female ratio, cyclicity of the female, length of breeding season and social interactions among animals. The pasture mated bulls may perform 30-35 services per day provided a stimulus is adequate.

Signs of estrus in cattle and buffalo

- standing to be mounted by other cows
- attempt to mount other cows
- stringy mucous hanging from vulva
- mucus smeared on buttocks
- increased restlessness
- drop in milk yield
- reduced feed intake
- frequent bellowing
- chin resting on cow's rump by other cow, tail raising
- vulval oedema
- frequent urination

9.3 Breeding Behaviour of Sheep and Goat

The various components of copulatory patterns in male domestic animals are:

1. Sexual arousal
2. Courtship (sexual display)
3. Erection

4. Penile protrusion
5. Mounting
6. Intromission
7. Ejaculation
8. Dismounting
9. Refractoriness

Sexual arousal

The finding of the sexual partner is the first step for sexual arousal and in that all the senses like sight, hearing and smell are important. The senses of sight, hearing and olfaction help estrus females to be attracted towards the males. The stimuli from males greatly influence the females for exhibiting sexual responses.

Courtship (Sexual Display)

The patterns of courtship are simple in domestic animals but species differences do occur. Once attracted to a female partner, the bull tests her receptivity most often by sniffing and licking around the perineal region. These actions indicate chemical communication in between the male and female partners. Sniffing to female's genitalia and urine is very commonly seen in cattle, sheep and goat. Following sniffing to female's genitalia and urine, the male stands rigidly, makes the head in horizontal position with neck extended and the upper lips are curled upward to perform the "Flehmen's reaction". Flehmen's reaction is seen in all species except in swine. there is rhythmic emission of urine during sexual activity. In goats, frequent motion on forelegs is seen during sexual activity. Urination during sexual excitement has not been observed in cattle and sheep.

Species specific vocalization patterns are also observed in male during courtship. Courting bleats are noticed in male sheep and goat.

Nudging (Nudge = to push gently specially to draw attention) and licking of the female external genitalia and perineal region are noticed in cattle, sheep and goat. Nudging of the female through forelegs is commonly seen in sheep and goat.

Erection and penile protrusion

The penis of bull, ram and boar is fibroelastic and the vascular tissue is much less and there is varying amount of foreplay in these species. The erection process is predominantly under the control of parasympathetic system. Reflex stimulation from testicles, urethra, prostate or penis and specially the glans penis cause erection.

The penis of the sexually active male may erects partially and there may be to and fro penile movements before mounting. During this process dribblings of accessory fluid derived from the cowper's gland may also been seen, especially in bulls. The male rests his chin on female's body and the receptive female respond by standing quietly in order to allow mounting by males.

Mounting

The sexually active male mounts the female. Some initial mounts may be unsuccessful with excretion of dribblings. During this process the movements of bull's hind limbs and contractions of the abdominal muscles align the glans penis both horizontally and vertically to see vulva for penetration. The male mounts, grasp to female by fixing fore legs around female's body. During this process rhythmic pelvic thrusts may be performed.

Intromission

In farm animals one intromission takes pces per copulation. At mounting, the male's pelvic region is brought in close apposition to the female's genitalia. The movements of the male help the glans penis to seek vulva. The vulvar heat and moisture are detected by the superficial nerve endings of the glans penis and this sensation is the leading factor for proper intromission. The duration of the intromission varies greatly in between different species. The intromission is instant in bull, ram and goat.

Ejaculation

The process of ejaculation starts from epididymis, travel along ductus deferens and at the same time accessory sex glands contract and their contents are forced into urethra. At ejaculation there is maximum lengthening of the penis so that the semen is ejaculated near os-cervix in case of cattle, sheep and goat. At ejaculation in sheep and goat, the male's head is suddenly moved backward.

Dismounting

After the ejaculation takes place, the male dismounts and soon the penis is withdrawn into the prepuce. Postcoital reaction are seen in goat and sheep. The male goat licks the penis after ejaculation. The male sheep stretches its head and neck after ejaculation.

Refractoriness

Most of the males would not show sexual interest in females immediately following copulation and this is known as refractoriness. The period of refractoriness varies greatly in between individual males. Repeated and successive copulations greatly increase the period of refractoriness. The period of refractoriness is modified by environmental stimuli e.g. male to female ratio, cyclicity of the female, length of breeding season and social interactions among animals. The presentation of new stimuli can revitalize sexual interest in males. Generally, the approach of the male towards the female is selective in nature. The goat, boar and stallion reach exhaustion after smaller number of ejaculations than ram and bull. After long period of sexual rest, a ram may perform upto 50 services on first day but this frequency would greatly reduce on subsequent days.

9.4 Breeding Behaviour of Pig

The various components of copulatory patterns in male domestic animals are:

1. Sexual arousal
2. Courtship (sexual display)
3. Erection
4. Penile protrusion
5. Mounting
6. Intromission
7. Ejaculation
8. Dismounting
9. Refractoriness

Sexual arousal

The finding of the sexual partner is the first step for sexual arousal and in that all the senses like sight, hearing and olfaction are important. The senses of sight, hearing and olfaction help estrus females to be attracted towards the males. The stimuli from males greatly influence the females for exhibiting sexual responses.

Courtship (Sexual Display)

The patterns of courtship are simple in domestic animals but species differences do occur. Once attracted to a female partner, the bull tests her receptivity most oftenly by sniffing and licking around the perineal region. These actions indicate chemical communication in between the male and female partners. Sniffing to females head is commonly seen in swine and horses. Following sniffing to female's genitalia and urine, the male stands rigidly, makes the head in horizontal position with neck extended and the upper lips are curled upward to perform the "Flehmen's reaction". Flehmen's reaction is seen in all species except in swine. There is rhythmic emission of urine during sexual activity.

Species specific vocalization patterns are also observed in male during courtship. Courting grunts are observed in swine.

Nudging (Nudge = to push gently specially to draw attention) through nosing the flank area of the female is observed in swine.

Erection and penile protrusion

The penis of bull, ram and boar is fibroelastic and the vascular tissue is much less and there is varying amount of foreplay in these species. The erection process is predominantly under the control of parasympathetic system. Reflex stimulation from testicles, urethra, prostate or penis and specially the glans penis cause erection.

The penis of the sexually active male may erects partially and there may be to and fro penile movements before mounting. During this process dribblings of accessory fluid derived from the cowper's gland may also been seen, especially in bulls. The male rests his chin on female's body and the receptive female respond by standing quietly in order to allow mounting by males.

Mounting

The sexually active male mounts the female. Some initial mounts may be unsuccessful with excretion of dribblings. During this process the movements of boar's hind limbs and contractions of the abdominal muscles align the glans penis both horizontally and vertically to see vulva for penetration. The male mounts, grasp te female by fixing fore legs around female's body. During this process rhythmic pelvic thrusts may be performed.

Intromission

In farm animals one intromission takes places per copulation. At mounting, the male's pelvic region is brought in close apposition to the female's genitalia. The movements of the male help the glans penis to seek vulva. The vulvar heat and moisture are detected by the superficial nerve endings of the glans penis and this sensation is the leading factor for proper intromission. The duration of the intromission varies greatly in between different species. Boars on average take 5 minutes per mating, however they may maintain intromission upto 20 minutes.

Ejaculation

The process of ejaculation starts from epididymis, travel along ductus deferens and at the same time accessory sex glands contract and their contents are forced into urethra. At ejaculation there is maximum lengthening of the penis so that the semen is ejaculated near cervix and uterus in boars. During ejaculation, the boar remains motionless, however, scrotal contractions are observed. During such period of immobility some thrusts at irregular intervals are seen in boar. Among farm animals, the boar has the longest ejaculation time. Copulation is performed within 3-20 minutes with an average of 4-5 minutes.

Dismounting

After the ejaculation takes place, the male dismounts and soon the penis is withdrawn into the prepuce. Postcoital reaction are generally not seen in cattle, swine and horse.

Refractoriness

Most of the males would not show sexual interest in females immediately following copulation and this is known as refractoriness. The period of refractoriness varies greatly in between individual males. Repeated and successive copulations greatly increase the period of refractoriness. The period of refractoriness is modified by environmental stimuli e.g. male to female ratio, cyclicity of the female, length of breeding season and social interactions among animals. The presentation of new stimuli can revitalize sexual interest in males. Generally, the approach of the male towards the female is selective in nature. The goat, boar and stallion reach exhaustion after smaller number of ejaculation than ram and bull.

Female Pig

Signs of estrus

Behavioral changes occur in the female several days before the onset of oestrus; she becomes nervous and moves about at the slightest disturbance, restlessness, capricious appetite, mounting of other females, and frequent attempts to urinate, particularly in the presence of a boar, are characteristic behavioural signs of estrus. Spontaneous activity reaches about twice the normal level during late estrus.

The vulva begins to enlarge 2-8 days before the onset of heat. It becomes red and a mucous discharge appears.

Immobility reaction

When an estrus female is touched on the back by a boar or by a handler, she assumes a stationary position. Every estrus females assumes this stance more or less quickly when presented to a boar.

Learning Process and Support Material:

- a. Guided by teaching material

Assessment

1. Define refractoriness (1)
2. Write down sign of estrus in female pig. (4)
3. Write down about breeding behaviour of cattle and buffalo. (8)

Glossary

- **Apposition:** the positioning of things side by side or close together
- **Capricious:** sudden, unpredictable changes
- **Dribbling:** fall slowly in drops or a thin stream
- **Thrust:** push suddenly or violently in a specified direction.

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