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**UNIT
05**

Animal Reproduction
Male reproductive System

**SAMPATH
LANKADHEERA**

B.Sc. (Hons), M.Sc.

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SAMPATH LANKADHEERA

Unit
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Biology

Unit - 05

Animal Reproduction

- o Male reproductive system

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THEORY
in English Medium

New Syllabus



**Unit
05**

Animal Reproduction

○ Male reproductive system

Smart Note

SAMPATH LANKADHEERA

B.Sc. Hons. M.Sc. (Biotechnology)

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5.8.0 : Inquires in to the reproductive process in animals

5.8.1 : Inquires into different types of reproduction in animals

Number of Periods : 05

Learning Outcomes:

- briefly describes the reproduction and states the different types of asexual reproduction with examples
- states what is sexual reproduction, bisexuality, uni -sexuality, parthenogenesis, gametogenesis and fertilization
- compares the features of sexual reproduction with features of asexual reproduction
- accepts that reproduction is an important process to ensure the survival of species

Suggested Teaching- Learning Process

- Describe what reproduction is, and discuss asexual and sexual reproduction.
- Briefly describe following methods of asexual reproduction by giving relevant examples.
 1. Budding
 2. Fragmentation
- Explain bisexuality, unisexuality, parthenogenesis, gametogenesis, external and internal fertilization and use relevant examples whenever necessary to explain those terms.
- Guide students to compare asexual reproduction with sexual reproduction and ask them to tabulate the differences.

Assessment and Evaluation

- Assess students' table of comparison on asexual reproduction and sexual reproduction using following criteria.
- Accuracy of information
- Adequacy of information

Reproduction

Modes of reproduction seen among animals

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- **Two modes of reproduction are found among the animals:**
 1. **Asexual reproduction**
 2. **Sexual reproduction.**
- **For the most animals, reproduction is mainly or entirely sexual.**
- **Several forms of asexual reproduction are also seen especially among invertebrates.**

Asexual reproduction

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- **Asexual reproduction relies entirely on mitotic cell division.**
- **Asexual reproduction allows the rapid multiplication of individuals from single parents.**
- **Hence no time or energy is spent in searching the mates for the reproduction.**
- **The produced off spring are genetically identical to each other and to the single parent.**



- Several methods of asexual reproduction are found among invertebrates. They include
 1. Budding,
 2. Fragmentation and Regeneration
 3. Parthenogenesis

Budding:

- Budding is a form of asexual reproduction in which new individuals arise from outgrowths of the animal.
Eg. Hydra – A localized mass of mitotically dividing cells, develops into a small Hydra, which can eventually detach from the parent.

Fragmentation and regeneration:

- This is a form of asexual reproduction which involves breaking of the body or part of the body into several pieces, followed by the growth of a separate individual from each piece.
- Each fragment develops into a complete animal by re-growth of lost body parts (regeneration).
Eg. Certain annelid worms, numerous sponges, cnidarians.

Parthenogenesis:

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- Among invertebrates, parthenogenesis occurs in some animals such as bees, ants, aphids and wasps.
- The progeny can be haploid or diploid.
- In honey bees – males (drones) are fertile haploid adults that develop through parthenogenesis, whereas females including both sterile workers and the fertile queen, are diploid adults that developed from fertilized eggs.
- Parthenogenesis has also been observed very rarely among vertebrates (Eg. Some lizards and fish).

Sexual Reproduction

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- The female gamete, the egg, is large and non-motile, while the male gamete, the sperm, is generally much smaller and motile.
- The fusion of the female and male gametes forms a diploid cell called the zygote.
- The animal that develops mitotically from a zygote can in turn give rise to gametes by meiosis.
- For the most animals, reproduction is mainly or entirely sexual.

Gamete formation:

- In animals, reproductive cells called gametes (sperms and eggs) are the vehicles that transmit genes from one generation to the next.
- Each gamete is a haploid, unicellular reproductive cell. Gametes in animals are formed by meiosis in special organs called gonads.







Bisexual organism and Unisexual organism:

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Eg. Earthworms.

- In unisexual organisms (dioecious), one individual bears either male or female reproductive structures. Therefore production of male or female gametes occurs in separate organisms.
Eg. Humans

Fertilization:

- Union of egg and sperm (gametes) culminating (highest development) in fusion of their nuclei is called fertilization.
- Fertilization can be either external or internal.

External fertilization

- External fertilization occurs in aquatic environments.
- In species with external fertilization, the female releases eggs while the male releases sperm into the external environment and fertilization occurs in the water.
- A moist habitat is almost always required for external fertilization both to prevent the gametes from drying out and to allow the sperm to swim toward the eggs.
Eg. Many invertebrates, amphibians, most bony fish.

Internal fertilization

- In internal fertilization, sperms are deposited in or near the female reproductive tract and fertilization occurs within the female reproductive tract.
Eg. insects, reptiles, mammals.
- Internal fertilization is an adaptation that enables sperm to reach an egg even when the environment is dry.
- The male copulatory organ delivers sperm and the female reproductive tract often has receptacles for storage and delivery of sperm to mature eggs.
- Internal fertilization is typically associated with the production of fewer gametes than external fertilization but results in the survival of a higher fraction of zygotes.
- Internal fertilization often provides greater protection to the embryos.
- Many animals show parental care.
- Internally fertilized eggs of birds and other reptiles possess shells and internal membranes that protect against water loss and physical damage. Some retain the embryo for a portion of any development within the female reproductive tract.

Significance of asexual reproduction and sexual reproduction

- Asexual reproduction and sexual reproduction are important biological processes to ensure existence of a species.
- Asexual reproduction allows rapid multiplication of individuals from single parents. Hence no time or energy is needed to be spent in searching mates for the reproduction.

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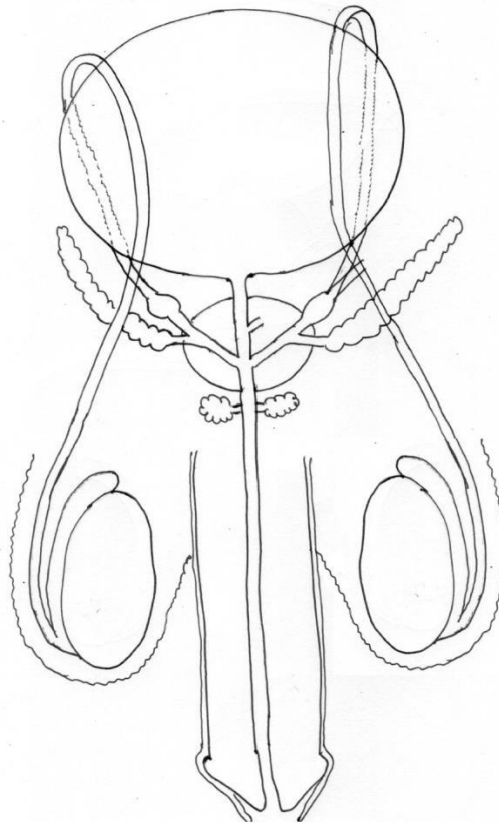


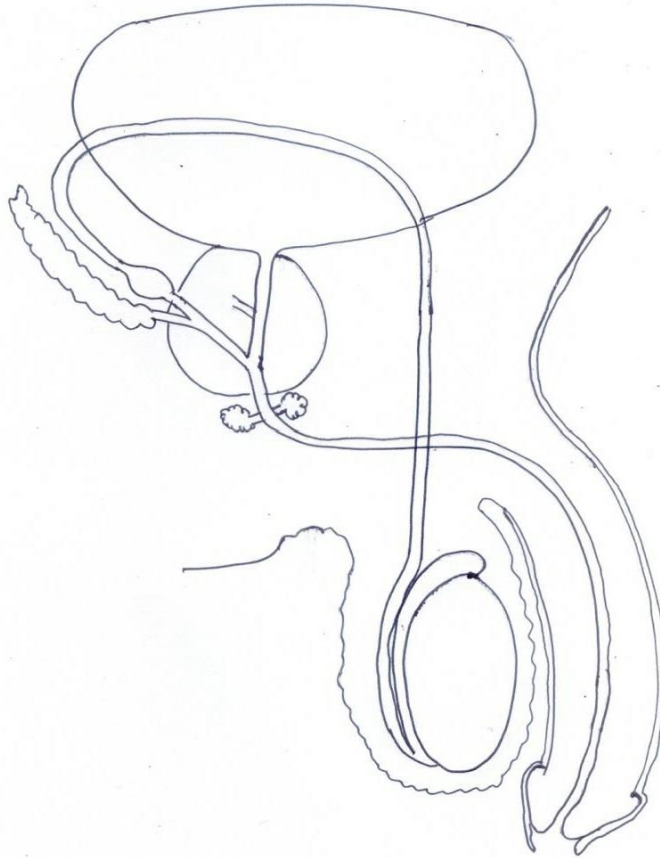
Assessment and Evaluation

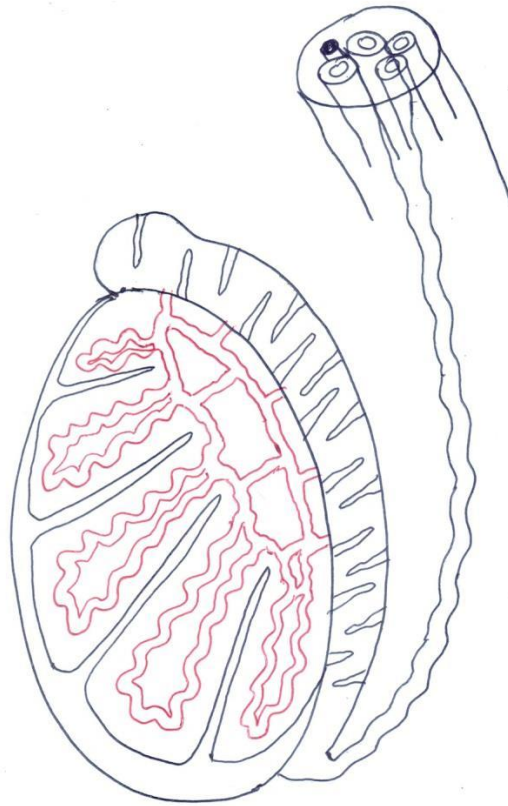
- Asses students' chart on the male reproductive system using following criteria.
 1. Accuracy of information
 2. Relevancy
 3. Attractiveness

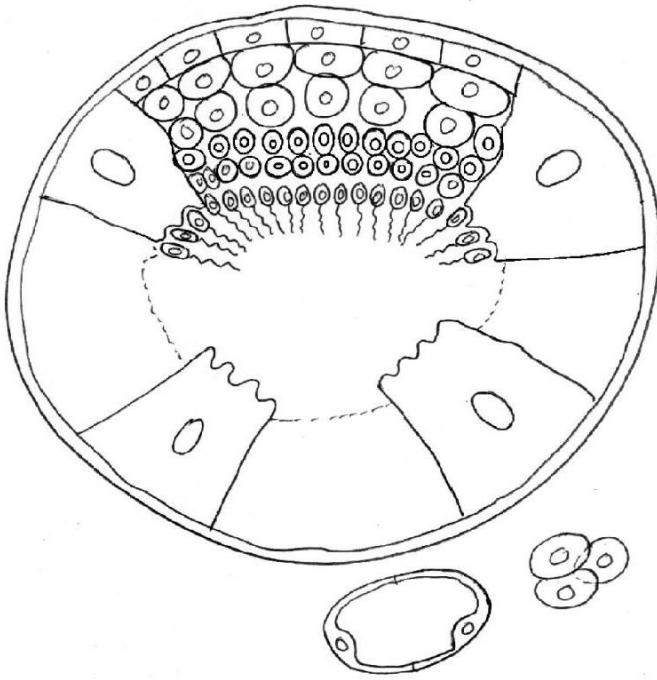
Structure and Function of the Human Male Reproductive System

- **Main internal reproductive structures of a male consist of gonads (testes) which produce sperm and reproductive hormones, epididymis which store mature sperms, accessory glands that secrete products required for sperm movement and ducts that transport the mature sperm and glandular secretions.**
- **The external reproductive organs of a male are the scrotum and penis.**









Scrotum:

- Scrotum is a pouch formed by a fold of the body wall.
- Scrotum is divided into two compartments.
- Each compartment contains one testis, one epididymis and part of the spermatic cords which suspend the testis in the scrotum.

Testes:

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- The testes are cooled by their position outside the abdominal cavity and the thin covering of the scrotum. Each testis contains many lobules.
- Within each lobule there are highly coiled (convoluted) loops called seminiferous tubules.
- Sperms are produced within these tubules.

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- These cells secrete the hormone inhibin and nourish and provide attachment for cells that are in different stages of spermatogenesis.
- Groups of cells called Leydig cells (or interstitial cells) are present in the connective tissue between the seminiferous tubules.
- Leydig cells secrete the hormone testosterone and other androgens after puberty which promote spermatogenesis in the tubules.
- The seminiferous tubules combine to form a single tubule (duct) at the upper part of the testes.

Epididymis:

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- From the seminiferous tubules, the sperm pass into the epididymis.
- Since it is very long (about 6 m in length), it takes about 3 weeks for sperm to travel the length of this duct. During this time the sperms become matured and motile.



- Matured sperms are stored within the epididymis until ejaculation.

Vas deference, ejaculatory duct, urethra and penis:

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- The ejaculatory ducts open into the urethra which is the passageway for both urinary excretion and delivery of sperms in semen into the female reproductive tract.
- The urethra runs through the penis and opens to the outside at the tip of the penis which contains erectile tissues derived from modified veins and capillaries.

Spermatogenesis

- Spermatogenesis is the process of male gamete formation which includes formation of spermatocytes from a spermatogonium, meiotic division of the spermatocytes, and transformation of the four resulting spermatids (from each spermatocyte) into spermatozoa (sperm).
- Spermatogenesis occurs within the seminiferous tubules of the testes.
- The time taken to produce mature sperm cells from a specific spermatogonia in a seminiferous tubule is about seven weeks from start to finish.
- The formation and development of sperms is continuous and inexhaustible in adult human males.
- Cell division and maturation during gametogenesis occur throughout the seminiferous tubules.
- Hundreds of millions of sperm are produced each day by spermatogenesis.
- In contrast to oogenesis (discussed later), in spermatogenesis all four cells produced during meiosis of each spermatocyte develop into mature gametes.
- Spermatogenesis starts at puberty and occurs throughout life.
- Spermatogenesis produces mature sperms from precursor cells in a continuous sequence.

Main steps in Spermatogenesis

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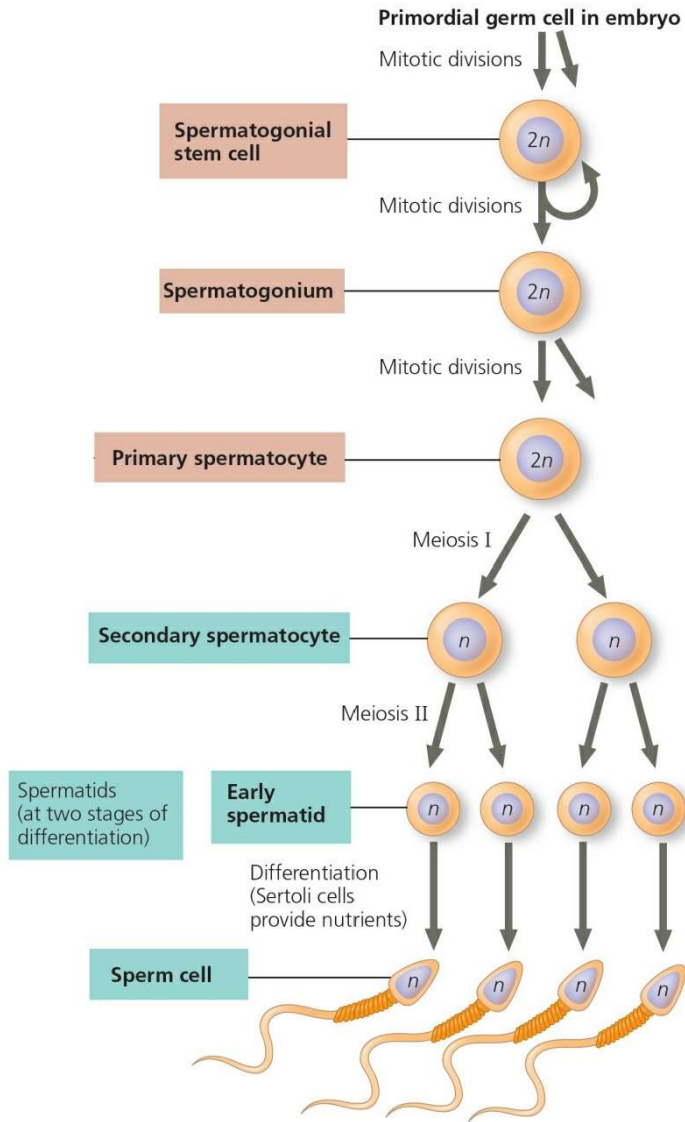
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- These spermatids differentiate into sperms with its characteristic head, midpiece and tail.
- The sperms are released into the fluid-filled lumen of the tubule and they travel along the tubule into the epididymis, where they become mature and motile.
- After puberty, Leydig cells present between the seminiferous tubules secrete the hormone testosterone which promotes spermatogenesis.
- Different cells that undergo spermatogenesis are surrounded and connected to special type of supporting cells called Sertoli cells.
- These cells extend from the wall of the seminiferous tubules to the lumen.
- These cells secrete inhibin hormone and nourish and provide attachment for cells that are in different stages of spermatogenesis.
- Each sperm is made up of three main parts, the head, midpiece (body) and tail. (2.5 μ m in diameter /50 μ m in length)
- Head of the sperm contains the haploid nucleus carrying the paternal genetic material. A special vesicle called the acrosome is present at the anterior end of the head.
- It contains hydrolytic enzymes such as trypsin and hyaluronidase that help the sperm to penetrate the outer layers of the ovum.
- Midpiece of the sperm contains many mitochondria that provides ATP necessary for the movement of the tail.
- The tail of the sperm contains a long flagellum with typical 9+2 arrangement of microtubules. It is produced by the centriole found near the base of the nucleus.
- The tail enables the sperm to swim along the female reproductive tract towards an ovum.





Semen (Seminal Fluid)

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- Normally, the sperms comprise less than 10% of the final ejaculate. Main fraction of the semen is made up of secretions from seminal vesicles and the prostate gland.
- The semen contains several components such as mucus, enzymes, prostaglandins, ascorbic acid, citrate and fructose which promote the survival of sperm.
- The semen provides a liquid medium for the sperm movement and also helps to neutralize the acidity in the female reproductive tract.
- The life expectancy of a sperm is about 48-72 hours after ejaculation.

Accessory glands associated with the male reproductive system

- There are three sets of accessory glands that produce secretions necessary for sperm survival and movement.
- They are
 1. Seminal vesicles
 2. Prostate gland
 3. Bulbourethral glands/Cowpers gland

Seminal vesicles:

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- Seminal fluid is alkaline to protect the sperm in the acidic environment of the vagina.
- It contains mucus, fructose (that provides most of the sperm's energy), a coagulating enzyme (helps semen coagulates after ejaculation), ascorbic acid and local regulators called prostaglandins.
- This fluid contributes to about 60% of the volume of semen.
- Each seminal vesicle opens into a short duct that joins the corresponding vas deference to form an ejaculatory duct.

Prostate gland:

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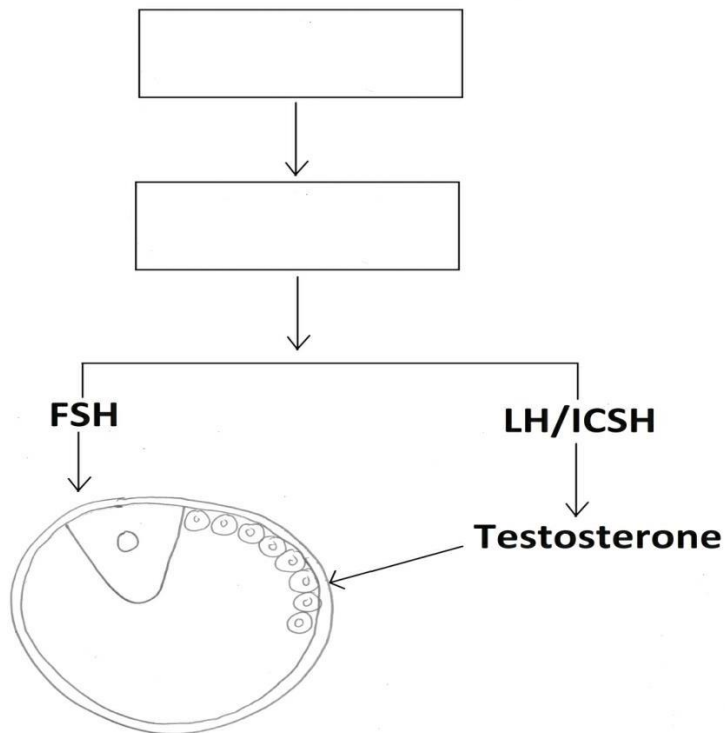
- This milky secretion contains coagulants, anticoagulant enzymes and citrate which is a sperm nutrient. This fluid contributes to about 30% of the volume of semen.

Bulbourethral glands:

- They are a pair of small glands found along the urethra below the prostate.
- These glands secrete a clear alkaline mucus that is able to neutralize any acidic urine remaining in the urethra and lubricates the lining of the urethra.



Hormonal control of the male reproductive system



- In males, in response to the release of GnRH from the hypothalamus (just before puberty), results in the release of FSH and LH by the anterior pituitary.
- Rising levels of the FSH and LH hormones at puberty promotes mature functioning of the male reproductive organs.
- The hormones regulate the development, growth, pubertal maturation and reproductive processes of the body.
- FSH and LH hormones direct spermatogenesis by acting on different types of cells in the testis
- FSH stimulates Sertoli cells to nourish the developing sperm.
- LH causes Leydig cells to produce testosterone and other androgens to promote spermatogenesis.
- Two negative-feedback mechanisms control sex hormone production in males.
- Testosterone inhibits GnRH, FSH and LH in blood through its effect on the hypothalamus and anterior pituitary.
- Additionally inhibin produced by Sertoli cells, acts on anterior pituitary gland to reduce FSH secretion.
- These negative feedback circuits maintain testosterone and other androgen levels in the normal range.



PRACTICAL NO. 29

Study of male reproductive system using models or diagrams.

Expected Learning Outcomes

1. Observes and identifies the structure of the male reproductive system.
2. Relates the structure to the functions performed by the parts of reproductive system.

Materials and Equipment

- Chart of vertical sectional view of lower abdominal region of male showing the reproductive organs as well as the urinary system.
- A transverse section of the human testis.
- Electron micrograph of a human sperm
- Microscope

Instructions

- Allow the students to study the chart/diagram/computer illustrations carefully and understand the structure and relative positions of each organ of the male reproductive system.
- Guide them to observe the T.S of testis, to note the various stages of the germinal epithelium, the sperms and their relative arrangements, Leydig cells and Sertoli cells.
- Lead a discussion on the relationship of structure to their functions.

Revision Questions

1. State the importance of reproduction.

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2. What are the 2 methods of reproduction?

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3. State different organisms show following asexual reproductions methods?

Budding	-
Fragmentation and regeneration	-
Parthenogenesis	-

4. What is sexual reproduction

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5. What are the different fertilization methods?

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6. What is the fertilization method shown by aquatic organisms?

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