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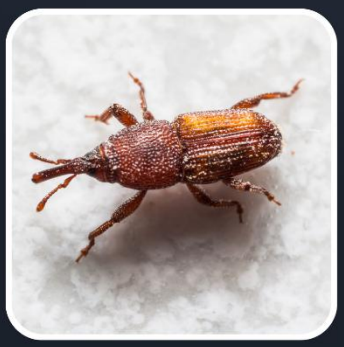
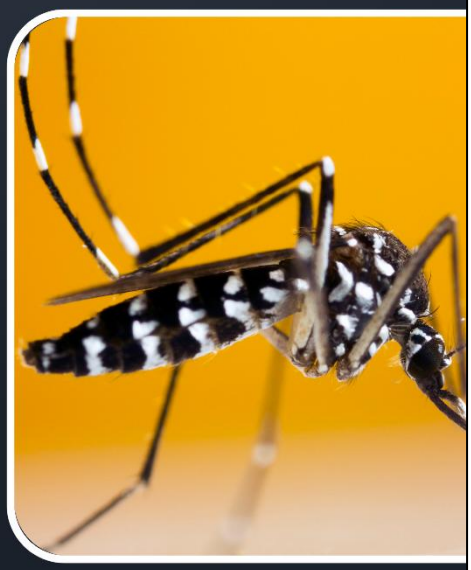
PRACTICAL HANDBOOK OF ZOOLOGY MAJOR

(B. SC. II, SEM IV)

AS PER NEP-2020 (2.0) SYLLABUS OF SHIVAJI UNIVERSITY, KOLHAPUR

K. J. Adate
S. A. Vhanalakar
V. V. Ajagekar
L. P. Lanka





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Authors

Mr. Kishor J. Adate
Head,
Department of Zoology,
Shivraj College, Gadhinglaj,
Dist – Kolhapur, M.S., India

Dr. Sagar A. Vhanalakar
Head,
Department of Zoology,
Karmaveer Hire College, Gargoti
Dist – Kolhapur, M.S., India

Dr. Vinayak V. Ajagekar
Head,
Department of Zoology,
Ajara College, Ajara,
Dist – Kolhapur, M.S., India

Dr. Lazarus P. Lanka
Head,
Department of Zoology,
Devchand College, Arjunnagar,
Dist – Kolhapur, M.S., India

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Author: Mr. K. J. Adate, Dr. S. A. Vhanalakar, Dr. V. V. Ajagekar, Dr. L. P. Lanka

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PREFACE

Dear Students,

It is with great pleasure that we present this practical manual, meticulously crafted to align with the B. Sc. Part – II, Semester – IV (NEP 2.0) Major Zoology Practical – IV syllabus of Shivaji University, Kolhapur. This book is designed to be your essential companion as you delve into the fascinating realms of Reproductive Biology and Applied Entomology.

In line with the National Education Policy (NEP 2.0), this syllabus emphasizes a hands-on, experiential learning approach, aiming to equip you with not just theoretical knowledge but also the critical skills necessary for scientific inquiry and real-world application.

This manual is structured to facilitate your learning process, offering clear instructions, relevant diagrams and expected observations for each practical exercise. We encourage you to engage actively, observe keenly, and interpret your findings critically. Practical work is not merely about performing experiments but also about developing a scientific temperament, problem-solving abilities, and an appreciation for the complexities of the biological world.

We are confident that this practical book will serve as an invaluable resource, helping you to explore, understand, and master the concepts of Reproductive Biology and Applied Entomology. We wish you an enriching and successful learning experience.

Best regards,

- Authors

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MAJOR ZOOLOGY PRACTICAL IV

(Based on Reproductive Biology and Applied Entomology)

PRACTICAL: 60 Hrs. MARKS-50 (CREDITS: 02)

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UNIT I: REPRODUCTIVE BIOLOGY

1. Study of the Animal House

a) Set up and maintenance of the animal house

b) Breeding techniques

c) Care of normal and experimental animals with the help of models/photographs

2. Stages/phases of the menstrual cycle.

3. Surgical techniques: Principles of surgery in endocrinology in rats through Demonstration or Video

a) Ovariectomy

b) Tubectomy

c) Hysterectomy

d) Orchiectomy

e) Vasectomy

4. Examination of histological sections from photomicrographs/permanent slides of Rat /Rabbit

a) Testis

b) Epididymis

c) Ovary

d) Fallopian tube

e) Uterus (proliferative and secretory phases),

f) Cervix

g) Vagina

5. Structure of human sperm and ovum

6. Composition of Semen

7. Detection of pregnancy by using a kit.

8. Study of contraceptive devices by photographs or models.

UNIT II: APPLIED ZOOLOGY

9. Study of arthropod vectors associated with human diseases

a) Anopheles Mosquito

b) Aedes mosquito

c) Musca Housefly

10. Study of mosquito-borne diseases

d) Malaria

e) Dengue

11. Study of house fly-transmitted disease

a) Typhoid

b) Dysentery

12. Study of insect pests through damaged products/photographs.

A. Crop Pests

a) Gram pod borer (*Helicoverpa armigera*)

b) Sugarcane leaf hopper (*Pyrilla perpusilla*)

c) Lemon Butterfly (*Papilio demoleus*)

B. Stored grains pests

a) Pulse Beetle (*Callosobruchus chinensis*)

b) Rice Weevil (*Sitophilus oryzae*)

c) Red Flour Beetle (*Tribolium castaneum*)

13. Study of Insects involved in the forensic investigations

a) Blow fly, Calliphora spp.

b) Common flesh fly, Sarcophaga spp.

c) Head louse Pediculus humanus capitis

1. STUDY OF ANIMAL HOUSE

a) Set up and maintenance of animal house
b) Breeding techniques
c) Care of normal and experimental animals with the help of model/photographs

A) SET UP AND MAINTENANCE OF AN ANIMAL HOUSE

Setting up an animal house involves creating a controlled environment suitable for housing and studying animals. Here are the key steps involved.

a) Facility design: Design the animal house facility based on the specific requirements of the animals to be housed. Consider factors such as Temperature Control, Lighting, Ventilation, Noise Reduction, Waste Management and Bio-Security.

b) Animal housing: Provide appropriate housing systems such as cages, pens, or tanks based on the species and size of animals. Consider factors like Space Requirements, Bedding Material, Nesting Areas and Environmental Enrichment to ensure the well-being of animals.

c) Temperature and humidity control: Install heating, cooling, and humidification systems to maintain optimal environmental conditions for the animals. This may involve using heaters, air conditioners, humidifiers or exhaust systems.

d) Lighting: Establish a lighting system that replicates natural light cycles to regulate the animals' circadian rhythms. This may involve installing timers or automatic lighting systems.

e) Ventilation: Ensure proper air exchange and control of airborne contaminants to maintain air quality within the animal house. This can be achieved through the use of air filters, exhaust systems and airflow monitoring.

f) Waste management: Implement a system for proper waste disposal, including animal waste, bedding and other materials. This may involve the use of specialized waste collection and treatment methods to prevent contamination and odors.

g) Bio-security: Establish protocols to prevent the entry and spread of diseases within the animal house. This includes strict hygiene practices, quarantine procedures and monitoring for potential pathogens.

Maintenance of an animal house involves regular upkeep and monitoring to ensure a clean, safe, and healthy environment for the animals. This includes routine cleaning, sterilization of equipment, pest control measures, monitoring of temperature and humidity levels, and regular health checks for the animals.

B) BREEDING TECHNIQUES

Breeding techniques in an animal house involve methods to control and manage the reproduction of animals for various purposes, including maintaining genetic lines, studying

inheritance patterns, and producing experimental animals. Here are some common breeding techniques

a) **Natural breeding:** Allowing animals to mate naturally, either by housing males and females together or by controlled introduction for mating.
b) **Artificial insemination:** Collecting semen from a male animal and introducing it into the reproductive tract of a female, bypassing natural mating. This technique allows for controlled breeding and the use of genetically superior males.
c) **In vitro fertilization (IVF):** Collecting eggs from a female and fertilizing them with sperm outside the body, then transferring the resulting embryos to surrogate mothers.
d) **Embryo transfer:** Collecting embryos from a donor female and transferring them to recipient females for gestation and birth.
e) **Genetic engineering:** Using advanced techniques such as gene editing to modify the genetic makeup of animals, introducing or removing specific genes for research or production purposes.

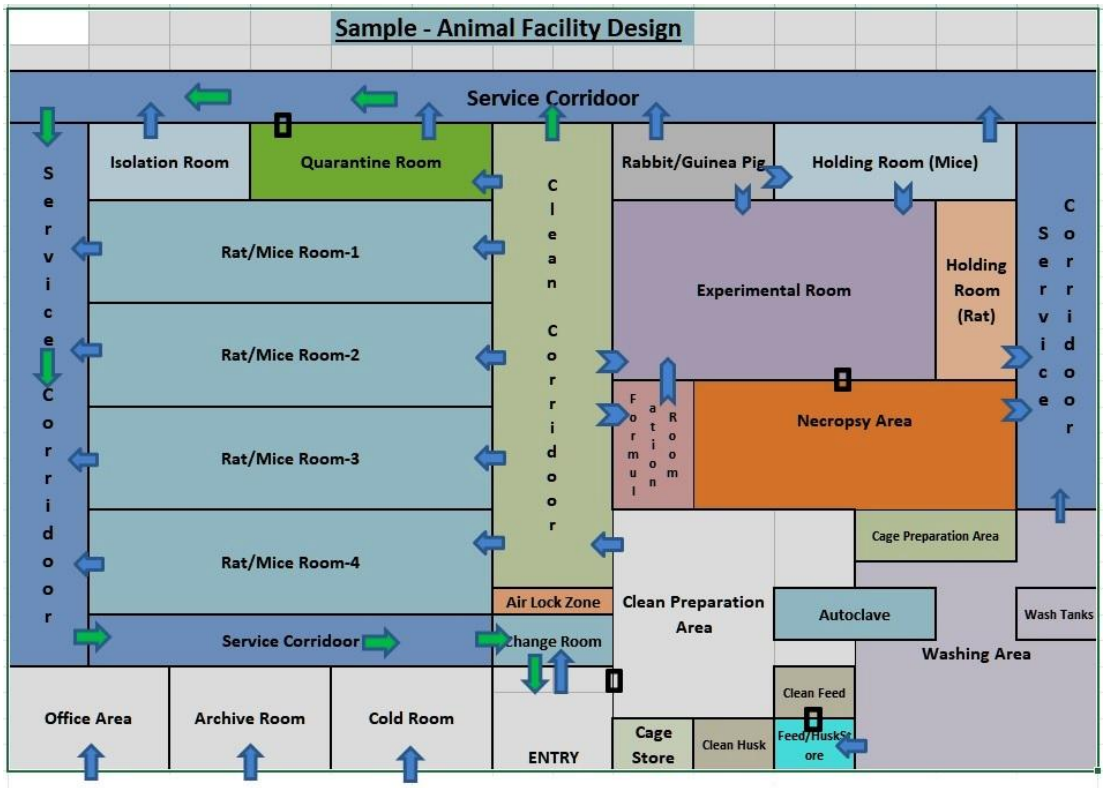
C) CARE OF NORMAL AND EXPERIMENTAL ANIMALS WITH THE HELP OF MODELS/PHOTOGRAPHS

To provide proper care for animals in an animal house, it is essential to follow established guidelines and protocols. Models and photographs can be used as educational tools to demonstrate the correct procedures and techniques. Here are some aspects of animal care

a) **Feeding and nutrition:** Animals should be provided with appropriate diets that meet their nutritional needs. This may include commercial feeds, specialized diets, or custom-formulated diets based on the species and research requirements.
b) **Environmental enrichment:** Animals should be provided with an environment that promotes their physical and mental well-being. This may include providing toys, hiding places, climbing structures, and social interactions to prevent boredom and stress.
c) **Veterinary care:** Regular veterinary check-ups should be conducted to monitor the animals' health, detect any illnesses or injuries, and provide necessary treatment. This may involve vaccinations, parasite control, and medical interventions as required.
d) **Behavioral observation:** Animals should be monitored for their behavior and overall well-being. This may involve the use of behavioral scoring systems, video monitoring, or direct observation to identify any signs of distress or abnormal behavior.
e) **Handling and restraint:** Animals should be handled with care and following proper techniques to minimize stress and potential harm. This includes training personnel on

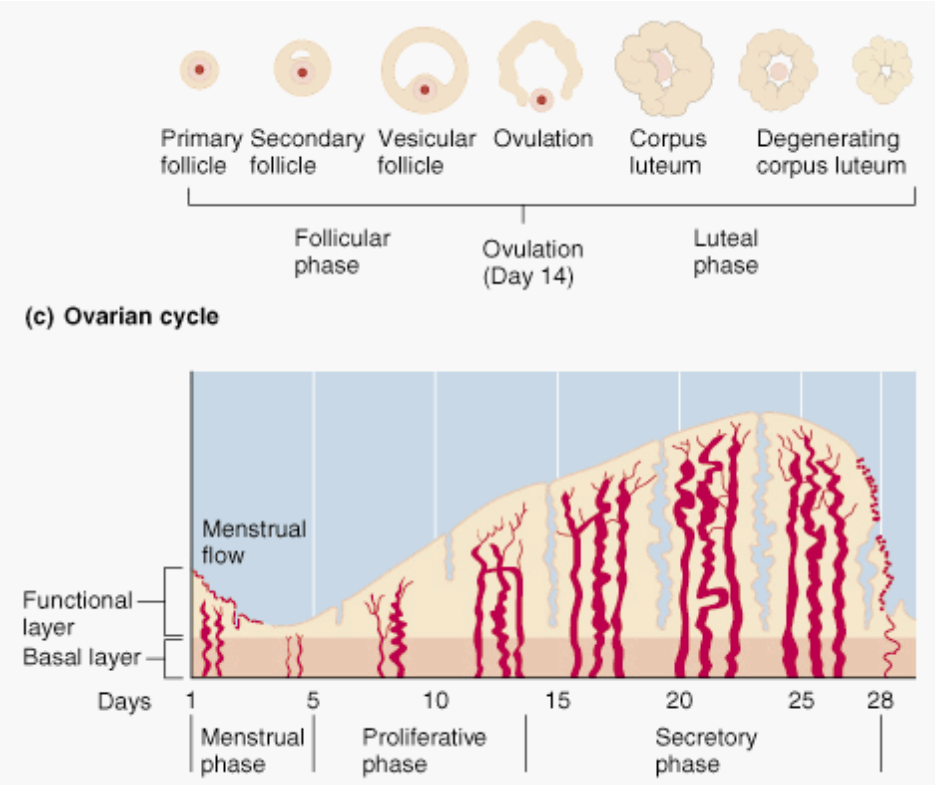
appropriate handling methods and the use of appropriate equipment such as gloves or nets.

By utilizing models and photographs, researchers and caretakers can effectively communicate and demonstrate the correct procedures for animal care, ensuring that animals are treated ethically and in compliance with animal welfare regulations.



2. STAGES/PHASES OF MENSTRUAL CYCLE.

The menstrual cycle refers to the hormonal and physiological changes that occur in the reproductive system of females, primarily in humans and some other mammals. It is a recurring process that prepares the body for potential pregnancy. The menstrual cycle typically lasts about 28 days, although variations in duration are common. Here are the stages/phases of the menstrual cycle



PHASES OF MENSTRUAL CYCLE

a) **Menstruation (Days 1-5):** The menstrual cycle begins with menstruation, also known as the menstrual period. During this phase, the lining of the uterus (Endometrium) that has built up in the previous cycle is shed. This results in bleeding from the vagina, which typically lasts for a few days.

b) **Follicular Phase (Days 1-13):** The follicular phase begins on the first day of menstruation and lasts until ovulation. The follicular phase is characterized by the development of follicles in the ovaries. Follicles are fluid-filled sacs that contain immature eggs. As the follicles develop, one dominant follicle becomes the primary focus of hormonal stimulation.

c) **Ovulation (Day 14):** Ovulation is the release of a mature egg (ovum) from the ovary into the fallopian tube. It usually occurs around the midpoint of the menstrual cycle, approximately 14 days before the start of the next menstrual period. Ovulation is

triggered by a surge in luteinizing hormone (LH), which causes the dominant follicle to rupture and release the egg.

d) **Luteal Phase (Days 15-28):** The luteal phase follows ovulation and lasts until the start of the next menstrual period. After the egg is released, the ruptured follicle in the ovary forms a structure called the corpus luteum. The corpus luteum produces hormones, primarily progesterone, which prepares the uterus for potential implantation of a fertilized egg. If fertilization does not occur, the corpus luteum degenerates, hormone levels drop, and the next menstrual cycle begins.

Throughout the menstrual cycle, the levels of various hormones, including estrogen and progesterone, fluctuate to regulate the changes in the uterus and other reproductive organs. These hormonal fluctuations are responsible for the characteristic changes observed in cervical mucus, basal body temperature and other physiological parameters during different phases of the menstrual cycle.

It's important to note that the duration and characteristics of the menstrual cycle can vary among individuals and can be influenced by factors such as hormonal imbalances, stress, and certain medical conditions.

SURGICAL TECHNIQUES

PRINCIPLES OF SURGERY IN ENDOCRINOLOGY

Surgery in endocrinology focuses on treating disorders of the endocrine glands and their hormones. Key principles guiding these procedures include:

- **Preoperative Assessment:** A thorough evaluation of the patient's medical history, physical condition, and diagnostic test results (blood work, imaging, hormone levels) to determine suitability for surgery and plan the approach.
- **Localization:** Precisely identifying the location, size, and extent of the diseased endocrine gland or tumor using various imaging techniques (ultrasound, CT, MRI, nuclear medicine scans) to guide surgical planning.
- **Minimally Invasive Techniques:** Utilizing advanced approaches like laparoscopic and robotic-assisted surgery to minimize trauma, reduce pain, speed recovery, and improve cosmetic outcomes through small incisions and specialized instruments.
- **Surgical Expertise:** Requiring specialized knowledge of endocrine anatomy, physiology, diseases, and surgical techniques. Endocrine surgeons stay updated on advancements to provide optimal patient care.
- **Preservation of Function:** Whenever possible, surgeons aim to remove diseased tissue while preserving the normal function of endocrine glands. For example, during thyroid surgery, efforts are made to protect the parathyroid glands to prevent complications like hyperparathyroidism.
- **Hormone Replacement:** If an endocrine gland's removal leads to hormone deficiency, the surgical team collaborates with endocrinologists to initiate appropriate postoperative hormone replacement therapy. This is vital for glands like the thyroid, adrenals, and pituitary.
- **Postoperative Care:** Close monitoring after surgery to ensure proper healing, manage pain, and detect complications. This includes regular follow-up visits, hormone level monitoring, and ongoing collaboration with the endocrinology team.
- **Multidisciplinary Approach:** A collaborative effort involving surgeons, endocrinologists, radiologists, pathologists, and other specialists to ensure accurate diagnosis, proper preoperative preparation, and comprehensive postoperative care for the best patient outcomes.

It's important to remember that these principles can vary based on the specific condition being treated, such as thyroid disorders, adrenal gland tumors or pituitary gland disorders. Individualized patient care and a tailored surgical approach are crucial in endocrine surgery.

a) OVARIECTOMY

Ovariectomy is the surgical removal of the ovaries in female rats. This procedure is commonly performed to study the effects of Ovariectomy on reproductive physiology, hormonal regulation, and various disease models. It is also performed to induce menopause-like conditions in rats. The surgical technique involves making an incision in the abdominal wall, locating the ovaries and carefully removing them.

Aim: To perform Ovariectomy in a normal female rat/ mice

Requirements: Sterilized surgical instruments, hemostat, suture needle, suture thread (catgut), ether, antiseptic powder, alcohol, Dettol, ether cones, etc.



PROCEDURE

1. Carefully etherize the animal.
2. Make a small incision in the abdominal region on the ventral side just below the last rib on the lateral side.
3. Cut through the layers of muscle and connective tissue.
4. Expose the fat bodies located below the incision in this region.
5. Locate the ovary, fallopian tube and part of the uterus embedded in the fat body.
6. Carefully place the hemostat between the ovary and the fallopian tube to prevent excessive bleeding.
7. Remove the ovary using a fine angular scissor.
8. Remove the hemostat and replace the organs in the abdominal region without damaging them.
9. Suture the incision both on the inside as well as on the skin, with small sutures. Clean the area with antiseptic and place antibiotic powder.
10. Repeat the process on the other side.

Thus bilateral Ovariectomy involves removal of the ovary on both sides without damaging the other organs.

b) TUBECTOMY

Tubectomy, also known as fallopian tube ligation or sterilization, is a surgical procedure performed to prevent pregnancy in female rats. It involves the ligation or blocking of the fallopian tubes to prevent the eggs from reaching the uterus for fertilization. This procedure is reversible in some cases. The technique involves making a small incision in the

abdomen, locating the fallopian tubes, and either legating them or applying clips or electrocautery to block them.

c) HYSTERECTOMY

Hysterectomy involves the surgical removal of the uterus in female rats. This procedure is performed for various reasons, including studying reproductive disorders, investigating the effects of uterus removal on hormone regulation, and reproductive toxicology studies. The surgical technique involves making an incision in the abdomen, locating the uterus, and carefully removing it while preserving the surrounding tissues.

d) ORCHIECTOMY

Orchiectomy, also known as castration, is the surgical removal of the testes in male rats. This procedure is performed to eliminate testosterone production and study the effects of castration on reproductive physiology, behavior, and various disease models. It is also used as a means of sterilization in male rats. The surgical technique involves making a small incision in the scrotum, exposing the testes, and carefully removing them.

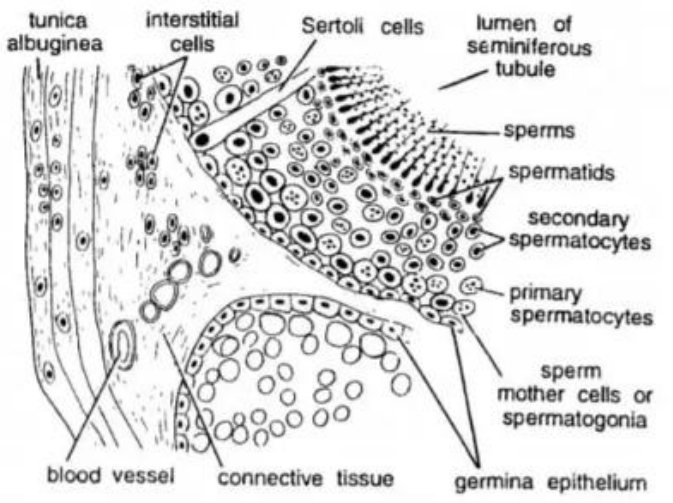
e) VASECTOMY

Vasectomy is a surgical procedure performed in male rats to block the vas deferens, the tubes that carry sperm from the testes to the urethra. It is a form of sterilization that prevents the male rat from impregnating females while maintaining hormone production. The surgical technique involves making a small incision in the scrotum, locating the vas deferens, and either legating, cutting, or sealing them to prevent the passage of sperm.

It is important to note that these surgical procedures should be performed by trained professionals following ethical guidelines and in accordance with local regulations. Proper anesthesia, aseptic techniques and postoperative care are essential to minimize pain, distress and complications for the animals.

EXAMINATION OF HISTOLOGICAL SECTIONS OF RAT /RABBIT (PHOTOMICROGRAPHS/ PERMANENT SLIDES)

HISTOLOGY OF TESTIS



1. The testis is a somewhat oval or rounded organ surrounded by the peritoneum, and it is encased by a layer of fibrous connective tissue known as the tunica albuginea.
2. Histologically, each testis exhibits a complex structure consisting of coiled seminiferous tubules. These tubules are separated from one another by intertubular connective tissue, which not only provides structural support but also houses blood vessels and interstitial cells.
3. The interstitial cells play a crucial role in the production of a hormone called testosterone, which is responsible for the development of male secondary sexual characteristics.
4. Each seminiferous tubule has an oval or rounded appearance and is surrounded by a basement membrane. These tubules are lined with germinal epithelium, where the process of spermatogenesis (sperm cell development) takes place.
5. Within the germinal epithelium, large Sertoli cells are interspersed, providing essential nourishment and support to the developing sperms during their maturation process.

HISTOLOGY OF EPIDIDYMIS

The epididymis is a highly convoluted, comma-shaped structure located on the posterior surface of the testis. It plays a crucial role in the maturation, storage, and transport of spermatozoa (mature sperm cells). Histologically, the epididymis exhibits the following key features:

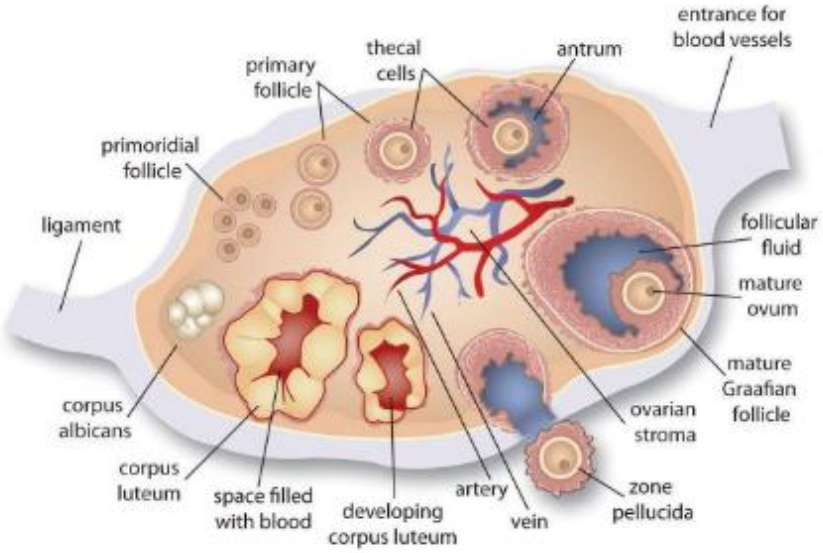
1. **Epithelial Lining:** The epididymal duct is lined with pseudo stratified columnar epithelium, which consists of several cell types.

2. **Principal Cells:** The majority of the epithelial cells are called principal cells. They have stereocilia (long microvilli) on their apical surface, which increase the surface area for absorption and secretion. These cells are responsible for reabsorbing most of the fluid and nutrients from the luminal fluid, which helps concentrate and mature the sperm.
3. **Basal Cells:** Scattered among the principal cells are basal cells, which are involved in cell renewal and replenishing the epithelial lining.
4. **Clear Cells**: Occasional clear cells are present, and they are believed to be involved in the absorption and secretion of certain substances.
5. **Connective Tissue**: The epithelium is surrounded by a layer of connective tissue containing blood vessels, nerves, and smooth muscle cells, which help in the contraction and movement of sperm along the epididymis.

The epididymis can be divided into three segments: the initial segment, the caput (head), the corpus (body), and the cauda (tail) epididymis. As sperm move through the epididymis, they undergo changes in their morphology and acquire motility, becoming capable of fertilization.

HISTOLOGY OF OVARY

The ovary is a complex organ with distinct histological features involved in the production and release of ova (eggs) and the synthesis of hormones.



1. **Germinal Epithelium:** The ovary is covered by a layer of simple cuboidal epithelium known as the germinal epithelium, which is surrounded by a layer of connective tissue called the tunica albuginea.
2. **Ovarian Stroma:** The main bulk of the ovary is composed of the ovarian stroma, supportive tissue rich in elastic fibers, and containing large blood vessels, lymphatics, and nerves.

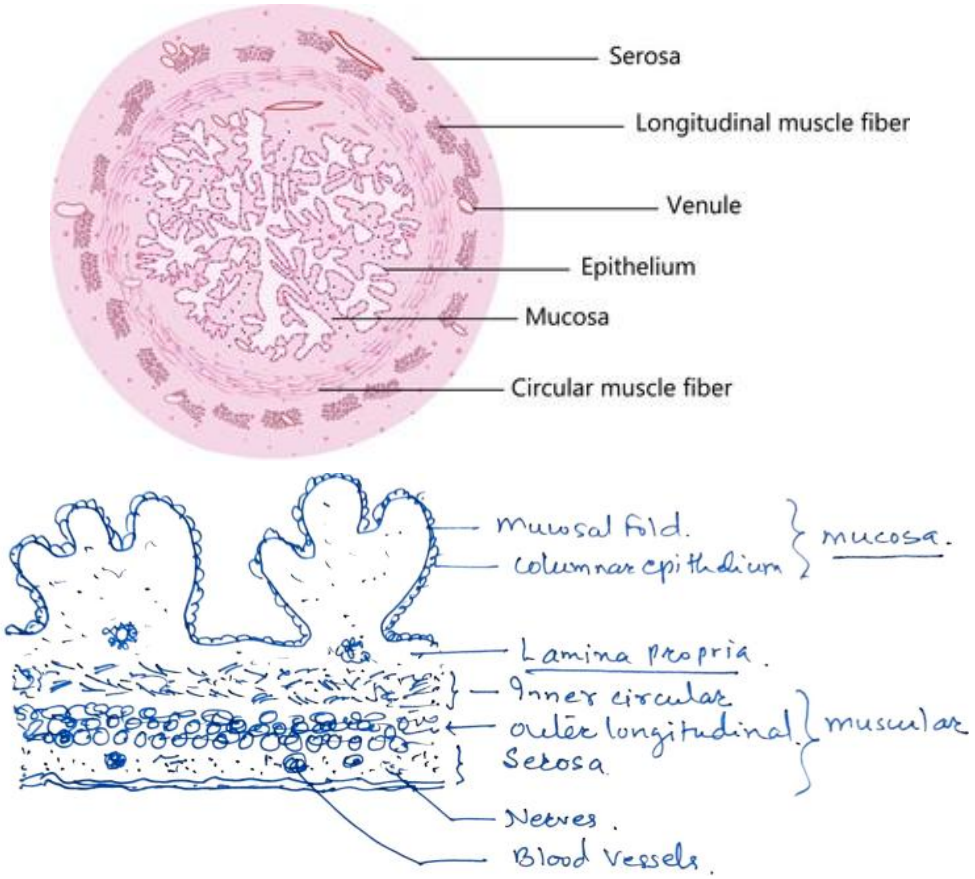
3. **Follicles and oocytes:** Within the stroma, various stages of egg cells, called oocytes, can be found. Each oocyte is enclosed by supporting cells, forming structures known as follicles. The follicles provide nourishment to the developing oocytes and also contribute to the production of hormones.
4. **Follicular Development:** The ovary exhibits different stages of follicular development, including:
5. **Primordial Follicles**: These are the earliest stage of follicles and are found in the ovarian cortex, derived from the germinal epithelium.
6. **Primary Follicles:** Primordial follicles can develop into primary follicles, consisting of a single layer of follicle cells surrounding the oocyte.
7. **Secondary Follicles:** Primary follicles further mature into secondary follicles with multiple layers of follicle cells.
8. **Mature Follicles (Graafian Follicles):** The most developed follicles are known as mature or Graafian follicles. They have a fluid-filled cavity called the antrum, which separates the oocyte and its surrounding cells from the rest of the follicle.
9. **Ovulation and Corpus Luteum:** Upon maturation, a mature follicle releases the oocyte during ovulation, making it available for fertilization. The remaining part of the mature follicle transforms into a structure called the corpus luteum. The corpus luteum is responsible for producing hormones, particularly progesterone, which is essential for maintaining a potential pregnancy.
10. Corpus Albicans: If fertilization does not occur, the corpus luteum regresses, and the structure is eventually replaced by fibrous tissue known as the corpus albicans

HISTOLOGY OF FALLOPIAN TUBE

The fallopian tubes, also known as uterine tubes or oviducts, are a pair of slender, tubular structures in the female reproductive system. They extend from the upper lateral corners of the uterus and are essential for the transport of eggs (oocytes) from the ovaries to the uterus. Additionally, they are the site of fertilization, where sperm and egg meet. Let's explore the histology of the fallopian tube:

Mucosa (or Mucous Membrane)

The innermost layer of the fallopian tube is the mucosa, which is composed of simple columnar epithelium. The epithelium is lined with cilia, hair-like structures that beat in a coordinated manner towards the uterus. The cilia create currents in the fluid within the fallopian tube, helping to move the egg and captured sperm toward the uterus. The mucosa also contains secretory cells that produce nourishing fluids to support the oocyte and early embryo.



Lamina Propria

The mucosa is supported by a thin layer of connective tissue called the lamina propria, which contains blood vessels, lymphatics and nerves.

Muscularis

Surrounding the lamina propria is the muscularis layer, consisting of smooth muscle fibers. The muscularis layer exhibits peristaltic contractions, which aid in the movement of the egg and embryo through the fallopian tube.

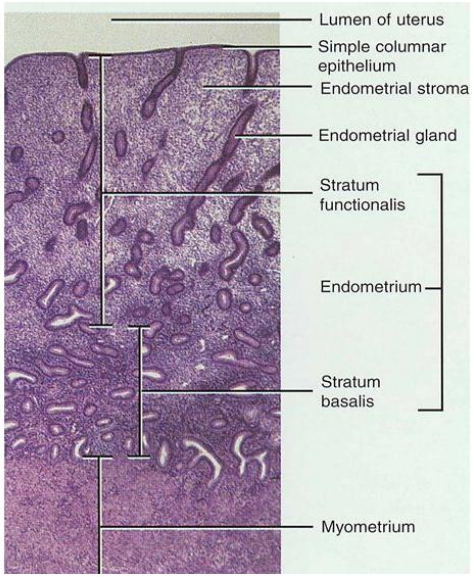
Serosa (or Adventitia)

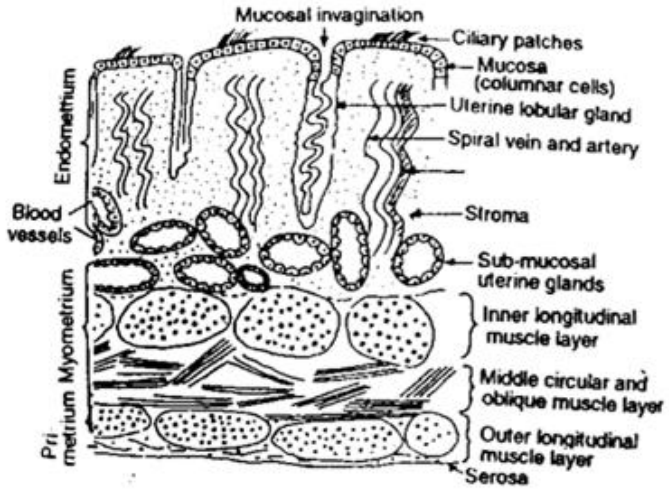
The outermost layer of the fallopian tube is either a Serosa (if covered by peritoneum) or an adventitia (if covered by connective tissue). The Serosa/adventitia provides structural support and allows the fallopian tube to be anchored within the pelvic cavity.

The fallopian tubes histological features, particularly the ciliated epithelium and smooth muscle layer, play a crucial role in the transport of the oocyte and sperm, as well as the early stages of embryonic development. Fertilization typically occurs within the ampulla of the fallopian tube, where the sperm encounter the mature egg. After fertilization, the resulting zygote undergoes rapid cell divisions (cleavage) as it travels through the fallopian tube toward the uterus, where it eventually implants and develops into an embryo.

HISTOLOGY OF THE UTERUS

The uterus is an important organ in the female reproductive system, located between the vagina and the fallopian tubes. Histologically, the wall of the uterus can be divided into three layers





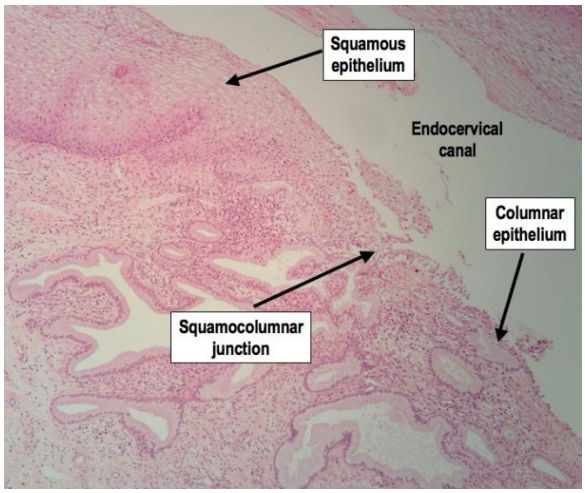
1. **Perimetrium or Serosa:** This is the outermost protective layer that forms part of the broad ligament. It provides support and allows blood vessels, lymphatics and nerves to reach the uterus.
2. **Myometrium or Muscularis:** The myometrium constitutes the middle muscular layer of the uterus. It is a thick layer consisting of smooth muscle fibers, connective tissue, and large blood vessels. The muscular contractions of this layer are essential during childbirth and menstruation.
3. **Endometrium or Mucosa:** The endometrium is the innermost layer of the uterus and is a mucous membrane. It is composed of a columnar epithelium and a supportive layer called the lamina propria. The endometrium undergoes cyclical changes throughout the menstrual cycle.
4. The stroma of the uterine wall contains simple tubular uterine glands. The endometrium can be further divided into two zones based on changes during menstruation:

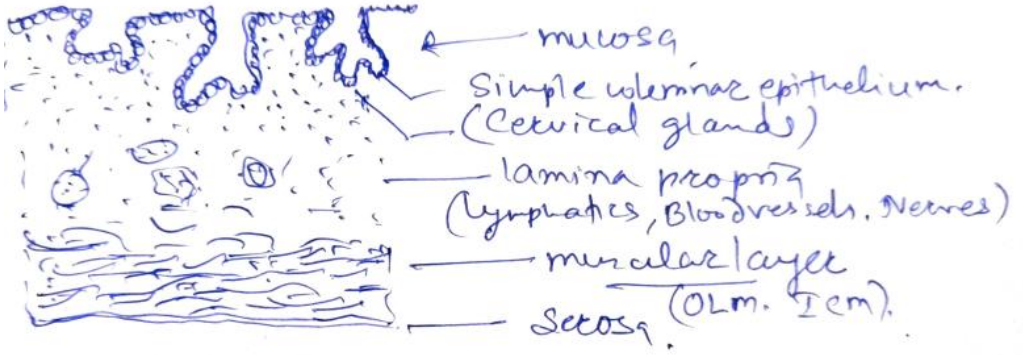
a) **Endometrium Functionalis:** This is the functional layer of the endometrium that undergoes cyclical changes in response to hormonal fluctuations. It is the part that thickens during the menstrual cycle and is periodically shed during menstruation.

b) **Endometrium Basalis:** The endometrium basalis is the deeper layer that remains relatively unchanged during the menstrual cycle. It serves as the source of new endometrial tissue after menstruation.

HISTOLOGY OF CERVIX

The cervix is the lower part of the uterus that connects to the upper part of the vagina. It plays a crucial role in the female reproductive system by facilitating the passage of menstrual blood and sperm, and it also serves as a protective barrier during pregnancy. Let's explore the histology of the cervix:





Cervical Canal Epithelium

The cervical canal is the passageway that extends through the center of the cervix. The lining of the cervical canal is characterized by two types of epithelium:

a. **Simple Columnar Epithelium:** This type of epithelium lines the cervical canal's inner portion, also known as the endocervix.
b. **Stratified Squamous Epithelium:** This epithelium lines the portion of the cervix that protrudes into the vagina, known as the ectocervix or exocervix.

The boundary between the two types of epithelium is called the transformation zone. This zone can shift during a woman's life, and its position is significant in cervical cancer screening.

Cervical Glands

The cervix contains numerous glands that secrete mucus. These glands are mainly located in the endocervix and extend into the underlying cervical stroma. The mucus produced by these glands varies in consistency during the menstrual cycle, influenced by

hormonal changes. This mucus plays a vital role in fertility and acts as a barrier against infections.

Cervical Stroma

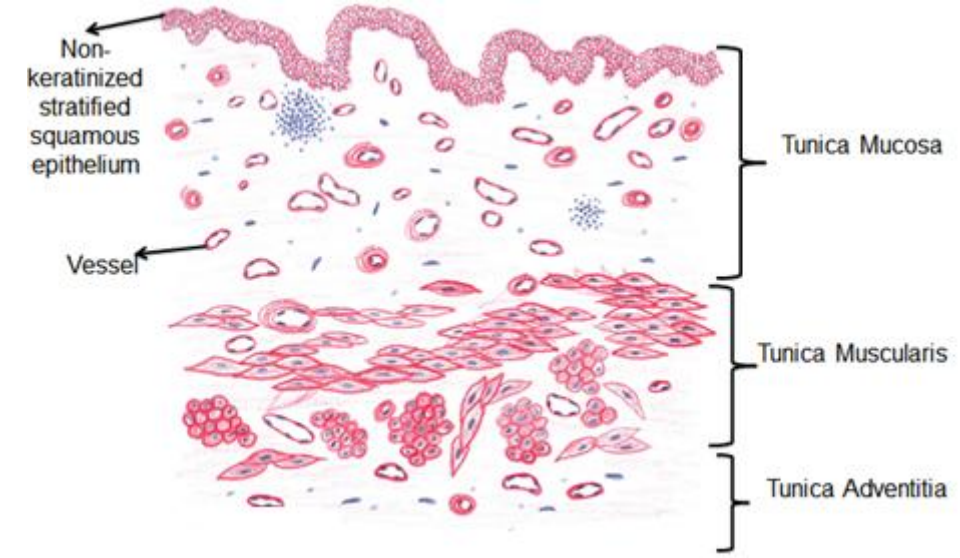
The stroma refers to the connective tissue matrix that supports the epithelial layers and glands of the cervix. It contains fibroblasts, collagen fibers, and blood vessels, providing structural support to the cervix.

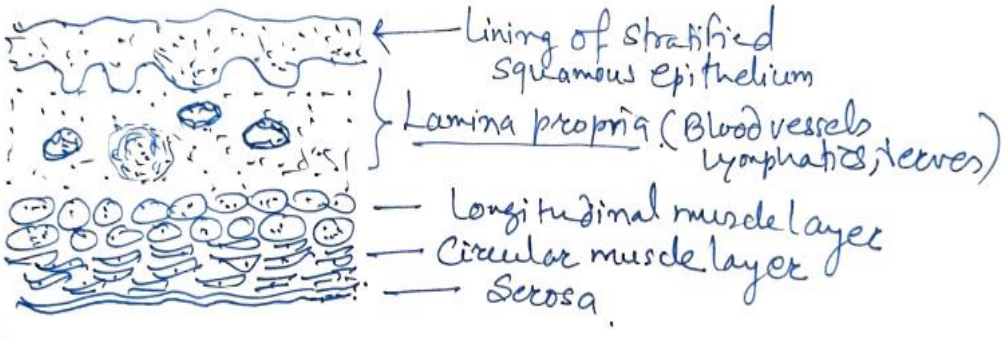
Ligaments and Supportive Structures

The cervix is supported by several ligaments and connective tissues that anchor it to the surrounding pelvic structures**.**

HISTOLOGY OF THE VAGINA

The vaginal wall is composed of several layers, each with specific characteristics:





Mucosa (or Mucous Membrane)

The innermost layer of the vaginal wall is the mucosa, which is lined with non-keratinized stratified squamous epithelium. This epithelium is designed to withstand friction and acidic environments and serves as a protective barrier against infection. The surface cells are constantly being shed and replaced, maintaining the integrity of the mucosal layer.

Lamina Propria

Beneath the epithelial layer is the lamina propria, which consists of connective tissue containing blood vessels, nerves, and lymphatics. It also contains elastic fibers that allow the vaginal wall to stretch during intercourse and childbirth.

Muscularis

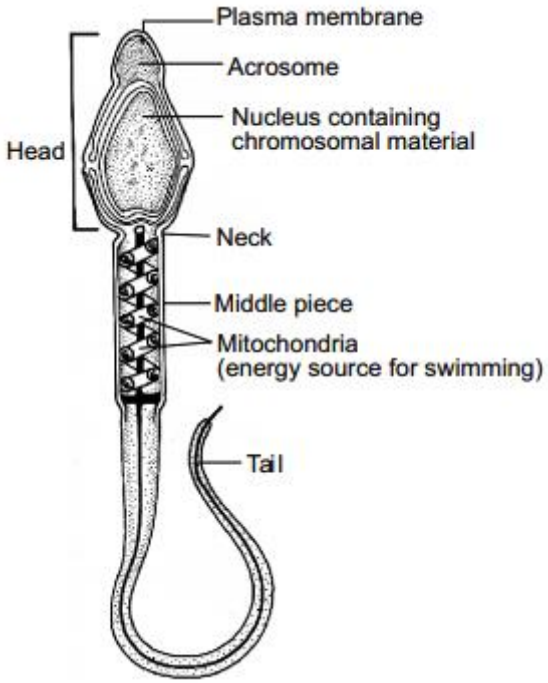
The Muscularis layer is composed of smooth muscle fibers arranged in inner circular and outer longitudinal layers. These muscles contribute to the contractility and elasticity of the vagina.

Adventitia (or Serosa)

The outermost layer of the vaginal wall is the adventitia, which consists of connective tissue and collagen fibers. It provides support and connects the vagina to the surrounding structures, such as the pelvic floor.

STRUCTURE OF HUMAN SPERM

Human sperm, also known as spermatozoa, are the male reproductive cells responsible for fertilizing the female egg during sexual reproduction. Here is the structure of human sperm



1) **Head:** The head is the front part of the sperm and contains the genetic material necessary for fertilization. It is oval-shaped and covered by a cap-like structure called the acrosome. The acrosome contains enzymes that help the sperm penetrate and fertilize the egg.

a) **Acrosome:** The acrosome is a specialized vesicle located at the tip of the sperm head. It contains enzymes that are released during the process of fertilization to break down the protective layers surrounding the egg.

b) **Nucleus:** The nucleus is the central part of the sperm head and contains the haploid set of chromosomes (23 chromosomes), which is the half of the genetic material required for the formation of a new individual.

2) **Neck:** The neck is a short region between the head and midpiece of the sperm.

3) **Midpiece:** The midpiece is the part of the sperm located just behind the head. It is packed with numerous mitochondria that provide the energy required for the sperm's movement.

   a) Mitochondria: Mitochondria are organelles responsible for generating energy through cellular respiration. They are abundant in the midpiece of the sperm.

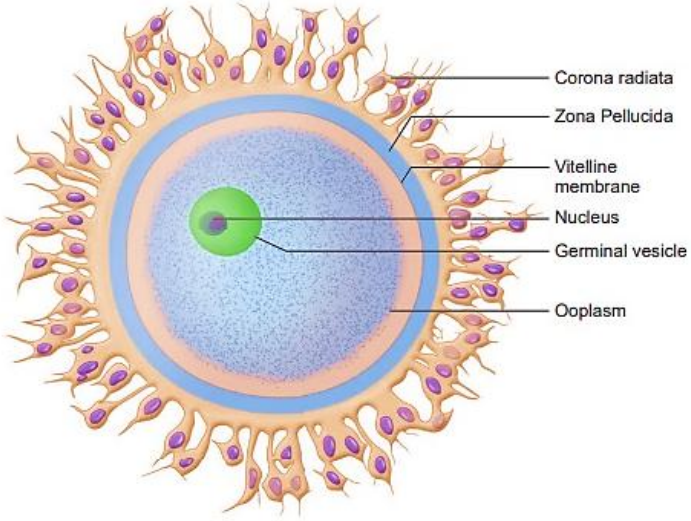
4) **Tail (Flagellum):** The tail, also known as the flagellum, is a long, whip-like structure that extends from the midpiece. It is responsible for the sperm's motility, allowing it to swim through the female reproductive tract towards the egg.

5) **Basal Body:** The basal body is a small structure that anchors the tail to the sperm's head and provides structural support.

The structure of human sperm is highly specialized for its function of fertilization. When released during ejaculation, millions of sperm are present in the semen, but only a few will reach the egg. The journey of the sperm from the male reproductive system to the egg is a complex and competitive process, and only one sperm will successfully fertilize the egg to initiate the formation of a new human life.

STRUCTURE OF HUMAN OVUM

The human ovum, also known as the egg or oocyte, is the female reproductive cell responsible for sexual reproduction. Here is the structure of a human ovum:



1) **Zona Pellucida:** The zona pellucida is a thick, transparent layer that surrounds the ovum. It is composed of glycoproteins and serves as a protective barrier, helping to prevent multiple sperm from fertilizing the same egg.
2) **Cell Membrane:** Beneath the zona pellucida is the cell membrane, which is the outer boundary of the ovum. It is a semi permeable membrane that regulates the exchange of substances between the ovum and its surrounding environment.
3) **Cytoplasm:** The cytoplasm is the gel-like substance that fills the interior of the ovum. It contains various organelles, nutrients and molecules required for the initial stages of embryonic development.
4) **Nucleus:** The nucleus is the central part of the ovum and contains the genetic material in the form of chromosomes. The human ovum is haploid, meaning it contains only one set of 23 chromosomes, which is half of the genetic material needed to form a complete human being.
5) **Polar Bodies:** During oogenesis, the process of egg development, the ovum produces polar bodies. Polar bodies are small cells that contain the excess genetic material and are eventually discarded. They do not participate in fertilization but are important for reducing the ovum's genetic material to half and ensuring proper chromosome distribution during fertilization.
6) **Mitochondria:** The cytoplasm of the ovum contains numerous mitochondria, which are responsible for generating energy through cellular respiration. These mitochondria are inherited solely from the mother and play a crucial role in early embryonic development.
7) **Vesicles and Other Organelles:** The ovum's cytoplasm also contains various vesicles and organelles involved in cellular processes and early development.

The human ovum is released from the ovary during ovulation and is transported through the fallopian tube, where it awaits fertilization by a sperm cell. If fertilization occurs, the nuclei of the sperm and ovum merge to create a zygote with a complete set of 46 chromosomes (23 from the mother and 23 from the father), initiating the formation of a new human life. If fertilization does not occur, the ovum will degenerate and be expelled from the body during menstruation.

COMPOSITION OF SEMEN

Semen, also known as seminal fluid or ejaculate, is a complex biological fluid produced by the male reproductive system. It's much more than just sperm; it's a mixture of various secretions from different glands, all working together to transport, nourish and protect sperm, facilitating their journey to fertilize an egg.

1. Sperm (Spermatozoa)

- Origin: Produced in the testes and mature in the epididymis.
- Contribution: Makes up a small percentage of the total semen volume, typically 1% to 5%.
- Function: The primary male gametes, carrying the genetic material (23 chromosomes, including either an X or Y chromosome) to potentially fertilize a female egg.

2. Seminal Plasma (Fluid Components): This is the fluid portion of semen, primarily secreted by accessory glands.

i. Seminal Vesicle Fluid (Largest Contributor: ~65-75% of total semen volume)

- **Origin:** Produced by the two **seminal vesicles**, which are sac-like glands located behind the bladder.
- **Key Components and Functions**
    - **Fructose:** This is the primary energy source for sperm motility. Sperm metabolize fructose to produce ATP, which powers their flagella (tails) for swimming.
    - **Prostaglandins:** These hormone-like substances are believed to stimulate contractions in the smooth muscle of the female reproductive tract (uterus and fallopian tubes). This "peristalsis" may help draw sperm further into the female reproductive system, aiding their journey towards the egg. They may also play a role in suppressing the female immune response against sperm.
    - **Clotting Factors (e.g., Fibrinogen, Semenogelin):** Immediately after ejaculation, seminal vesicle proteins like semenogelin cause the semen to coagulate or form a temporary gel-like plug within the vagina. This coagulation helps to prevent the immediate backflow of semen from the vagina, keeping sperm localized near the cervix and protecting them from the acidic vaginal environment.
    - **Alkaline Fluid:** The seminal vesicle fluid is slightly alkaline, which helps to neutralize the naturally acidic environment of the vagina. This neutralization is crucial for sperm survival, as sperm are highly sensitive to acidic conditions.
    - **Other substances:** Include amino acids, citric acid, phosphorus, and potassium, all contributing to sperm viability and the overall properties of the seminal plasma.

ii. Prostatic Fluid (Significant Contributor: ~25-30% of total semen volume)

- **Origin:** Secreted by the **prostate gland**, which surrounds the urethra just below the bladder.
- **Key Components and Functions**
    - **Prostate-Specific Antigen (PSA) and other Proteolytic Enzymes (e.g., Fibrinolysin):** These enzymes are critical for the **liquefaction** of semen. After the initial coagulation caused by seminal vesicle factors, prostatic enzymes break down the semenogelin clot, typically within 10-30 minutes. This liquefaction releases the sperm, allowing them to become highly motile and begin their swim towards the egg.
    - **Citric Acid:** Another nutrient for sperm, contributing to their metabolic needs.
    - **Acid Phosphatase:** An enzyme presents in high concentrations, often used as a marker for semen in forensic investigations. Its exact physiological role in semen is not fully understood but may be involved in sperm metabolism or regulating other enzymes.
    - **Zinc:** Important for stabilizing sperm chromatin (DNA) and membrane integrity, contributing to overall sperm quality and fertility. High levels of zinc may also have antibacterial properties.
    - **Other substances:** Include lipids, cholesterol, sodium, and calcium.
    - **Slightly Acidic:** While prostatic fluid itself is slightly acidic, the overall semen pH is alkaline due to the larger volume of alkaline fluid from the seminal vesicles. The initial prostatic fluid often contains the highest concentration of sperm during ejaculation.

iii. Bulbourethral Gland (Cowper's Gland) Fluid (Minor Contributor: ~5% or less of total semen volume)

- **Origin:** Secretions from the two **bulbourethral glands** (also known as Cowper's glands), small, pea-sized glands located below the prostate.
- **Key Components and Functions**
    - **Mucus (Mucoproteins):** This clear, viscous, lubricating fluid is often released as "pre-ejaculate" or "pre-cum" during sexual arousal before full ejaculation.
    - **Lubrication:** It lubricates the urethra, facilitating the smooth passage of semen.
    - **Neutralization of Urethral Acidity:** It helps neutralize any residual acidity in the male urethra (from urine), creating a more favorable environment for sperm to pass through without damage.

- **Cleansing:** It also helps to flush out any urine residue or foreign material from the urethra, ensuring a clean pathway for the ejaculate.

General Characteristics of Semen

- **Volume:** Typically, 2-5 milliliters per ejaculation.
- **Appearance:** Whitish-gray, opaque, and slightly viscous, often becoming more liquid after a few minutes due to enzymatic liquefaction.
- **pH:** Slightly alkaline (pH 7.2-7.8) to help neutralize the acidic environment of the vagina, which would otherwise be harmful to sperm.
- **Odor:** Often described as having a faint chlorine-like or sometimes fishy odor, partly due to the presence of polyamines like spermine.

Overall Functions of Semen

- **Transport:** Provides the medium for sperm to travel through the male and female reproductive tracts.
- **Nourishment:** Supplies energy (fructose, citric acid) and other vital nutrients to sustain sperm viability and motility.
- **Protection:** Buffers sperm against the acidic environment of the vagina and contains protective substances.
- **Lubrication:** Aids in sexual intercourse.
- **Facilitation of Fertilization:** Contains compounds that may influence the female reproductive system to enhance sperm's chances of reaching and fertilizing an egg.

DETECTION OF PREGNANCY BY USING KIT

Title: Pregnancy Detection Using a Home Pregnancy Test Kit

Objective:

The objective of this practical is to familiarize students with the process of using a home pregnancy test kit to detect pregnancy. Students will learn the principles behind pregnancy test kits and how to perform the test accurately.

Materials Required

1. Home pregnancy test kit (readily available at pharmacies or online)
2. A clean container to collect urine
3. Timer or stopwatch
4. Disposable gloves (optional but recommended)
5. Pen and paper for recording observations

Procedure

Step 1: Introduction to the Home Pregnancy Test Kit

Start by introducing the concept of a home pregnancy test kit and explaining its significance in detecting pregnancy. Discuss the principle behind the test, which is based on detecting the presence of the hormone human chorionic gonadotropin (hCG) in the urine, which is produced during pregnancy.

Step 2: Preparing for the Test

Ensure that the students have clean hands before handling the kit to avoid contamination. Familiarize the students with the components of the kit, typically a test sticks or strip and an instruction leaflet. Emphasize the importance of reading and following the instructions carefully.

Step 3: Collecting the Urine Sample

Instruct the students on the proper method of collecting a urine sample. It's best to use the first-morning urine sample for higher accuracy, but any urine sample collected after holding the urge to urinate for at least a few hours will suffice. If possible, provide each student with a clean container to collect their urine samples.

Step 4: Performing the Test

Direct the students to carefully follow the instructions provided with the pregnancy test kit. The steps typically include

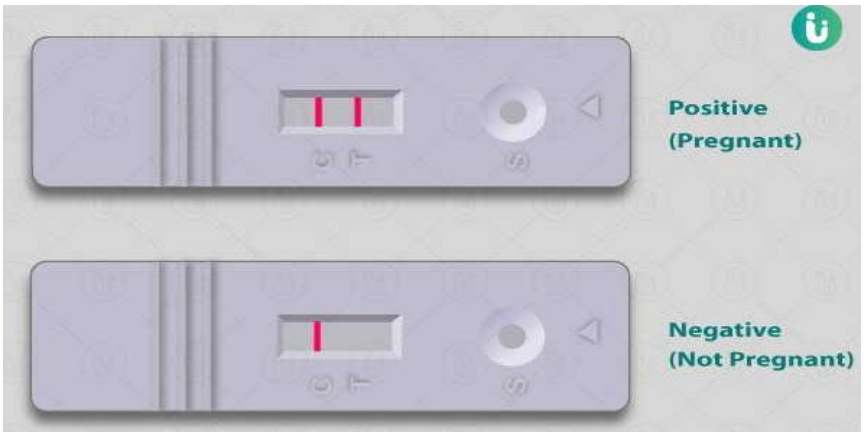
i. Removing the test strip from its packaging and exposing the testing area.
ii. Holding the test strip in a way that the testing end is submerged in the collected urine.
iii. Allowing the strip to absorb the urine for the specified time mentioned in the instructions (usually a few seconds).

iv. Placing the test strip on a flat surface and waiting for the stipulated time for the results to develop.

Step 5: Reading the Results

Explain how to interpret the results correctly:

i. Two lines usually indicate a positive result (pregnant).
ii. One line indicates a negative result (not pregnant).
iii. No lines or an invalid control line means the test is invalid and the test should be repeated.



Step 6: Recording Observations

Ask the students to record their observations, including the date and time of the test and the test results.

Step 7: Discussion and Conclusion

Lead a discussion on the accuracy and limitations of home pregnancy test kits. Emphasize the importance of following instructions and interpreting results correctly. Conclude the practical by summarizing the key points learned and their real-world applications.

Note: While this practical activity simulates the process of using a home pregnancy test kit, it is essential to remind students that the actual determination of pregnancy should be done under the guidance of a healthcare professional for confirmation and further care.

STUDY OF CONTRACEPTIVE DEVICES BY PHOTOGRAPHS OR MODELS

The prevention of pregnancy or conception is called contraception. The devices used for contraception are called contraceptives. The following are the methods of contraception with their contraceptives.

CONTRACEPTIVE METHOD USED

1. Natural method
    a) Total abstinence from coitus.
    b) Interrupted coitus.
    c) Rhythm.
2. Mechanical method: Diaphragm, cervical cap, condom/sheath {Nirodh}
3. Chemical method: Foam tablets, Jellies, and creams
4. Intra-uterine devices {IUD}: Copper-T and Loop
5. Oral contraceptives Pills/Tablets.
6. Sterilization operations: a] Male sterilization- Vasectomy
    b] Female sterilization or Tubectomy/ Tubal ligation.
7. Abortion Medical pregnancy termination- MTP.

1) NATURAL METHOD

A] TOTAL ABSTINENCE OR COITUS

Conception is prevented when the couple has intercourse. One can apply this method with a full understanding of the partner. This is the real, sure way of preventing conception.

B] INTERRUPTED COITUS

This is the earliest form of birth control. It needs knowledge of the reproductive process. Conception requires not only sexual union but also ejaculation of semen into the female tract. During sexual intercourse one has to withdraw the penis from the vagina before ejaculation. Failure in this method is either due to pre-ejaculatory escape of fluid containing sperm or failure to withdraw before ejaculation

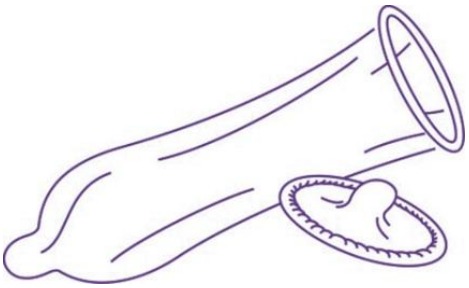
C] RHYTHM/CALENDAR METHOD

In this method one must have the knowledge of reproductive physiology that ovum can be fertilized only during a period of 3-5 days in each menstrual cycle. Those days are 3 days before ovulation {11, 12, and 13}. The day of ovulation {14th day} and three days after ovulation ie {15, 16, & 17}. During these mentioned days couples must retain from intercourse effectiveness of such a rhythm method for birth control is poor because all ladies will not have a regular cycle. Couples are instructed to know and understand the rhythm of their sexual cycle.

2] MECHANICAL METHOD

In this method a barrier is created between the male organ and the interior of the female passage. The barrier is purely mechanical like condom diaphragm, cervical cap etc.

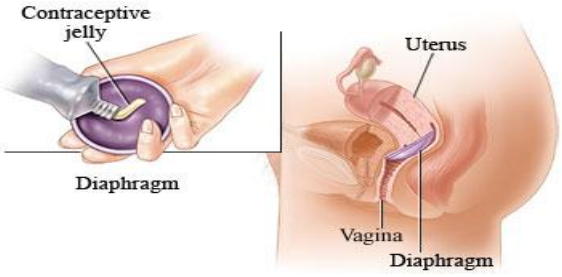
A] CONDOM



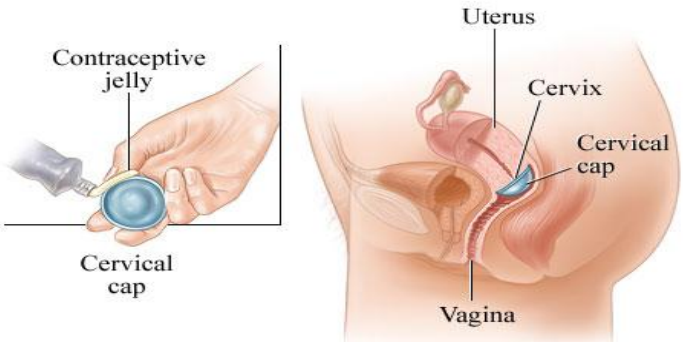
Condoms are of two types like Male condoms and Female condoms. In male it is placed over penis and hence it prevents the deposition of sperms in the vagina. Male condom is an elastic pouch rolled and placed in a safe packet. Before intercourse it is taken out of the packet to place on the erect penis, leaving space at the tip. Unrolling is then done gradually covering the whole penis. This method also prevents various STD infections {sexual transmitting diseases} and it is the only contraceptive to prevent AIDS infection too. A female condom is inserted to fit over the cervix. It is essential to do the proper use of condoms during each sexual intercourse.

B] DIAPHRAGM

It is a dome shaped rubber structure that fits over the cervix. Diaphragm prevents the sperms from passing into the cervix. It is generally used with spermicidal agents that kill the sperms. Diaphragm should be fitted by a physician.



C] CERVICAL CAPS



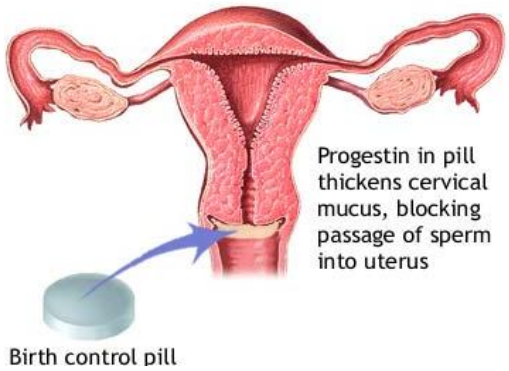
It is a plastic cap of 4cm diameter. It fits snugly over the cervix and it is held in position by suction. It is also fitted by a physician.

3] CHEMICAL METHOD

Use of foam tablets, jellies and creams are the chemical method of contraception.

A] FOAM TABLETS

These are the tablets which produce foam when they are moistened. They are used one at a time. A tablet is moistened and placed deep in vagina before the intercourse. The foam produced destroys the sperm during intercourse.



B] JELLY

This is available in the market in a tube along with its applicator and its operation is to be done carefully. One has to fix the applicator to the jelly tube. If a jelly tube is pressed the applicator naturally gets filled with felly. Such an applicator full of jelly is then inserted into the vagina. If the plunger is pressed slowly while taking out the applicator the jelly will be released into the vagina. Jelly destroys the sperms during intercourse.

C] CREAMS

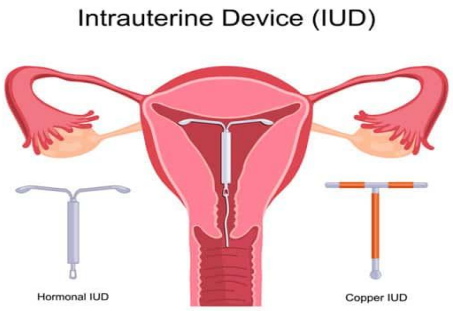
Various creams are also used as contraceptives. They are applied to vagina before the intercourse. These creams are spermicidal in their actions to kill the sperms in vagina.

4] INTRAUTERINE DEVICES {IUD}

The commonly used IUDs are Copper-T and Lippies loop. They are small objects made of copper, stainless steel and plastic. Plastic Loop is not commonly used but Copper-T is in best use. Plastic Loop is a device made of polyethylene. It is a relatively permanent method.

COPPER-T

It is a permanent method of contraception for a relatively long period. Once it is introduced into the uterus it does not allow the egg to implant and thus pregnancy is prevented. Copper-T is to be introduced into the uterus by doctors. One has to change or replace old by new one after 3 years. Loops also prevent a fertilized egg from being implanted into the uterus. Following are some advantage and disadvantage of Copper-T



ADVANTAGES OF COPPER-T

a) It is effective {100%}
b) It is aesthetic and reversible.
c) It is non-interfering and reversible.
d) Its association is painless.
e) No problems with storage and disposal.
f) It provides opportunity for gynecological examination

DISADVANTAGES OF COPPERT

a) Sometimes they can cause cramps like pain. Back ache, menstrual bleeding, spotting etc.
b) These side effects are not serious and usually disappear after a few months.

5] ORAL CONTRACEPTIVES {O.C./Pills}

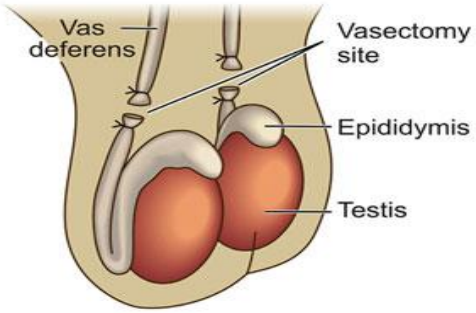
Pregnancy can be prevented by suppressing ovulation. This is done by some oral contraceptive agents, which are available in the form of tablets or capsules/pills. Contraceptive pills work by inhibiting the release of an egg from the ovaries during the menstrual cycle, thus preventing fertilization by sperm. The tablets should be taken for 21 days continuously starting on the 5th day of the menstrual cycle and finishing on the 25th day. Bleeding usually occurs on the 28th day. The next course of tablet should begin again on the 5th day of the next cycle.

6] STERILIZATION OPERATIONS

It is a popular method of birth control. By this method relatively permanent infertility is achieved. In the case of males, it is called Vasectomy and in females it is called Tubectomy.

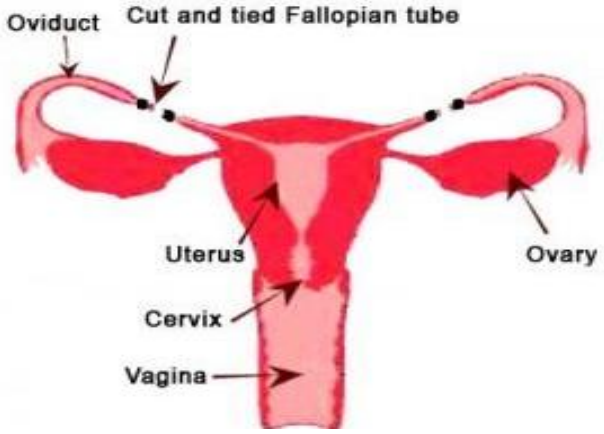
A] VASECTOMY

It is a surgical operation done is male. In male vasectomy, the vas deferens is cut on the sides of the testis. The cut ends are made into knots. This operation is simple and is completed within 20 minutes.



B] TUBECTOMY

It is also called Tubal ligation. In Tubectomy the fallopian tubes are cut and cut ends are made into knots. So that the passage of sperm into the tubes is blocked therefore there will not be any fertilization as such after separation she should not carry weights or do not heavy manual work for at least one month.



7] ABORTION

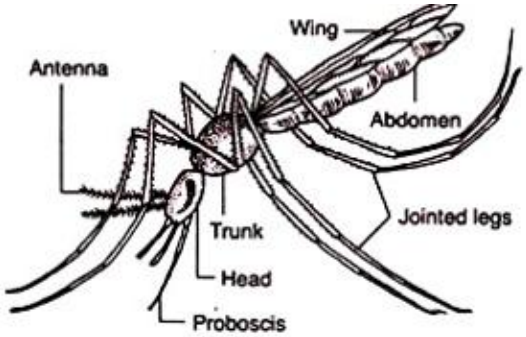
Abortion is the expulsion of conception products from the uterus. It is done by a physician. It is a birth control method and should be done before the 20th week of gestation. In the medical field, abortion is called MTP {Medical termination of pregnancy}, D & C {Dilation and surgical curettage}. In MTP the cervix is dilated with instrument & embryo is sucked out.

UNIT II: APPLIED ZOOLOGY

STUDY OF ARTHROPOD VECTORS ASSOCIATED WITH HUMAN DISEASES

A) ANOPHELES MOSQUITO

Only female Anopheles mosquitoes bite and transmit the malaria parasite. When an infected mosquito bites a human, it injects the parasites, which then multiply in the liver and red blood cells, causing the symptoms of malaria. Different species of Anopheles are vectors in different regions of the world.

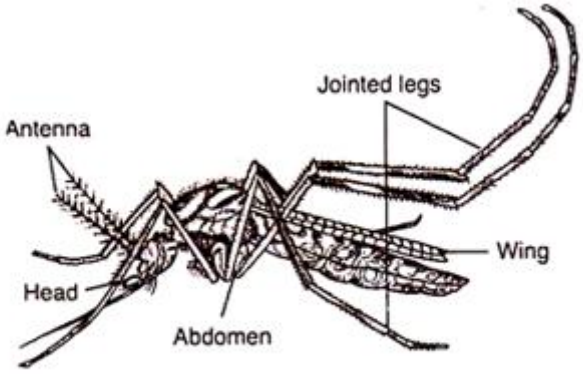


ANOPHELES MOSQUITO

Diseases Transmitted: Primarily **malaria**, a parasitic disease caused by Plasmodium parasites. Anopheles mosquitoes are the sole vectors of malaria in humans. They can also transmit some types of filarial worms that cause lymphatic filariasis.

B) AEDES MOSQUITO

Aedes aegypti and *Aedes albopictus* are two of the most significant species in this genus. They are often found in urban and suburban areas, breeding in artificial containers like tires, flower pots, and water storage containers. These mosquitoes are active during the daytime. When an *Aedes* mosquito bites an infected person, it picks up the virus, which then replicates within the mosquito's body and is subsequently transmitted to other humans through subsequent bites.



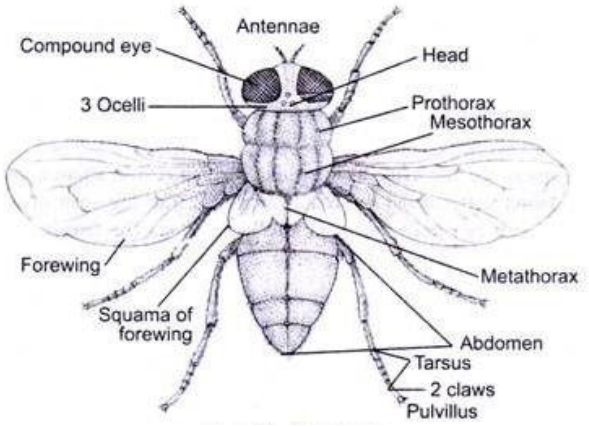
Aedes aegypti

Diseases Transmitted: Aedes mosquitoes are notorious for transmitting a variety of viral diseases, including:

- Dengue fever
- Chikungunya fever
- Yellow fever
- Zika virus
- Some species can also transmit filarial nematodes (e.g., *Dirofilaria*).

C) MUSCA HOUSEFLY

Houseflies have a strong attraction to decaying organic matter and excrement, where they feed and breed. Their hairy bodies and sticky footpads readily pick up microorganisms. When they land on food or surfaces in human environments, they can deposit these pathogens, leading to contamination and potential infection. They also regurgitate and defecate on surfaces, further spreading germs.



HOUSEFLY

Diseases Transmitted: Houseflies (Musca domestica) are primarily mechanical vectors. This means they do not host the pathogen's life cycle but rather pick up pathogens on their bodies, legs, and mouthparts from contaminated sources (like feces, decaying matter, garbage) and then transfer them to human food, drinks, or surfaces. They can transmit over 100 different types of pathogens, including:

- **Bacterial diseases:** Cholera, typhoid fever, dysentery (caused by *Shigella*), salmonellosis, tuberculosis, anthrax.
- **Viral diseases:** Poliomyelitis, viral hepatitis, ORF virus.
- **Parasitic diseases:** Ascariasis (roundworm eggs), amoebiasis.

All three are arthropod vectors associated with human diseases, their modes of transmission and the types of diseases they carry differ significantly. Mosquitoes (Anopheles and Aedes) are biological vectors that transmit pathogens through their bites after the

pathogen has replicated within them, while houseflies (Musca) are primarily mechanical vectors, passively transferring pathogens.

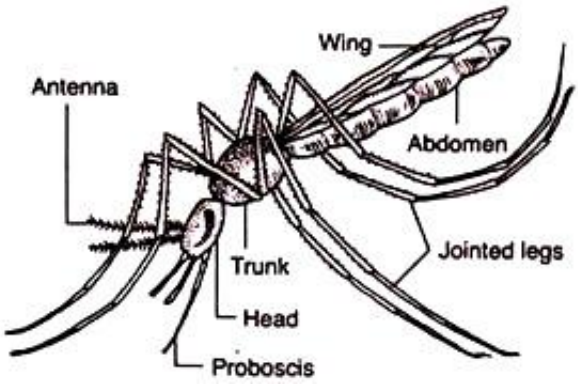
STUDY OF MOSQUITO BORNE DISEASES

Mosquitoes are biological vectors, meaning that the disease-causing pathogen (virus, parasite) actually replicates or undergoes developmental stages within the mosquito's body before being transmitted to a human. This makes them highly efficient at spreading diseases.

When an infected mosquito bites a human, it injects saliva containing anticoagulants and pathogens into the bloodstream. When an uninfected mosquito bites an infected human, it ingests the pathogens with the blood, and these pathogens then develop within the mosquito, making it capable of transmitting the disease to another human in a subsequent bite.

Mosquito-Borne Diseases

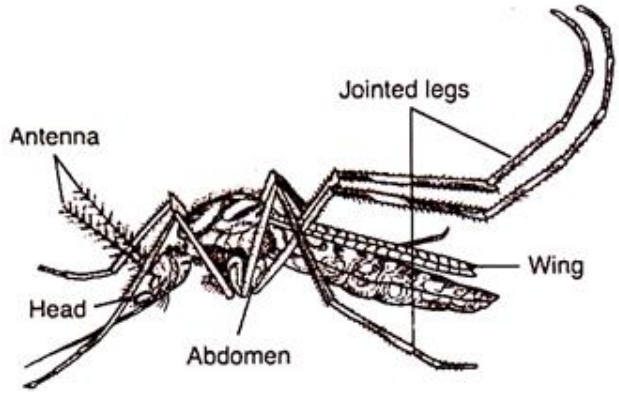
A) MALARIA



Anopheles

- **Causative Agent:** Parasites belonging to the genus Plasmodium (e.g., Plasmodium falciparum, P. vivax, P. ovale, P. malariae, P. knowlesi).
- **Vector:** Primarily transmitted by female Anopheles mosquitoes.
- **Transmission Cycle:** An infected Anopheles mosquito bites a human, injecting Plasmodium sporozoites. These travel to the liver, mature, and then infect red blood cells, causing the characteristic cyclical fevers and chills. When another Anopheles mosquito bites an infected human, it picks up gametocytes (a stage of the parasite) from the blood. These gametocytes mature within the mosquito, making it infectious.
- **Symptoms:** Fever, chills, sweating, headache, muscle aches, fatigue. Severe malaria can lead to anemia, jaundice, seizures, coma, and death. It remains a major global health burden.

B) DENGUE



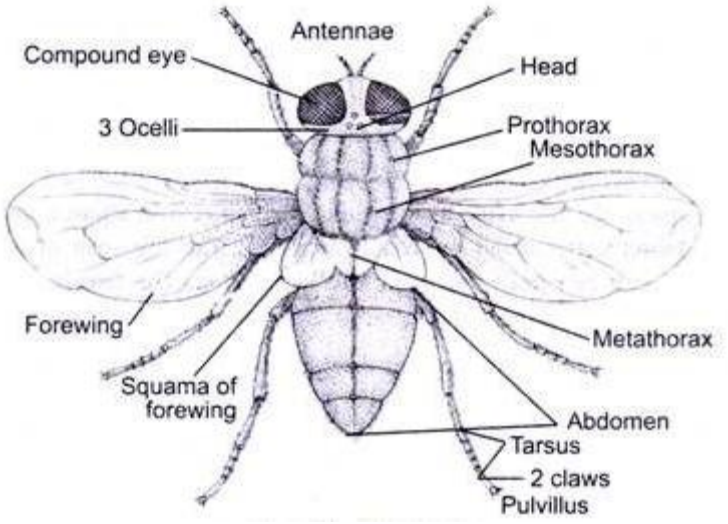
Aedes aegypti

- **Causative Agent:** Dengue virus (DENV), which has four distinct serotypes (DENV-1, DENV-2, DENV-3, DENV-4).
- **Vector**: Primarily transmitted by female Aedes aegypti mosquitoes, and to a lesser extent by Aedes albopictus.
- **Transmission Cycle**: An Aedes mosquito bites a person infected with the dengue virus. The virus replicates within the mosquito. The infected mosquito then bites a healthy person, transmitting the virus. Subsequent infections with different serotypes can increase the risk of severe dengue.
- **Symptoms:** High fever, severe headache, pain behind the eyes, muscle and joint pain, rash, and sometimes mild bleeding. Severe dengue (Dengue Hemorrhagic Fever/Dengue Shock Syndrome) can lead to plasma leakage, severe bleeding, organ impairment, and can be fatal.

Both Malaria and Dengue are classic and very significant examples of diseases transmitted by mosquitoes. They differ in the type of pathogen (parasite vs. virus) and the primary mosquito genus involved (Anopheles for malaria, Aedes for dengue), but both highlight the critical role of mosquitoes as disease vectors impacting millions globally.

STUDY OF HOUSE FLY TRANSMITTED DISEASE

The House Fly (*Musca domestica*) as a Disease Vector



HOUSE FLY (*Musca domestica*)

The house fly is a mechanical vector, meaning it carries disease-causing microorganisms on its body parts (legs, mouthparts, body hairs) and in its gut, rather than acting as a biological host where the pathogen replicates within the fly (like mosquitoes for malaria).

Their habits make them highly effective in spreading pathogens:

- They feed on a wide variety of decaying organic matter, including feces (human and animal), garbage, sewage, and rotting food.
- They also feed on human food and surfaces where food is prepared.
- They move frequently between contaminated sources and uncontaminated surfaces, including food, utensils, and human skin.
- They regurgitate digestive fluids and defecate frequently, depositing pathogens directly onto surfaces.

Diseases Transmitted by House Flies

A) TYPHOID FEVER

- **Causative Agent:** *Salmonella Typhi* bacteria.
- **Transmission:** A person with typhoid fever or a carrier sheds the bacteria in their feces. House flies land on contaminated feces, pick up the bacteria on their legs and body, and ingest them. When the fly then lands on food or water intended for human consumption, it can deposit the bacteria through its contaminated feet, mouthparts, or by defecating/regurgitating on the food. When a person consumes this contaminated food or water, they can become infected.

- **Symptoms:** High fever, weakness, fatigue, headache, loss of appetite, rash and sometimes diarrhea or constipation. It can be severe and life-threatening if untreated.

B) DYSENTERY

- **Causative Agents:** Can be caused by various pathogens, most commonly
  - **Bacteria:** *Shigella* species (bacillary dysentery) and some strains of *E. coli*.
  - **Amoebae:** *Entamoeba histolytica* (amoebic dysentery).
- **Transmission:** Similar to typhoid, dysentery-causing pathogens are shed in the feces of infected individuals. House flies contaminate themselves by landing on these faeces. They then transfer these pathogens to food, water, or surfaces that humans come into contact with, leading to oral-fecal transmission.
- **Symptoms:** Severe diarrhea often containing blood and mucus, abdominal cramps, fever, and tenesmus (a feeling of incomplete defecation).

Both Typhoid and Dysentery are classic examples of diseases that are efficiently transmitted by house flies through mechanical contamination of food and water sources. Their filthy habits and constant movement between unsanitary and sanitary environments make them significant vectors for these and many other enteric (intestinal) diseases.

STUDY OF INSECT PESTS THROUGH DAMAGED PRODUCTS/PHOTOGRAPHS.

A) CROP PEST: GRAM POD BORER (*Helicoverpa armigera*)

The Gram pod borer (Helicoverpa armigera) is a highly destructive insect pest that poses a significant threat to various crops, especially legumes such as Chickpea (Gram), Pigeon Pea and Soybean. It is widely distributed in many parts of the world and is known by various names, including the corn earworm, cotton bollworm and tomato fruit worm.

The role of the Gram pod borer as a crop pest is as follows:

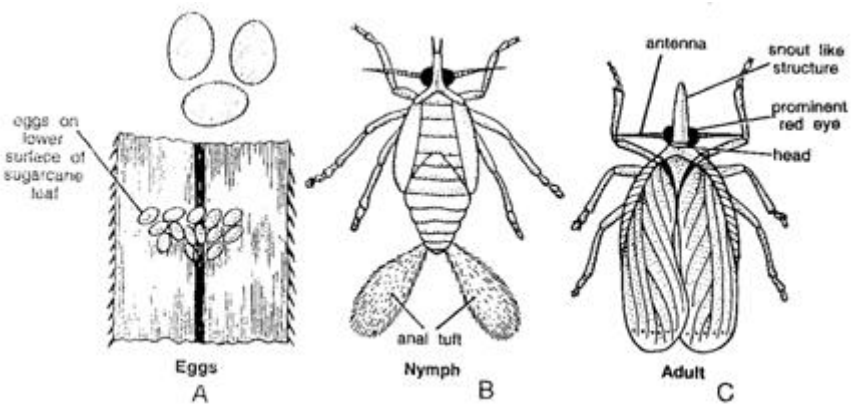
1) **Feeding on Plant Parts:** The Gram pod borer larvae primarily feed on different parts of the host plants. They are voracious feeders and can cause considerable damage to crops by consuming leaves, flowers, pods and seeds.
2) **Reduction in Crop Yield:** Infestations of Gram pod borer can lead to significant yield losses in affected crops. Since they feed on reproductive structures like pods and seeds, the damage can directly affect the quantity and quality of the harvested produce.
3) **Secondary Infections:** The entry points created by Gram pod borer larvae while feeding can serve as entry points for pathogens, leading to secondary infections that further damage the plants.
4) **Widespread Host Range:** The Gram pod borer has a broad host range, affecting several economically important crops, which makes it a significant threat to agricultural production and food security.
5) **Resilience to Pesticides:** The Gram pod borer has shown a remarkable ability to develop resistance to many chemical pesticides used for control. This has led to challenges in managing infestations and controlling their populations effectively.
6) **Seasonal Outbreaks:** The population dynamics of Gram pod borer can be unpredictable, leading to sudden and severe outbreaks in certain years or regions. During outbreaks, the damage to crops can be especially severe.

Farmers employ various methods to manage Gram pod borer infestations, including cultural practices such as crop rotation, intercropping, and the use of resistant varieties. Biological control using natural enemies like predators and parasitoids is also commonly used to reduce the pest population. Additionally, integrated pest management (IPM) approaches that combine different control methods, including judicious use of insecticides are employed to minimize crop losses while reducing the risk of resistance development.

Effective management of the Gram pod borer requires continuous monitoring of pest populations and the adoption of sustainable and environmentally friendly pest control strategies to mitigate its impact on crops and agricultural productivity.

B) CROP PEST: SUGARCANE LEAF HOPPER (*Pyrilla perpusilla*)

The Sugarcane leafhopper (Pyrilla perpusilla) is a notorious insect pest that affects sugarcane crops, causing significant economic losses to sugarcane growers. It is a sap-sucking insect that feeds on the leaves of sugarcane plants. The role of the Sugarcane leafhopper as a crop pest includes the following



1. **Feeding Damage:** Sugarcane leafhoppers feed by inserting their needle-like mouthparts into the plant tissues and sucking out the plant sap. This feeding activity weakens the plant and reduces its photosynthetic capacity, leading to stunted growth and reduced yield.
2. **Direct Crop Damage:** The direct damage caused by Sugarcane leafhoppers leads to the formation of chlorotic spots on the leaves and the appearance of "Hopper Burn," a characteristic condition where leaves dry up and wither due to excessive sap removal.
3. **Transmission of Pathogens:** The leafhoppers can act as vectors for plant pathogens, including viruses and phytoplasmas. When they feed on infected plants, they can pick up the pathogens and transmit them to healthy sugarcane plants during subsequent feedings, leading to the spread of diseases.

4. **Honeydew Production:** Like many sap-sucking insects, Sugarcane leafhoppers excrete honeydew, a sugary substance. The honeydew provides a medium for the growth of sooty mold, which can further reduce the plant's ability to photosynthesize and contribute to reduced plant vigor.
5. **Crop Yield Losses:** Severe infestations of Sugarcane leafhoppers can result in substantial yield losses, affecting both cane tonnage and sucrose content in the harvested sugarcane.
6. **Disruption of Plant Growth:** The feeding activity of the leafhoppers can disrupt the normal physiological processes of the sugarcane plant, affecting its overall growth and development.

To manage Sugarcane leafhopper infestations, sugarcane growers employ a combination of cultural, biological and chemical control strategies. These may include

1) **Monitoring and Early Detection:** Regular monitoring of sugarcane fields allows growers to detect leafhopper infestations early and take timely action.
2) **Cultural Practices:** Crop rotation, planting resistant varieties and maintaining good field hygiene can help reduce leafhopper populations.
3) **Biological Control:** Natural enemies, such as predatory insects and parasitoids, can help control leafhopper populations and are often integrated into pest management programs.
4) **Insecticides**: Chemical control measures, such as the judicious use of insecticides, are sometimes necessary to manage severe infestations. Integrated pest management (IPM) approaches aim to minimize the use of insecticides while maximizing their effectiveness.
5) **Tolerant Varieties:** Developing and planting sugarcane varieties with some level of tolerance to leafhopper feeding can help mitigate the impact of infestations.
6) **Neem-Based Products:** The use of neem-based insecticides has shown promise in controlling sugarcane leafhoppers while being less harmful to beneficial insects.

It is essential for sugarcane growers to implement a holistic approach to manage sugarcane leafhopper infestations effectively. This includes combining cultural practices, biological control and judicious use of insecticides to minimize crop damage and ensure sustainable sugarcane production.

C) CROP PEST: LEMON BUTTERFLY (*Papilio demoleus*)

The Lemon Butterfly (Papilio demoleus) also known as the Common Lime Butterfly or Citrus Swallowtail, is a pest that can cause damage to certain crops, particularly plants in the citrus family. Its role as a crop pest is as follows

1) **Feeding on Leaves and Fruits:** The Lemon Butterfly larvae (caterpillars) feed on the leaves of various host plants, including citrus trees such as lemon, lime, orange and other related species. They can consume large quantities of foliage, leading to defoliation and weakening of the plant.
2) **Damage to Young Shoots:** The caterpillars may also feed on young shoots and tender plant parts, affecting the growth and development of the citrus trees.
3) **Reduction in Crop Yield:** Severe infestations of Lemon Butterfly caterpillars can cause substantial damage to citrus crops, resulting in reduced fruit production and lower quality fruits.
4) **Transmitting Plant Diseases**: While the Lemon Butterfly itself is not a vector for plant diseases, its feeding activity can create entry points for pathogens, making the plants more susceptible to infections.
5) **Indirect Damage:** In addition to direct feeding damage, the presence of caterpillars can attract predators and parasites that may further affect the crop's health and productivity.
6) **High Reproductive Rate:** The Lemon Butterfly has a high reproductive rate, and its population can quickly increase under favorable conditions, leading to higher pest pressure on citrus crops.

To manage Lemon Butterfly infestations and reduce crop damage, several control measures can be employed:

1) **Cultural Practices:** Maintaining good field hygiene, pruning affected plant parts and removing egg masses and caterpillars can help reduce population levels.
2) **Biological Control:** Natural predators and parasitoids, such as birds, wasps, and spiders, can provide natural control of Lemon Butterfly populations.
3) **Chemical Control:** In severe infestations, the judicious use of insecticides may be necessary. However, care should be taken to follow Integrated Pest Management (IPM) practices and avoid harming beneficial insects and pollinators.

4) **Resistant Varieties:** Planting citrus varieties that are less preferred by Lemon Butterflies can help minimize damage.
5) **Trap Crops:** Growing trap crops that attract Lemon Butterflies away from the main citrus crop can be effective in reducing direct damage to the main crop.

It's important to note that while the Lemon Butterfly can be a pest for citrus crops, it also serves as a pollinator for various plants and plays a role in the ecosystem. Therefore, the management of this pest should be carried out carefully, with consideration for its ecological impact and the use of sustainable pest management practices.

B. STORED GRAINS PESTS

a) Stored grains pest: Pulse Beetle (*Callosobruchus chinensis*)

The Pulse Beetle (Callosobruchus chinensis), also known as the Cowpea Weevil or Grain Beetle, is a significant pest of stored grains, particularly pulses such as Chickpeas, Lentils, Mung Beans and Cowpeas. This beetle is a serious threat to stored grain commodities and its role as a stored grain pest includes the following:

1) **Infestation of Stored Grains:** Adult Pulse Beetles lay eggs on or inside the grains, especially in cracks or damaged seeds. The larvae (grubs) hatch from these eggs and bore into the grains to feed on the internal contents.
2) **Damage to Grains:** The feeding activity of the Pulse Beetle larvae inside the grains can cause extensive damage. They consume the endosperm, reducing the nutritional value of the grain and leading to a decrease in grain quality.
3) **Spoilage of Grains:** As the larvae feed and develop inside the grains, they produce frass (excrement) and secretions, which can lead to mold growth and contamination of the stored grains. This can render the grains unfit for human or animal consumption.
4) **Reproduction and Population Growth:** Pulse Beetles have a rapid reproductive rate, and a small infestation can quickly multiply into a large population, leading to widespread damage in stored grain facilities.
5) **Resistance to Insecticides:** The Pulse Beetle has shown the ability to develop resistance to various chemical insecticides used for pest control. This can make management challenging and requires the use of integrated pest management (IPM) strategies.

6) **Longevity and Survival:** Adult Pulse Beetles have a relatively long lifespan, and they can survive for extended periods in storage facilities, allowing them to infest multiple batches of stored grains.

To manage the infestation and prevent damage caused by Pulse Beetles in stored grains, the following control measures are often employed:

1) **Sanitation and Hygiene:** Regular cleaning of storage facilities to remove debris, damaged grains and residues helps reduce the beetle's breeding sites.
2) **Temperature and Moisture Management:** Maintaining proper temperature and moisture levels in storage can help prevent insect development and reproduction.
3) **Fumigation:** Controlled application of fumigants in storage facilities can be effective in controlling Pulse Beetle populations. However, fumigants should be used with caution, following safety guidelines and regulations.
4) **Use of Insect-Resistant Packaging:** Using insect-resistant storage containers or bags can help prevent the entry of adult beetles and reduce infestations.
5) **Monitoring and Early Detection:** Regular monitoring of stored grains for signs of infestation allows for early detection and timely intervention.
6) **Natural Enemies:** Natural predators and parasitoids can provide biological control of Pulse Beetle populations and help suppress their numbers.

By implementing these management strategies, farmers and grain storage facilities can reduce losses caused by Pulse Beetles and maintain the quality of stored grains. Additionally, preventing infestations is essential for ensuring food security and preserving grain supplies for human and animal consumption.

B) STORED GRAINS PEST: RICE WEEVIL (*Sitophilus oryzae*)

The Rice Weevil (Sitophilus oryzae) is one of the most common and destructive pests of stored grain, particularly rice, but it can also infest other grains such as Wheat, Barley, Oats, and Corn. As a stored grain pest, the Rice Weevil plays the following roles:

1) **Infestation of Stored Grains:** Adult Rice Weevils lay their eggs inside the grain kernels, making small holes to deposit them. The developing larvae (grubs) feed on the internal contents of the grains, causing damage.

2) **Damage to Grains:** The feeding activity of the Rice Weevil larvae and adults inside the grains leads to a reduction in grain quality. They consume the endosperm, causing a loss of nutritional value and making the grains unfit for consumption.
3) **Spoilage of Grains:** As the Rice Weevil larvae feed and develop inside the grains, they produce frass (excrement) and secretions, leading to mold growth and contamination of the stored grains. This can further reduce the quality and market value of the grains.
4) **Reproduction and Population Growth:** The Rice Weevil has a rapid reproductive rate, and a single female can lay hundreds of eggs during her lifetime. This allows for quick population growth and widespread infestations in storage facilities.
5) **Resistance to Insecticides:** The Rice Weevil has developed resistance to many chemical insecticides commonly used for pest control. This makes managing infestations more challenging and necessitates the use of integrated pest management (IPM) strategies.
6) **Longevity and Survival**: Adult Rice Weevils have a relatively long lifespan and can survive for extended periods in storage facilities, even under adverse conditions, allowing them to persist and infest multiple batches of stored grains.

To manage infestations and prevent damage caused by Rice Weevils in stored grains, the following control measures are typically employed

1) **Sanitation and Hygiene:** Regular cleaning of storage facilities to remove spilled grains, dust and debris helps reduce the weevils' breeding sites.
2) **Temperature and Moisture Management:** Maintaining proper temperature and moisture levels in storage can help prevent insect development and reproduction.
3) **Fumigation:** Controlled application of fumigants in storage facilities can be effective in controlling Rice Weevil populations. However, fumigants should be used with caution, following safety guidelines and regulations.
4) **Use of Insect-Resistant Packaging:** Using insect-resistant storage containers or bags can help prevent the entry of adult weevils and reduce infestations.
5) **Monitoring and Early Detection:** Regular monitoring of stored grains for signs of infestation allows for early detection and timely intervention.
6) **Natural Enemies:** Natural predators and parasitoids can provide biological control of Rice Weevil populations and help suppress their numbers.

By implementing these management strategies, farmers and grain storage facilities can minimize losses caused by Rice Weevils and preserve the quality of stored grains. Proper pest management practices are essential for ensuring food security and preventing economic losses due to stored grain pests.

c) RED FLOUR BEETLE (*Tribolium castaneum*)

Identifying Features

Tribolium castaneum, commonly known as the Red Flour Beetle, is a common pest that infests stored grain products, including flour, cereal, grains and various processed food products. Here are some identifying features of *Tribolium castaneum*:

a. **Size:** Adult Red Flour Beetles are small insects, measuring approximately 3 to 4 millimeters in length. The body is elongated and flattened, with a reddish-brown or dark brown coloration.
b. **Body Shape:** *Tribolium castaneum* has an oval-shaped body with distinct ridges along the wing covers (elytra). The elytra cover the abdomen and meets in a straight line down the middle of the back.
c. **Antennae:** The Red Flour Beetle has segmented antennae that arise from the front of its head. The antennae are slender and clubbed at the tips, giving them a distinct shape.
d. **Wings:** Although they possess wings, Red Flour Beetles are poor fliers. The wings are membranous and located underneath the elytra. However, the beetles primarily rely on crawling for movement.

Economic Importance

Tribolium castaneum, the Red Flour Beetle, has significant economic importance due to its impact on stored grain products and processed food. Here are some key points regarding its economic importance:

a. **Damage to Stored Food Products:** Red Flour Beetles infest and feed on a wide range of stored grain products, including flour, meal, cereal and other processed food items. They can penetrate packaging materials and contaminate the products, resulting in quality degradation, off-flavors, and off-odors. Infested products may also become unappetizing and unsuitable for human consumption, leading to economic losses for food manufacturers and retailers.
b. **Product Contamination:** *Tribolium castaneum* beetles and their larvae can contaminate stored food products with their feces, body parts, and cast skins. This

contamination poses a health risk, as it can introduce pathogens, bacteria and allergens into the food, potentially leading to food borne illnesses and product recalls.

c. **Rapid Reproduction:** Red Flour Beetles have a rapid reproductive cycle, with females capable of laying hundreds of eggs in their lifetime. The eggs are laid in food products, and the hatched larvae feed on the products, further increasing the damage and potential for infestation spread. This reproductive capability allows for quick population growth and infestation development in storage facilities.

d. **Resistance to Control Measures:** *Tribolium castaneum* has demonstrated the ability to develop resistance to various insecticides used for control. This resistance poses challenges for effective pest management and necessitates Integrated Pest Management (IPM) strategies, including the use of multiple control methods and regular monitoring for resistance.

Effective management of *Tribolium castaneum* infestations involves a combination of preventive measures and control techniques. This includes maintaining proper sanitation, implementing good storage practices, employing physical controls (such as heat treatment and freezing), and utilizing insecticidal treatments when necessary. By implementing robust pest management practices, food producers can minimize the economic losses caused by Red Flour Beetle infestations and ensure the quality and safety of their products.

STUDY OF INSECTS INVOLVED IN THE FORENSIC INVESTIGATIONS

Forensic Entomology is a fascinating and crucial branch of forensic science that utilizes the study of insects (and other arthropods) to aid in legal investigations. Its primary application is in determining the Post Mortem Interval (PMI), or the time elapsed since death, especially in cases where a body has been found after several days, weeks, or even months, and other methods of PMI estimation are no longer effective.

Pioneering Colonizers: The most important insects in forensic entomology related to death investigations are those that are attracted to decaying remains and colonize them in a predictable succession. These are primarily necrophagous insects, meaning they feed on dead or decaying tissue.

a) BLOW FLY *(Calliphora* spp. - and other genera like Lucilia, Chrysomya)

Blow flies are often the first insects to arrive at a corpse, sometimes within minutes of death, especially if the body is exposed. They are highly attracted to the odors of decomposition.

Life cycle and PMI Estimation: They lay eggs (oviposit) on the body, particularly in natural orifices (nose, mouth, eyes, open wounds). These eggs hatch into larvae (maggots), which go through several instars (growth stages), feeding on the decaying tissue. After reaching a certain size, they migrate away from the body to pupate. The pupa then develops into an adult fly.

Why they are crucial: The development of blow flies is highly dependent on temperature. Forensic entomologists can collect larvae or pupae from a body, identify the species, and then, knowing the local temperatures (from weather stations or on-site temperature loggers), calculate the age of the insects. This age provides a minimum PMI (PMI min), indicating at least how long the body has been exposed to insect activity. Different species have slightly different developmental rates, making accurate identification essential.

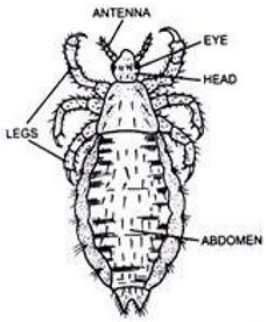
b) COMMON FLESH FLY (*Sarcophaga* spp.)

Flesh flies are also significant early colonizers, often arriving shortly after or even concurrently with blow flies.

Key Difference (Viviparity): Unlike blow flies which lay eggs, flesh flies are viviparous, meaning they deposit live larvae directly onto the decaying remains. This can sometimes make them appear to be "older" on the body than blow fly eggs laid at the same time.

Role in PMI: Similar to blow flies, their larval development stages are predictable based on temperature, allowing forensic entomologists to use their presence and development to estimate PMI. They contribute to the overall entomological evidence, especially when found alongside or in place of blow flies.

c) HEAD LOUSE (Pediculus humanus capitis)



The head louse is an obligate ectoparasite of humans, meaning it lives exclusively on the external surface of the human body, specifically the hair and scalp, and feeds on human blood.

No Role in Decomposition: Head lice are adapted to living on a living host. They are not attracted to or involved in the decomposition process of a deceased body. Once a host dies, the body cools, blood circulation stops, and the lice will eventually die or abandon the host.

Forensic Relevance (Limited): Their presence on a deceased person might, in very specific and rare circumstances, indicate things like personal hygiene history or recent contact with an infested individual. However, they play no role in determining the time of death or the circumstances surrounding the death through entomological succession or decomposition patterns. They certainly wouldn't be used to estimate PMI.

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About Authors

Prof. K. J. Adate is working as a Head, Department of Zoology, Shivraj College Gadhinglaj, Dist-Kolhapur since last twenty two years. He has published many research papers in reputed journals. He has completed one minor research project of UGC. Till today Published twenty one books for B. Sc. I and B. Sc. II Zoology on Theory and practical syllabus of Shivaji University, Kolhapur.
Mob. 9271692747; E-mail: kjadate@gmail.com

Dr. Sagar A. Vhanalakar is presently working as an Associate Professor and Head, Department of Zoology, Karmaveer Hire College, Gargoti, Dist – Kolhapur. He has 15 years of teaching experience and 14 years of research experience. There are 53 research papers, 12 book chapters 14 edited book, 50 popular newspaper articles and 5 books on the name of Dr. Vhanalakar. He worked as an organizing secretary for two international, three national and ten university level conferences and seminars.
Mob. No. 9511266950; E-mail: sagarayan36@gmail.com

Dr. V. V. Ajagekar is working as a Head, Department of Zoology, Ajara Mahavidyalaya, Ajara, Dist-Kolhapur since last twenty six years. He is Research guide for M.Phil. and Ph.D. of Shivaji University, Kolhapur. He has completed one Minor Research Project and published sixteen research papers in reputed Journals. Till today Published twenty one books for B. Sc. I and B. Sc. II on syllabus of Shivaji University Kolhapur.
Mob. 9890087915; E-mail: vvajagekar@gmail.com

Prof. (Dr.) L. P. Lanka is presently working as a Head, Department of Zoology, Deuchand College, Arjunnagar, Dist – Kolhapur. He has 28 years of teaching experience at UG level and 6 years of PG. He is also the member of BoS in Zoology of Shivaji University, Kolhapur. Dr. Lanka has published 22 research papers in various reputed national & international Journals. He has participated and presented his research work in 32 conferences, seminars, etc. He has completed one minor research project funded by UGC. He is a research Guide in Zoology and Agrochemicals & Pest Management.
Mob. 9890677213; E-mail: lankalazarus@yahoo.co.in

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