- (i) Define the following terms (any four):
  - (a) Mehlis gland
    - Mehlis gland is a gland found in flatworms, particularly in trematodes and cestodes. It is located near the ootype and is involved in the formation of the eggshell. It secretes a lubricating fluid that aids in the passage of the egg and also contributes to the tanning of the eggshell.
  - (b) Bilateral Symmetry
    - Bilateral symmetry is a body plan where an organism can be divided into two mirror-image halves along a single sagittal plane. This type of symmetry allows for cephalization (development of a head region) and is commonly observed in actively moving animals, providing directional movement.
  - (c) Plasmotomy
    - Plasmotomy is a type of asexual reproduction observed in some multinucleated protozoans, such as Opalina. In this process, the multinucleated organism divides into two or more smaller multinucleated individuals without prior nuclear division. The nuclei are simply distributed among the daughter cells.
  - (d) Ootype
    - The ootype is a specialized chamber or region in the female reproductive system of flatworms (Platyhelminthes), particularly in trematodes and cestodes. It is where the ovum, vitelline cells (which provide yolk and shell material), and secretions from Mehlis' gland come together to form the encapsulated egg.
  - (e) Kinety
    - A kinety refers to a longitudinal row of kinetosomes (basal bodies) and their associated kinetodesmal fibrils found in

ciliated protozoans. It represents a functional unit involved in ciliary movement and is a significant morphological feature used in the classification of ciliates.

- (ii) Differentiate between the following pairs (any two):
  - (a) Schizogony and Sporogony
    - **Schizogony:**
      - Type of asexual reproduction in certain parasitic protozoa (e.g., Plasmodium).
      - Occurs in the definitive host (e.g., human red blood cells or liver cells for Plasmodium).
      - Involves multiple fission of a nucleus followed by cytoplasmic division, leading to the formation of numerous merozoites.
      - Results in rapid multiplication within the host.
    - **Sporogony:**
      - Type of sexual reproduction followed by asexual multiplication in certain parasitic protozoa (e.g., Plasmodium).
      - Occurs after gamete formation and fertilization, typically in the invertebrate vector (e.g., mosquito gut for Plasmodium).
      - Involves the formation of sporozoites from a zygote (oocyst) through meiosis and subsequent mitotic divisions.
      - Results in infective stages (sporozoites) that can transmit the parasite to a new host.
  - (b) Primary host and Secondary host

- **Primary host (Definitive host):**
    - The host in which a parasite reaches sexual maturity and undergoes sexual reproduction.
    - For Plasmodium (malarial parasite), humans are the primary host as sexual reproduction (gametogony and fertilization) occurs here.
- **Secondary host (Intermediate host):**
    - The host in which a parasite undergoes larval development or asexual reproduction.
    - For Plasmodium, the Anopheles mosquito is the secondary host as asexual multiplication (sporogony) occurs here, and it harbors the larval stages (oocysts).

- (c) Cnidoblast and Trichocyst
    - **Cnidoblast:**
        - Specialized stinging cell found exclusively in cnidarians (e.g., Hydra, jellyfish).
        - Contains a nematocyst, a barbed, coiled, and often venomous thread that is everted explosively upon stimulation.
        - Primarily used for prey capture and defense.
    - **Trichocyst:**
        - Rod-like extrusome found in the pellicle of some ciliated protozoans (e.g., Paramecium).
        - Discharged as a long, slender, sharp filament when the cell is stimulated.

- Believed to be involved in defense, anchorage, or possibly prey capture, though their exact function can vary.

- (iii) Match the Columns:
  - (a) Pinacocytes - 3) Sponges
  - (b) Amphids - 4) Nematoda
  - (c) Comb Plates - 2) Ctenoplana
  - (d) Gastrovascular cavity - 1) Hydra
- (iv) Give the exact location and one function of each of the following (any three):
  - (a) Pyrenoids
    - **Location:** Within the chloroplasts of certain algae and hornworts.
    - **Function:** Site of starch synthesis and storage (or other storage polysaccharides). They act as centers for polymerization of glucose into starch.
  - (b) Acetabulum
    - **Location:** Typically on the ventral surface of parasitic flatworms (trematodes and some cestodes).
    - **Function:** Acts as a suckling or adhesive organ, allowing the parasite to attach firmly to the host's tissues or organs.
  - (c) Coloblast cells
    - **Location:** Present on the tentacles of ctenophores (comb jellies).
    - **Function:** Used for capturing prey. They secrete a sticky substance that adheres to the prey, allowing the ctenophore to draw it towards its mouth.

- (d) Pneumatophore
  - **Location:** Found in colonial siphonophores (a type of cnidarian, e.g., Physalia physalis or Portuguese Man O' War). It is the gas-filled float at the surface.
  - **Function:** Provides buoyancy to the colonial organism, allowing it to float on the water surface.

- (a) Give the illustrated account of life history of malarial parasite in man.
  - The life cycle of the malarial parasite (Plasmodium) is complex, involving two hosts: humans (as the intermediate host, though often referred to as the primary host due to sexual reproduction occurring here in older terminology) and the female Anopheles mosquito (as the definitive host). Here, we focus on the stages in man.
  - **Infection of Man (Pre-erythrocytic or Exo-erythrocytic Cycle):**
    - When an infected female Anopheles mosquito bites a human, it injects **sporozoites** (the infective stage) along with its saliva into the bloodstream.
    - The sporozoites rapidly travel through the bloodstream and invade liver cells (hepatocytes) within minutes.
    - Inside the liver cells, each sporozoite undergoes asexual reproduction called **exo-erythrocytic schizogony**.
    - The sporozoite grows and divides multiple times to form a large multinucleated structure called a **schizont**.
    - After 5-16 days (depending on the Plasmodium species), the liver schizont ruptures, releasing thousands of **merozoites** into the bloodstream.
    - *(Note: For P. vivax and P. ovale, some sporozoites can remain dormant in the liver as **hypnozoites**, causing relapses weeks or months later.)*

- **Infection of Red Blood Cells (Erythrocytic Cycle):**
  - Merozoites released from the liver rapidly invade red blood cells (erythrocytes).
  - Inside the red blood cell, a merozoite develops into a **ring stage** (early trophozoite).
  - The ring stage then grows into an **amoeboid trophozoite**, feeding on hemoglobin.
  - The trophozoite then develops into an **erythrocytic schizont**, where the nucleus divides multiple times to produce 8-32 daughter nuclei.
  - The cytoplasm then divides around each nucleus, forming numerous new **merozoites**.
  - The infected red blood cell eventually ruptures, releasing these new merozoites into the bloodstream. This rupture coincides with the characteristic paroxysms of fever, chills, and sweating associated with malaria.
  - The released merozoites then invade fresh red blood cells, repeating the erythrocytic cycle. This cycle repeats every 48 or 72 hours, depending on the Plasmodium species.
- **Gametocyte Formation:**
  - After several cycles of erythrocytic schizogony, some merozoites, instead of developing into asexual schizonts, differentiate into sexual forms called **gametocytes** (male microgametocytes and female macrogametocytes) within the red blood cells.
  - These gametocytes circulate in the peripheral blood. They do not cause disease symptoms in the human host but are essential for transmission to the mosquito.

- *(Illustration would typically show: Sporozoites entering liver, liver schizont, merozoites released, merozoite invading RBC, ring stage, trophozoite, erythrocytic schizont, rupture of RBC, release of merozoites, and formation of gametocytes within RBCs.)*

- (b) Describe the process of conjugation in Paramecium and discuss its significance.
  - **Process of Conjugation in Paramecium:**
    - Conjugation is a temporary sexual process in ciliates like Paramecium that involves the reciprocal exchange of genetic material between two compatible individuals (conjugants). It is not a reproductive process in terms of increasing population size, but it leads to genetic recombination.
    - **Stages of Conjugation:**
      - **Pairing:** Two Paramecia of opposite mating types come into contact, usually at their oral grooves, and adhere to each other.
      - **Macronuclear Degeneration:** In each conjugant, the large, polyploid macronucleus breaks down and disintegrates.
      - **Micronuclear Meiosis:** The diploid micronucleus in each conjugant undergoes meiosis, producing four haploid micronuclei.
      - **Micronuclear Degeneration (Selective):** In each conjugant, three of the four haploid micronuclei degenerate. The remaining one undergoes mitosis.
      - **Mitosis of Remaining Micronucleus:** The single remaining haploid micronucleus in each conjugant divides mitotically to form two haploid pronuclei: a stationary pronucleus (female pronucleus) and a migratory pronucleus (male pronucleus).

- **Exchange of Migratory Pronuclei:** The two conjugants exchange their migratory pronuclei across a cytoplasmic bridge formed between them. Each conjugant now has one stationary pronucleus (its own) and one migratory pronucleus (from the other conjugant).
- **Fusion (Synkaryon Formation):** The stationary and migratory pronuclei in each conjugant fuse to form a single diploid **synkaryon** (zygote nucleus). This completes the genetic recombination.
- **Post-Conjugation Divisions:**
  - The two conjugants separate, now called exconjugants.
  - The synkaryon in each exconjugant undergoes several mitotic divisions to restore the normal nuclear complement. Typically, it divides three times, producing eight nuclei.
  - Of these eight nuclei, some differentiate into new macronuclei (usually four), and others develop into new micronuclei (usually four).
  - The exconjugants then undergo two binary fissions, distributing these new nuclei, ultimately resulting in four new individuals, each with a complete set of a macronucleus and micronuclei.

- **Significance of Conjugation:**
  - **Genetic Recombination:** This is the primary significance. Conjugation allows for the exchange and recombination of genetic material between two different individuals. This leads to increased genetic variation within the Paramecium population.

- **Restoration of Nuclear Potency:** Over successive asexual reproductions (binary fissions), Paramecium can accumulate mutations or lose vigor. Conjugation, particularly the formation of a new macronucleus from a fresh micronuclear lineage, helps to rejuvenate the cell and restore its full vitality and reproductive capacity.
- **Elimination of Deleterious Mutations:** Through recombination and the formation of new nuclei, conjugation can help to eliminate or reduce the accumulation of harmful mutations that might arise during prolonged asexual reproduction.
- **Maintaining Genetic Diversity:** In fluctuating environments, genetic diversity is crucial for adaptation. Conjugation ensures that a diverse range of genotypes is produced, increasing the chances of survival for the population under changing conditions.
- **Differentiation and Development:** The controlled differentiation of micronuclei into new macro- and micronuclei after synkaryon formation provides insights into gene regulation and developmental processes in ciliates.

- (a) Give the general characteristics of Phylum Porifera.
  - **Habitat:** Mostly marine, a few are freshwater.
  - **Symmetry:** Mostly asymmetrical, some are radially symmetrical.
  - **Level of Organization:** Cellular level of organization, meaning cells are loosely organized and do not form true tissues or organs.
  - **Body Plan:** Have a porous body with numerous pores (ostia) for water entry and a large excurrent opening (osculum) for water exit.
  - **Water Canal System:** Possess a unique water transport or canal system (ambulacral system) for feeding, respiration, and excretion.

- **Skeletal Support:** Body supported by a skeleton made of calcareous or siliceous spicules, or by proteinaceous spongin fibers, or a combination of both.
- **Choanocytes (Collar Cells):** Presence of choanocytes lining the spongocoel and radial canals. These flagellated cells create water current and filter food particles.
- **Digestion:** Intracellular digestion, occurring within individual cells (choanocytes and amoebocytes).
- **Nervous System:** Lack true nerve cells or a nervous system.
- **Reproduction:**
  - **Asexual:** By budding or gemmule formation.
  - **Sexual:** Hermaphroditic (monoecious) or dioecious. Fertilization is internal.
- **Development:** Indirect development, involving a free-swimming larval stage (e.g., amphiblastula or parenchymula larva).
- **Locomotion:** Sessile (immobile) as adults.

- (b) Give an account of different types of canal systems in Porifera and give its significance.
  - The canal system in Porifera is a distinctive feature that facilitates water circulation through the sponge body, enabling feeding, respiration, and waste removal. There are three main types:
  - **1. Ascon Type (Simplest):**
    - **Structure:** This is the simplest type of canal system, found in small, tube-shaped sponges (e.g., *Leucosolenia*).
    - **Water Pathway:** Water enters through numerous minute dermal ostia (incurrent pores) directly into a large central cavity called the **spongocoel**.

        - The spongocoel is lined by choanocytes.
        - Water then exits through a single, large terminal opening called the **osculum**.
        - **Efficiency:** Least efficient due to the small surface area of choanocytes relative to the spongocoel volume.
    - **2. Sycon Type (Intermediate):**
        - **Structure:** More complex than ascon type, found in medium-sized sponges (e.g., *Scypha/Sycon*). The body wall is folded, forming radial canals.
        - **Water Pathway:** Water enters through dermal ostia into **incurrent canals**.
        - From incurrent canals, water passes through small openings called **prosopyles** into **radial canals**.
        - The radial canals are lined by choanocytes.
        - From radial canals, water passes through internal openings called **apopyles** into the central **spongocoel** (which is lined by pinacocytes, not choanocytes).
        - Finally, water exits through the **osculum**.
        - **Efficiency:** More efficient than ascon type due to the increased surface area provided by the choanocyte-lined radial canals.
    - **3. Leucon Type (Most Complex):**
        - **Structure:** The most complex and common type, found in large-sized sponges (e.g., *Spongilla*, *Euspongia*). The body wall is highly folded and extensively branched, forming numerous small, flagellated chambers.
        - **Water Pathway:** Water enters through dermal ostia into **incurrent canals**.

    - These incurrent canals branch extensively and lead to small, spherical or oval **flagellated chambers** (choanocyte chambers). These chambers are where the choanocytes are exclusively located.
    - From the flagellated chambers, water passes into **excurrent canals** (also called aphodal canals or apopyles leading into excurrent canals).
    - These excurrent canals converge into larger canals, eventually leading to one or more **oscula**.
    - **Efficiency:** Most efficient due to the immense increase in the surface area of choanocytes housed within numerous flagellated chambers. This allows for more effective water filtration and nutrient absorption.

- **Significance of Canal Systems:**
    - **Feeding:** The continuous flow of water brings in food particles (bacteria, detritus, plankton) which are then filtered and ingested by choanocytes.
    - **Respiration:** Oxygen dissolved in the water is absorbed by the cells, and carbon dioxide is released into the water current.
    - **Excretion:** Metabolic waste products are released into the water current and carried out of the sponge body.
    - **Reproduction:** Gametes (sperm) are released into the water current for fertilization, and larvae are expelled through the system.
    - **Increased Surface Area:** As the complexity increases from ascon to leucon, the surface area lined by choanocytes significantly increases, which directly correlates with the sponge's feeding efficiency and overall size potential.

- **Body Size and Complexity:** The type of canal system dictates the maximum size and complexity a sponge can attain. Leuconoid sponges, with their highly efficient system, can grow much larger than asconoid or syconoid forms.

- (a) Describe Polymorphism in Cnidaria. Comment upon its significance.
  - **Polymorphism in Cnidaria:**
    - Polymorphism refers to the occurrence of different morphological forms (zooids) within the same species, with each form specialized for a particular function. It is a prominent feature, especially in colonial cnidarians. The two basic polymorphic forms are the polyp and the medusa.
    - **Basic Forms:**
      - **Polyp:**
        - Sessile (attached) and typically cylindrical in shape.
        - Mouth usually directed upwards, surrounded by tentacles.
        - Primarily adapted for feeding and asexual reproduction (budding).
        - Examples: Hydra, sea anemones, coral polyps.
      - **Medusa:**
        - Free-swimming and typically bell or umbrella-shaped.
        - Mouth usually directed downwards, with tentacles hanging from the rim of the bell.
        - Primarily adapted for sexual reproduction and dispersal.

        - Examples: Jellyfish.

    - **Degrees of Polymorphism in Colonial Cnidarians:**
        - In many colonial cnidarians (like siphonophores, e.g., *Physalia*, the Portuguese Man O' War), polymorphism is highly developed, leading to specialized zooids (individuals) that are morphologically distinct and functionally interdependent, forming a superorganism.
        - **Gastrozooids (feeding polyps):** Specialized for capturing and digesting food. They possess a mouth and tentacles, and often lack gonads.
        - **Dactylozooids (defensive/protective polyps):** Long, often highly contractile tentacles armed with numerous nematocysts, used for defense and prey capture. They lack a mouth.
        - **Gonozooids (reproductive polyps):** Responsible for sexual reproduction, producing medusae or gametes. They may or may not possess mouths.
        - **Pneumatophore (float):** A gas-filled float, modified medusa or polyp, providing buoyancy. (e.g., in *Physalia*)
        - **Phyllozooids (bracts):** Leaf-like or plate-like structures, often protective, covering other zooids.

- **Significance of Polymorphism:**
    - **Division of Labor:** Polymorphism allows for a high degree of specialization among the different zooids in a colony. Each zooid form performs a specific function (feeding, defense, reproduction, locomotion), leading to efficient resource utilization and overall colony survival.

- **Increased Efficiency:** Specialization enhances the efficiency of vital life processes. For example, gastrozooids can focus solely on digestion, while dactylozooids are optimized for defense.
- **Enhanced Survival:** The specialized defensive zooids (dactylozooids) with their potent nematocysts provide strong protection against predators and aid in prey capture, increasing the colony's chances of survival.
- **Reproductive Success:** Gonozooids are dedicated to reproduction, often releasing free-swimming medusae which aid in dispersal and finding new habitats, thereby increasing reproductive success and species propagation.
- **Adaptation to Different Niches:** The different forms can be adapted to specific ecological roles or positions within the water column, enabling the species to exploit a wider range of resources and environments.
- **Evolutionary Advancement:** Polymorphism is considered an important evolutionary step towards higher levels of organization, where individual units cooperate and specialize for the benefit of the entire organism/colony. It bridges the gap between simple colonial forms and complex multicellular organisms.

- (b) Give an outline classification of phylum Cnidaria with characters and examples of each class.
  - **Phylum Cnidaria:** Radially symmetrical, diploblastic animals with stinging cells (cnidocytes). Possess a gastrovascular cavity.
  - **Class 1: Hydrozoa**
    - **Characters:**
      - Exhibit both polyp and medusa stages, or sometimes only one form dominates.

    - Medusae typically have a velum (a shelf-like projection from the bell margin).
    - Mesoglea is usually non-cellular.
    - Gonads are epidermal (develop from ectoderm).
    - Many are colonial and polymorphic.
  - **Examples:** *Hydra* (only polyp), *Obelia* (polyp and medusa, colonial), *Physalia* (Portuguese Man O' War, highly polymorphic colonial).
- **Class 2: Scyphozoa**
  - **Characters:**
    - "True jellyfish." Medusa stage is dominant and conspicuous; polyp stage is reduced or absent (represented by a small scyphistoma).
    - Medusae lack a velum.
    - Mesoglea is thick, gelatinous, and often cellular.
    - Gonads are gastrodermal (develop from endoderm).
    - Nematocysts are present in the gastrodermis as well as epidermis.
  - **Examples:** *Aurelia* (moon jelly), *Cyanea* (lion's mane jelly).
- **Class 3: Cubozoa**
  - **Characters:**
    - "Box jellyfish." Medusa stage is dominant, cube-shaped bell with tentacles arising from pedalium-like structures at each corner.
    - Possess complex eyes with lenses.

        - Extremely potent venom (some are highly toxic).
        - Polyp stage is very small and does not bud off multiple medusae.
    - **Examples:** *Chironex fleckeri* (sea wasp), *Tripedalia cystophora*.
  - **Class 4: Anthozoa**
    - **Characters:**
        - "Flower animals." Exclusively polyp form; medusa stage is completely absent.
        - Sessile, often colonial.
        - Gastrovascular cavity is divided by septa (mesenteries) that bear nematocysts and gonads.
        - Mouth leads into a pharynx (stomodeum).
        - Possess a siphonoglyph (ciliated groove) for water circulation.
        - Gonads are gastrodermal.
    - **Examples:** Sea anemones (*Metridium*), Corals (e.g., stony corals like *Acropora*, soft corals like sea fans), Sea pens.

- (a) Give a detailed account of parasitic adaptations in Helminthes.
  - Parasitic helminthes (worms like flukes, tapeworms, and roundworms) have evolved a remarkable array of adaptations to survive, reproduce, and thrive within their hosts. These adaptations can be broadly categorized as morphological, physiological, and reproductive.
  - **Morphological Adaptations:**
    - **Presence of Adhesive Organs:**

    - **Suckers:** Flukes (trematodes) and tapeworms (cestodes) possess muscular suckers (e.g., oral sucker, acetabulum/ventral sucker in flukes; scolex with suckers and hooks in tapeworms) to attach firmly to the host's internal tissues, preventing dislodgement by gut peristalsis or blood flow.
    - **Hooks:** Tapeworms (cestodes) often have hooks on their scolex (rostellum) for even stronger anchorage to the intestinal wall.
- **Degeneration of Locomotory Organs:** Since they live within a host, movement is often limited or unnecessary. Parasites typically lack cilia, flagella, or other complex locomotory structures.
- **Degeneration of Sense Organs:** Living in a relatively stable internal environment, complex sense organs (eyes, statocysts) are greatly reduced or completely absent as they are not needed for sensing external stimuli.
- **Body Covering (Tegument/Cuticle):**
    - **Tegument (Flatworms):** A non-ciliated, syncytial, protective outer layer that is highly resistant to host digestive enzymes and immune responses. It also facilitates absorption of nutrients.
    - **Cuticle (Nematodes):** A tough, flexible, and resistant outer cuticle protects against host digestive enzymes and provides structural support. It is often permeable to gases and nutrients.
- **Reduced Digestive System:**
    - **Trematodes:** Have a simple, often incomplete digestive system (mouth, pharynx, esophagus, branched caeca, no anus). They absorb partially digested food.

- **Cestodes:** Completely lack a digestive system. They absorb all nutrients directly through their tegument from the host's digested food.
- **Nematodes:** Have a complete digestive system (mouth, pharynx, intestine, anus), but it is often simplified compared to free-living forms.

- **Physiological Adaptations:**
  - **Anaerobic Respiration:** Many internal parasites live in environments with low oxygen tension (e.g., gut lumen, muscle tissue). They primarily rely on anaerobic respiration (glycolysis) to produce energy, often producing fatty acids or lactic acid as byproducts.
  - **Osmoregulation:** Possess specialized excretory/osmoregulatory systems (e.g., protonephridia with flame cells in flatworms, H-shaped excretory system in nematodes) to maintain internal fluid balance in varying osmotic environments within the host.
  - **Resistance to Host Defenses:**
    - **Enzyme Inhibitors:** Some parasites secrete substances that inhibit host digestive enzymes or proteases.
    - **Antigenic Variation/Mimicry:** Ability to change surface antigens or mimic host molecules to evade the host's immune system.
    - **Thick Tegument/Cuticle:** Provides a physical barrier against immune cells and enzymes.
    - **Cyst Formation:** Some parasites (e.g., larval tapeworms, some nematodes) can encyst within host tissues, forming a protective wall against host defenses and adverse conditions.

- **Reproductive Adaptations:**
    - **High Reproductive Potential (Fecundity):**
        - Parasites produce an enormous number of eggs or larvae. This compensates for the massive loss of offspring due to the complex life cycles and environmental hazards.
        - **Hermaphroditism:** Many flatworms (flukes, tapeworms) are hermaphroditic, allowing self-fertilization when a single parasite infects a host, ensuring reproduction.
        - **Asexual Multiplication:** Larval stages often undergo asexual multiplication (e.g., sporocyst and redia stages in trematodes), producing many more individuals from a single miracidium, dramatically increasing the number of infective stages.
        - **Strobilation:** In tapeworms, the body is divided into proglottids, each containing a complete set of male and female reproductive organs, capable of producing thousands of eggs. New proglottids are continuously formed.
    - **Complex Life Cycles:** Involving one or more intermediate hosts, which increases the chances of completing the life cycle and reaching the definitive host.
    - **Specific Host Adaptations:** Ability to locate and infect specific host tissues or organs.
    - **Early Maturation:** Rapid development to maturity once inside the host to maximize reproductive output.

- (b) Give graphic life cycle of Taenia solium.
    - *(Note: As per instructions, no schematic diagrams. The graphic life cycle will be described in textual points.)*

- **Life Cycle of Taenia solium (Pork Tapeworm):**
- **Stage 1: Eggs/Gravid Proglottids in Feces (Human - Definitive Host)**
  - Mature adult *Taenia solium* tapeworm lives in the small intestine of humans.
  - Gravid proglottids (segments filled with eggs) detach from the worm and are passed out in the feces.
  - These proglottids or free eggs contaminate soil, water, and vegetation.
- **Stage 2: Ingestion by Intermediate Host (Pig)**
  - Pigs (intermediate hosts) become infected by ingesting vegetation or food contaminated with *Taenia solium* eggs or gravid proglottids.
- **Stage 3: Oncosphere Hatching and Migration in Pig**
  - In the pig's intestine, the eggs hatch, releasing **oncospheres** (hexacanth embryos).
  - The oncospheres penetrate the intestinal wall and enter the bloodstream.
  - They are carried by the blood to various tissues, particularly striated muscles (e.g., tongue, diaphragm, thigh, heart).
- **Stage 4: Cysticercus Formation in Pig Muscles**
  - In the pig's muscles, the oncospheres develop into larval cysts called **cysticerci** (often called "bladder worms" or "pork measles").
  - Each cysticercus is a fluid-filled bladder containing an inverted scolex.
  - The pig's infected meat is now referred to as "measly pork."

- **Stage 5: Ingestion of Undercooked Pork by Human**
  - Humans become infected by consuming raw or undercooked pork containing viable cysticerci.
- **Stage 6: Development of Adult Tapeworm in Human Intestine**
  - In the human small intestine, the cysticercus excysts (everts its scolex).
  - The scolex attaches to the intestinal wall.
  - New proglottids are budded off from the neck region, and the tapeworm matures into an adult within 5-12 weeks.
  - The adult worm can live for many years, producing thousands of eggs daily.
- **Stage 7: Human Autoinfection or External Contamination (Additional Cycle - Cysticercosis)**
  - **Autoinfection:** In rare cases, if a human host with an adult worm ingests eggs (e.g., due to poor hygiene or reverse peristalsis), the eggs can hatch in their own intestine, and the oncospheres will migrate to various tissues (brain, muscles, eyes), forming cysticerci. This condition is called **cysticercosis**, which is a severe disease.
  - **External Contamination:** Humans can also get cysticercosis by ingesting *Taenia solium* eggs from contaminated food/water (e.g., from infected human feces), acting as an accidental intermediate host.
- *(A graphic representation would typically show arrows connecting these stages in a cyclical manner, highlighting the human and pig as hosts and the key larval stages like oncosphere and cysticercus.)*

- Write short notes on any three of the following:
- (a) Course of migration of Ascaris larva within its host body.

- The life cycle of *Ascaris lumbricoides* (human roundworm) involves a remarkable migratory phase of its larvae within the human host. This journey is crucial for their development into adult worms.
- **Ingestion of Eggs:** Humans become infected by ingesting embryonated eggs containing the L3 (third-stage) larva from contaminated soil, food, or water.
- **Hatching in Intestine:** The eggs hatch in the duodenum of the small intestine, releasing the L3 larvae.
- **Penetration of Intestinal Wall:** The L3 larvae then penetrate the intestinal wall and enter the mesenteric venules (blood vessels).
- **Hepatic Portal System:** They are carried by the hepatic portal vein to the liver. Some larvae may briefly reside and grow here.
- **Heart and Lungs:** From the liver, they travel through the hepatic veins to the inferior vena cava, then to the right side of the heart, and finally reach the pulmonary arteries, carrying them to the lungs.
- **Alveolar Migration:** In the lungs (usually 4-7 days post-infection), the larvae break out of the capillaries and migrate into the alveoli. Here, they undergo two molts, developing into the L4 (fourth-stage) larvae.
- **Tracheal Migration (Tracheal Migration/Wandering):** The L4 larvae then actively migrate upwards through the respiratory passages: from the alveoli, they move into the bronchioles, bronchi, trachea, and finally reach the pharynx. This upward migration can cause irritation, leading to a cough.
- **Swallowing:** Once in the pharynx, they are swallowed by the host, returning to the gastrointestinal tract.
- **Maturation in Small Intestine:** The swallowed larvae pass down the esophagus and stomach and reach the small intestine. Here, they mature into adult male and female worms. The entire migratory journey takes approximately 10-14 days.

- (b) Metagenesis.
  - Metagenesis, also known as alternation of generations, is a phenomenon observed in some animal phyla, most notably in Cnidaria, where two distinct morphological forms (generations) alternate in the life cycle, usually with one form reproducing asexually and the other sexually.
  - **Key Characteristics:**
    - **Alternation of Asexual and Sexual Forms:** Typically involves the alternation between an asexual, sessile polyp stage and a sexual, free-swimming medusa stage.
    - **Polyp Generation:** The polyp usually reproduces asexually, primarily by budding, to produce more polyps or to bud off medusae (e.g., strobilation in *Aurelia*).
    - **Medusa Generation:** The medusa is the sexually reproducing stage. It produces gametes (sperm and eggs) through meiosis. Fertilization results in a zygote, which develops into a larva (planula). The planula then settles and develops into a new polyp, completing the cycle.
  - **Example: *Obelia***
    - In *Obelia*, a colonial hydrozoan, the sessile polyp colony reproduces asexually. Specialized polyps (gonozooids) bud off free-swimming medusae.
    - These medusae are dioecious (separate sexes) and reproduce sexually, releasing gametes into the water.
    - The zygote develops into a ciliated planula larva.
    - The planula settles and metamorphoses into a new polyp colony, thus completing the metagenetic cycle.
  - **Significance:**

  - **Dispersal:** The free-swimming medusa stage facilitates dispersal of the species to new locations, reducing competition and allowing colonization of new habitats.
  - **Environmental Adaptation:** The two forms may be adapted to different environmental conditions or exploit different food resources.
  - **Genetic Variation:** Sexual reproduction in the medusa stage introduces genetic recombination, leading to increased genetic diversity within the population.

- (c) Asexual reproduction in protozoa.
  - Asexual reproduction is the primary mode of multiplication in most protozoa, leading to a rapid increase in population size without the involvement of gametes or genetic recombination.
  - **Types of Asexual Reproduction:**
    - **1. Binary Fission:**
      - The most common method. The parent cell divides into two approximately equal daughter cells.
      - **Simple Binary Fission:** Division occurs along any plane (e.g., *Amoeba*).
      - **Longitudinal Binary Fission:** Division occurs along the longitudinal axis (e.g., *Euglena*, *Trypanosoma*).
      - **Transverse Binary Fission:** Division occurs perpendicular to the longitudinal axis (e.g., *Paramecium*).
    - **2. Multiple Fission (Schizogony):**
      - The nucleus divides repeatedly to form numerous daughter nuclei, followed by cytoplasmic division, resulting in many small daughter cells simultaneously.

- Common in parasitic protozoa (e.g., *Plasmodium* in liver cells and red blood cells, forming merozoites).

- **3. Budding:**
    - A small outgrowth or bud forms on the parent cell, which then detaches and grows into a new individual. The bud may be internal or external.
    - Common in some suctorians (e.g., *Ephelota*) where a motile "swarmer" bud is produced, or in some yeasts (though yeasts are fungi, the concept applies to some protozoa).

- **4. Plasmotomy:**
    - Occurs in multinucleated protozoa (e.g., *Opalina*). The multinucleated parent organism divides into two or more multinucleated daughter individuals without nuclear division. The pre-existing nuclei are distributed among the daughter cells.

- **5. Sporulation:**
    - Formation of spores, which are often resistant stages, under unfavorable conditions. This typically involves multiple fission within a protective cyst wall.
    - Common in sporozoans.

- (d) Compare and contrast flatworms with roundworms.
    - **Comparison (Similarities):**
        - Both are invertebrate worms.
        - Both include free-living and parasitic forms.
        - Both exhibit bilateral symmetry.

- Both have a cephalized anterior end (head region, though more developed in some).
- Both lack a true coelom (body cavity), making them either acoelomate (flatworms) or pseudocoelomate (roundworms).

- **Contrast (Differences):**
  - **Phylum:**
    - **Flatworms:** Phylum Platyhelminthes.
    - **Roundworms:** Phylum Nematoda.
  - **Body Shape:**
    - **Flatworms:** Dorsoventrally flattened (e.g., tape-like or leaf-like).
    - **Roundworms:** Cylindrical, tapering at both ends, and round in cross-section.
  - **Body Cavity (Coelom):**
    - **Flatworms:** Acoelomate (lack a body cavity; the space between the body wall and internal organs is filled with parenchyma).
    - **Roundworms:** Pseudocoelomate (possess a false body cavity, the pseudocoelom, which is not lined by mesoderm on all sides).
  - **Digestive System:**
    - **Flatworms:** Incomplete digestive system (mouth, pharynx, intestine, but no anus) in most forms (e.g., planarians, flukes); completely absent in tapeworms.
    - **Roundworms:** Complete digestive system (mouth, pharynx, intestine, and anus).
  - **Cuticle/Tegument:**

  - **Flatworms:** Possess a non-ciliated, syncytial **tegument** in parasitic forms; free-living forms have ciliated epidermis.
  - **Roundworms:** Covered by a thick, tough, protective, non-cellular **cuticle** that is periodically shed (molted).
- **Musculature:**
  - **Flatworms:** Have circular, longitudinal, and diagonal muscle layers, allowing varied movements.
  - **Roundworms:** Primarily possess only longitudinal muscle fibers, resulting in a characteristic whipping or thrashing movement.
- **Excretory System:**
  - **Flatworms:** Protonephridia with flame cells.
  - **Roundworms:** H-shaped excretory canal system or a renette cell.
- **Circulatory/Respiratory System:**
  - **Flatworms & Roundworms:** Both lack specialized circulatory and respiratory systems; gas exchange occurs directly through the body surface.
- **Reproductive System:**
  - **Flatworms:** Often hermaphroditic (monoecious), complex reproductive system.
  - **Roundworms:** Typically dioecious (separate sexes), with distinct male and female individuals.
- **Development:**
  - **Flatworms:** Many have indirect development with larval stages.

- **Roundworms:** Mostly direct development, but parasitic forms may involve larval migrations.