Practical General Biology (B)

2017-2018
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Laboratory Safety Rules

1. Never work alone in the laboratory without permission and prior knowledge of the instructor.
2. Do not engage in rowdy, playful, or unprofessional activities in the laboratory. This includes not being disrespectful of your instructor or classmates.
3. Students should wash hands thoroughly after first entering the lab.
4. Students are allowed to have a drink with a lid during lectures and computer labs. Otherwise, they should never ever eat or drink anything in the laboratory without explicit permission from the instructor.
5. Wear appropriate clothing at all times in the laboratory. Wear closed-toe shoes that cover the top of the foot, unless permission otherwise is given by the instructor.
6. Wear examination gloves and safety glasses when dissecting or handling cadavers, caustic chemicals, bacterial broth cultures, or as otherwise advised by your instructor.
7. Wear gloves when handling any microorganisms. Wear lab aprons or lab coats as advised by your instructor.
8. Keep hands away from your face, eyes, and mouth when working with cadavers, chemicals, preserved specimens, microorganisms, or body fluids. This includes not applying cosmetics, not adjusting contact lenses, and not biting your finger nails.
9. If any chemicals or other agents splash into your eyes, immediately go to the nearest sink and flush your eyes with water.
10. Report ANY and ALL accidents, spills, BREAKAGES, or injuries to the instructor, no matter how trivial they appear.
11. Scalpels and other sharp objects can be used only if authorized by the instructor and only after given proper handling instructions. Use small trays to carry all sharp objects. When handling sharp objects, point their tips down and away from other people.
12. While wearing examination gloves, students must not leave the laboratory and must not touch any equipment such as microscopes, any personal items such as cell phones, or any door knobs.
13. Do not use any lab equipment without instruction and authorization from the instructor. Report any damaged or broken equipment to your instructor immediately.
14. Lab benches should be kept free of extraneous items while conducting experiments. This includes unnecessary books, backpacks, cell phones, and other personal items.
15. Any pregnant or immunocompromised student must notify the instructor of the course. Pregnant students will not be allowed to do dissections or work with any body fluids without having a doctor’s note for permission. A pregnant student is required to wear safety glasses and 2 sets of examination gloves when handling any bacterial broths or cultures.
Lab 1 : Fungi

Objectives

- Identification of Fungal characteristic, Shape & reproduction

Introduction:

- All organisms are composed of cells.
- Two very different kinds of cells exist in nature:
  1. Prokaryotic cell (kingdom Monera, Bacteria & Archaea)
  2. Eukaryotic cell (kingdoms: Animalia, Plantae, Fungi, Protista)

In this lab we will introduce to Kingdom fungi

- Mycology: is the branch of biology concerned with the study of fungi
- Mycologists: A biologist specializing in mycology

The Characteristics of Fungi:

- Non motile
- Non photosynthetic
- Most are saprobes (live on dead organisms)
- Important decomposers & recyclers of nutrients in the environment
- Absorptive heterotrophs (digest food first & then absorb it into their bodies)
- Release digestive enzymes to break down organic material or their host
- Grow best in warm, moist environments
Fungi include:

- single-celled creatures (the yeasts)
- multicellular such as molds & mushrooms.

1. Yeasts:
- look like little round or oval blobs under a microscope.
- Yeasts are widely dispersed in nature with a wide variety of habitats.
- They are commonly found on plant leaves, flowers, and fruits, as well as in soil.
- Yeast are also found on the surface of the skin and in the intestinal tracts of warm-blooded animals, where they may live symbiotically or as parasites.

Examples:

1. *Candida albicans*:
- is normally present on the skin and in mucous membranes such as the vagina, mouth, or rectum.
- becomes an infectious agent when there is some change in the body environment that allows it to grow out of control.
- A common cause of infection may be the use of antibiotics that destroy beneficial, as well as harmful, microorganisms in the body, permitting *Candida* to multiply in their place.
infection is called oral thrush when *Candida albicans* accumulates on the lining of your mouth.

Oral thrush causes creamy white lesions, usually on your tongue or inner cheeks. Sometimes oral thrush may spread to the roof of your mouth, your gums or tonsils, or the back of your throat.

It mostly affects children under two years of age, whose mother are taking antibiotic which get into breast milk, baby can pass thrush on to her mom, so it's important to seek treatment for mother and baby at the same time.

2. *Saccharomyces cerevisiae*:

- By fermentation, the yeast species *Saccharomyces cerevisiae* converts carbohydrates to carbon dioxide and alcohols.
- Fermentation of sugars by yeast is used in bread production (baker's yeast).

**Yeast reproduction**: 

- Yeast reproduce asexually by budding.
- Budding – a new organism develops from an outgrowth or bud due to cell division at one particular site. The new organism remains attached as it grows, separating from the parent organism only when it is mature, leaving behind scar tissue.

2. Molds:

- The cells of most fungi grow as tubular, elongated, and thread-like (filamentous) structures called *hyphae*.
- The hyphae keep growing and intertwining until they form a network of threads called a *mycelium*.
- *Hyphae*: Filled with cytoplasm & nuclei.
- Have hard cell wall of chitin.
• **Stolons** – horizontal hyphae that connect groups of hyphae to each other
• **Rhizoids** – rootlike parts of hyphae that anchor the fungus

**Hyphae under microscopic examination:**

- **Septate hyphae**: Cross-walls called SEPTA may form compartments along hyphae, septa have pores for movement of cytoplasm
- **Non-septate hyphae**: there is no septa, form syncytium (a multinucleate mass of cytoplasm resulting from fusion of cells)

**Hyphae Types:**

- **Vegetative hyphae**: like roots, keep mold in place, in physical contact with whatever the fungi is feeding on.
- **Aerial hyphae**: directly above the surface of media
- **Fertile or reproductive**: bear reproductive structures

**Reproduction in Fungi:**

- Most fungi reproduce **Asexually and Sexually** by spores
- **Asexual reproduction** is most common method & produces genetically identical organisms
- Fungi reproduce **Sexually** when conditions are poor & nutrients scarce
Asexual Reproduction:

- **Fragmentation** – part of the mycelium becomes separated & begins a life of its own
- **Budding** (yeasts)
- **Asexual spores** – production of spores by a single mycelium

**Spores may be Formed:**
1. **Directly** on hyphae
2. **Inside sporangia** (an upright stalk called the Sporangiosphore supports the spore case or Sporangium)
3. On **Fruiting bodies** (are modified hyphae that make asexual spores)

**Spores:**
- Spores are an adaptation to life on land
- Ensure that the species will disperse to new locations
- Each spore contains a reproductive cell that forms a new organism
- Non-motile
- Dispersed by wind

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**Figure 1.12 : 1**

**Figure 1.13: 2**

**Figure 1.14: 3**

**Figure 1.15 : sporangiophore & sporangium**

**Figure 1.16 : Spores**
Activates:

- Show different fungi growth on media

- Show Yeast & budding under microscope

- Show hyphae, mycelium, sporangiophore & spores under microscope
Lab 2: Fungi

Objectives
- Identify the classification of fungi
- Identify some examples of fungi and their importance

Classification of fungi:

1. According to nutrition:
   - **Saprobic**
     - Decomposers
     - E.g.: Molds & mushrooms.
   - **Parasite**
     - Harm host
     - E.g.: Rusts & smuts (attack plants)
   - **Mutualist**
     - Both benefit
     - E.g.: Lichens & Mycorrhizas

2. According to sexual reproduction:
1. Division Zygomycota:

- Most zygomycota are saprobes, while a few species are parasites.
- Hyphae have no cross walls (Aseptate)
- Zygomycota usually reproduce asexually
- Asexual reproductive structure called sporangium atop sporangiospores make spores
- Rhizoids anchor the mold & release digestive enzymes & absorb food
- Sexual spores are produced by conjugation
- Sexual spores are called ZYGOSPORES
- E.g: *Rhizopus stolonifer* (Black Mold or Black Bread) causes fruit rot on strawberry, tomato, and sweet potato

![Figure 2.1: Rhizopus stolonifer on bread](image1)
![Figure 2.2: Rhizopus stolonifer on tomato](image2)

2. Division Ascomycota

- Accounts for 75% of all described fungi
- Called Sac fungi
- Includes Cup fungi, truffles, yeasts
- The mycelium of ascomycetes is usually made up of septate hyphae.
- Reproduce sexually & asexually
Ascus - sac that makes ascospores in sexual reproduction
- Specialized hyphae known as Ascocarps contain the asci
- Ascomycota
- Asexual spores called conidia form on the tips of special hyphae called conidiophores
- But chlamydospores are also frequently produced.
- Furthermore, Ascomycota also reproduce asexually through budding.

Importance of Ascomycota:
- This group is of particular relevance to humans as sources for medicinally important compounds, such as antibiotics (*Penicillium*)
- for making bread, alcoholic beverages (*Saccharomyces cerevesiae*), and cheese
- but also as pathogens of humans and plants (powdery mildews)
- Almost half of all members of the phylum Ascomycota form symbiotic associations with algae to form lichens.

Lichen:
- is a composite organism that arises from algae or cyanobacteria (or both) living among filaments of a fungus in a symbiotic relationship
- The fungus benefits from the algae or cyanobacteria because they produce food by photosynthesis.
- The algae or cyanobacteria benefit by being protected from the
environment by the filaments of the fungus, which also gather moisture and nutrients from the environment, and (usually) provide an anchor to it.

3. Division Basidiomycota:

- Called Club fungi
- Reproduce sexually via the formation of specialized club-shaped end cells called basidia that normally bear external spores (usually four). These specialized spores are called basidiospores.
- One of the two large divisions that, together with the Ascomycota are often referred to as the "higher fungi"
- Represents 37% of all described fungi
- Many basidiomycota produce a typical toadstool-shaped fruitbody, with basidia lining the gills (Mushrooms)
Examples of basidiomycota:

1. **Mushrooms**: some are edible, while others are poisonous

![Mushroom structure](image1)

![Mushroom structure](image2)

2. **Rusts & Smuts**: damage crops

![Rust fungi on leaves](image3)

![Smut fungi on corn](image4)

3. **Division Deuteromycota**:
   - Fungi which do not fit into the commonly established taxonomic classifications of fungi because their sexual form of reproduction has never been observed, only their asexual form of reproduction is known, hence the name "imperfect fungi."
   - Most of the species are saprobes but some are parasitic.
   - Many fungal diseases that infect humans belong to this group including species which cause **athletes foot**
Athlete's foot:

- Also known as tinea pedis
- is a common skin infection of the feet caused by fungus
- It often results in itching, scaling, and redness, in severe cases the skin may blister
- Athlete's foot may affect any part of the foot, but occurs most often between the toes, the next most common area is the bottom of the foot
- Fungal infection of the nails or of the hands may occur at the same time
- Tinea pedis is caused by a number of different E.g: \textit{Trichophyton}

Activity:

- Show \textit{Rhizopus stolonifer} on Bread, tomato & under stereomicroscope
- Show \textit{Penicillum} & conidiospore under microscope
- Show Mushroom
- Show Lichen, Smuts & Rust sample
Lab 3: Non-vascular plants & simple vascular plants

Objectives

- This lab aims to identify the morphology, reproduction & importance of Bryophyte & seedless vascular plants (ferns).

Introduction

Land plants fall into two categories:

- Those that have special tissues (vascular system, xylem & phloem) to transport water and other materials, called vascular plants (higher plants).

- Those that do not have specialized tissues, called non-vascular plants (lower plants). Consequently, they are unable to control the rate of water loss from their tissues and are said to be poikilohydric, so they contain cuticle.

- Non-vascular plants include two distantly related groups:
  1. Bryophytes
  2. Green algae

1. Bryophytes are flowerless spore producing plants, include three separate land plant divisions: Mosses, Liverworts & Hornworts.

- Vascular plants can be divided by their method of reproduction:
  - Vascular plants that reproduce by the use of spores are characterized as ferns. This type of vascular plant is often referred to as a seedless vascular plant.

- The majority of vascular plants reproduce by creating seeds rather than spores (seed vascular plant) and are classified as either gymnosperms or angiosperms.
In this lab we will focus on Bryophyte & seedless vascular plants (ferns).

**Bryophytes:**

**I. Mosses:**

**General characteristics:**

- Mosses are almost twice as diverse as mammals.
- Typically 0.2 – 10 cm tall, though some species are much larger, like Dawsonia, the tallest moss in the world, which can grow to 50 cm in height.
- These simple plants typically grow in dense green clumps or mats, in damp areas such as forests or wetlands. You may have seen large patches of moss growing on a tree or rock or even on the forest floor.
- These bryophytes often look soft and cushiony, or they can also resemble feathers.
- In fact, moss has been found just about everywhere, except in salt water.
Mosses structure:

- Have an outer waxy Cuticle to prevent water loss.
- NO true roots, stems, or leaves.
- Bryophytes have a gametophyte stage and a sporophyte stage.
- Instead of producing flowers and seeds, they produce spores in small capsules.
- The spore capsule, often with a supporting stalk (called a seta), is the sporophyte and this grows from the gametophyte stage.

![Moss structure](image)

Moss Gametophyte stage:

- While it may be true to say that a moss gametophyte has "stems and leaves", but there is a lot of complexity and variety in these "stems and leaves" plants.

1. Moss stems:
   - are generally fairly weak and, if free-standing, fairly short have only a limited role in conducting water and nutrients.
   - Stem color varies from green to shades of brown, which may be simple or branched and upright or creeping.

![Moss stems](image)
2. moss leaves :
- The individual leaves are small (0.5-3 mm).
- They are always attached directly to the stem.
- In most genera the leaves are just one cell thick, making them translucent.

3. Moss rhizoid :
- Instead of roots they have rhizoids, which are small hairs which are used for anchoring the plant to its substrate but without the absorptive functions of true roots.
- Moss rhizoids are always multi-celled and often branched.

Note:
The male and female gametes (sperm and eggs) are produced on the gametophyte (in special structures called antheridia and archegonia, respectively). A fertilized egg will develop into a sporophyte. Thus the spores are part of the sexual reproduction cycle.

Moss sporophyte stage :
- A moss sporophyte consists of a spore-containing capsule (which is covered by a cap, called operculum), sitting atop a stalk (called a seta).
- Sporophyte lacks chlorophyll & gets food from the gametophyte.
- During much of the year most mosses consist of only the green plant (gametophyte, dominant structure), with the stalk and capsule (sporophyte) appearing only when conditions are right for reproducing.
Mosses Nutrition & water absorption:

- Like other plants, moss plants make their own food by photosynthesis.
- All of the cells in a moss plant can photosynthesize, so moss plants don’t need a circulatory or vascular system.
- Because they lack roots, bryophytes require contact with water so they can absorb it directly into their leaves.
- Mineral nutrients dissolved in the water are also absorbed directly into the bryophytes' leaves.

Reproduction in Moss:

A. Asexual Reproduction in Moss:

- May occur by Fragmentation: pieces of gametophyte break off & form new moss plants.
- May occur by Gemmae:
  - Tiny cup shaped structures on gametophytes
  - Is a single cell, or a mass of cells, or a modified bud of tissue, that detaches from the parent and develops into a new individual.
  - Rain drops separate gemmae from the parent plant so they spread & form new moss plants.

B. Sexual Reproduction in Moss:

- Moss alternate between haploid (1n) Gametophyte and a diploid (2n) Sporophyte.
- Gametophytes produce gametes (eggs & sperm) containing half the chromosome number.
- Sporophytes have a complete set of chromosomes & produces spores by meiosis.
- Moisture is essential for the reproductive cycle of mosses.
- The male sperm swims to the female egg for fertilization.
- Fertilized egg (zygote) undergoes mitosis to develop Sporophyte
- Spore capsule of sporophyte makes haploid spores by meiosis
- Once mature, the spore cap
  - (operculum) comes off releasing spores
- Spores germinate into juvenile
- plants called protonema
- Protonema becomes the gametophyte

**Mosses importance:**

- One of the better known ecological uses of moss is as bioindicators
- Since mosses can absorb water so easily, correspondingly contaminants in the water particles including pollutants affect mosses growth
- They are very good indicators of acid rain damage to an ecosystem as well.
- They are sensitive indicators of atmospheric pollutants (many of their nutritional requirements are met by nutrients deposited from the atmosphere) Changes in the distributions of mosses are therefore an early-warning signal of serious effects of atmospheric pollution.
Mosses are also used as erosion control agents as they aid in moisture control and stabilization of soil that would either be wind blown or washed away by water.

Mosses are aesthetically beautiful and provide an attractive covering over soil and concrete surfaces that would otherwise be bare.

food for other organisms & shelter for other organisms such as small insects.

II. Liverworts:

General characteristics:

are typically small, usually from 2–20 mm wide with individual plants less than 10 cm long.

Like mosses, they have gametophyte dominant stage and a sporophyte stage.

1. Thallose liverwort
   - consist of flattened, ribbon-like or branching structure called a thallus (plant body)
   - (in many cases, that's all there is to the gametophyte)

2. Leafy(scale) liverworts
   - The gametophyte consists of leaves on stems (most liverworts).
Liverworts can most reliably be distinguished from the apparently similar mosses by:

- Liverworts have unicellular rhizoids (root-like structures for anchoring)
- Leaves (scales) are multicellular and often lobed
- Leafy liverworts always have two lateral rows of leaves, and sometimes a row of leaves on the ventral side (bottom) of the stem.

III. Hornworts:

**General characteristics:**

- A tapering, horn-like or needle-like structure (the sporophyte) develops from a flattish, green sheet (thallus: the gametophyte)
- Archegonia & antheridia embedded deep in gametophytes
- Zygotes develop into long, horn-shaped Sporophytes
- Hornwort sporophytes lack setae, each tapering "horn-like" sporophyte embedded in the thallus is entirely spore capsule.
- The immature sporophyte is green, as the spores mature the sporophyte walls change from green to brown
- When spores near the apex are mature the sporophyte develops slits there.

![Figure 3.9 Hornworts](image-url)
Vascular plants:

I. Seedless vascular plants:

- Are plants that contain vascular tissue, but do not produce flowers or seeds.
- The seedless vascular plants, reproduce using haploid, unicellular spores instead of seeds.

Modern seedless vascular plants include species from several different phyla, including:

- Pterophyta – ferns (the great diversity of ferns)
- Psilophyta – Whisk ferns
- Lycophyta – Club mosses
- Sphenophyta – horsetails

Ferns:

General characteristic:

- They live in shady places that provide enough moisture
- Fern can survive in various climates and on different altitudes.
- Ferns consist of stems, leaves and roots.
- Depending on the species, fern develops as miniature herbaceous plant or as tall tree. (Smallest fern is only 2 to 3 inches high, largest fern can grow 30 feet high into the air).

Ferns Parts:

- Ferns have fibrous root that can easily absorb water and all nutrients required for successful growth.
- Do not have aerial stems. Instead, the leaves arise directly from an underground stem (rhizome) or a very short vertical stem at or near the soil surface.
- Leaves of ferns are referred as fronds (a large – divided leaf) have feathery structure and carry the reproductive organs of the plant.
Spores are produced in the structures called sporangia:
- They can be recognized as row of brown patches on the bottom side of the leaves
- Spores can be reddish, brownish, yellow or black in color.

Reproduction of ferns takes place in two morphologically different phases known as sporophyte (dominant stage) and gametophyte

1. **Sporophyte** can be easily recognized because it looks like typical fern.

2. A fern **gametophyte** typically consists of:

- **Prothallus**: A green, photosynthetic structure that is one cell thick, usually heart or kidney shaped, 3–10 mm long and 2–8 mm broad.
  The prothallus produces gametes by means of:
  - Antheridia: Small spherical structures that produce flagellate sperm.
  - Archegonia: A flask-shaped structure that produces a single egg reached by the sperm by swimming.

- **Rhizoids**: root-like structures (not true roots), water and mineral salts are absorbed over the whole structure, anchor the prothallus to the soil.
Note: Ferns live in the moist habitats because they require water for successful fertilization.

Ferns importance:
- Help prevent erosion
- Fiddleheads are eaten as food
- Ornamental plants for yards and homes
- Ferns can absorb heavy metals from the air and soil. They can be used to prevent pollution or for the cleaning of already polluted areas.
- Ferns are able to absorb nitrogen from the air. Because of this feature, some farmers use ferns as natural fertilizers on the rice fields.
- Certain types of tree ferns are used as building materials.
- Unfortunately, some species are toxic & harm animals

Activities:
- Show samples of mosses & ferns & identify their different parts
Objectives

- Identifying some characteristics of seed vascular plants (Gymnosperms & Angiosperms)

Seed vascular plant

1. Gymnosperms:
   - General characteristics:
     - are a group of plants that share one common characteristic: they bear seeds, but their seeds do not develop within an ovary (not enclosed in an ovary), but are exposed within any of a variety of structures, the most familiar being cones.
     - The word "gymnosperm", meaning naked seeds
     - The gymnosperms consist of four major, related groups: conifers, cycads, ginkgo, and gnetophytes.

Phylum Coniferophyta (conifers):

- General characteristic:
- Conifers are the largest group of gymnosperms.
- All living conifers are woody plants, and most are trees
- The size of mature conifers varies from less than one meter, to over 100 meters.
- The world's tallest, thickest, and oldest living trees are all conifers
- They have naked seeds produced inside cones
- They include evergreen trees such as pine, cedar, spruce, fir, and redwood trees.
Note:
- needle-like and are adapted for dry conditions
- such as hot summers or freezing winters.
- Needles lose water slower than broad, flat leaves and therefore do not need to be shed during seasons when water is scarce, so most conifers are evergreen.

Conifer cone:
- Cones (strobilus): is an organ on plant that contains the reproductive structures (protective woody structures)
- Every conifer species has male and female cones.
- Most conifer species produce male and female cones on the same individual (monoecious) But some appear on separate plants (Dioecious).
- Both female and male cones have a central shaft with scales or leaf-like projections called sporophylls that are specially shaped to bear sporangia (a reproductive unit).
1. The male cone (microstrobilus or pollen cone):
   - is structurally similar across all conifers, differing only in small ways (mostly in scale arrangement) from species to species.
   - the males do not grow to any appreciable size, and are shed from the plant soon after releasing pollen, & tend to grow on the lower branches of trees.
   - Extending out from a central axis are microsporophylls.
   - Under each microsporophyll is one or several microsporangia (pollen sacs).
   - Within the microsporangia are cells which undergo meiotic division to produce haploid microspores.
   - The gametophyte phase begins when the microspore,( while still within the microsporangium), begins to germinate to form the male gametophyte.
   - A single microspore nucleus divides by mitosis to produce a few cells.
   - At this stage the male gametophyte microgametophyte (called a pollen grain :1n ,yellow color ) is shed and transported by wind.
2. The female cones (Seed cones, ovulate cones, megastrobili):

- The female cone structure varies more markedly between the different conifer families, and is often crucial for the identification of many species of conifers.
- Female cones larger than male cones & tend to grow on the upper branches of trees.
- A megastrobilus contains many scales, called megasporophylls, that contain megasporangia.
- Within each megasporanion, a single cell undergoes meiotic division to produce four haploid megaspores, three of which typically degenerate.
- The remaining megaspore undergoes mitosis to form the female gametophyte.
- Female gametophyte function to produce eggs.

Figure 4.3: Female Cone

Ovule ("small egg"):
It consists of three parts:

- The integument forming its outer layer.
- The nucellus (or remnant of the megasporangium).
- Female gametophyte (formed from haploid megaspore) in its center.
- The female gametophyte (The megagametophyte) produces an egg cell (or several egg cells in some groups) for the purpose of fertilization.
- At this stage the ovule is ready to be fertilized.
- After fertilization, the ovule develops into a seed.
Pollination and Fertilization:

- Before fertilization can take place, however, the pollen grain must be transported to the female gametophyte—the process of pollination.
- In many gymnosperms, a sticky “pollination droplet” oozes from a tiny hole in the female megasporangium to catch pollen grains.
- In other species, the pollen grain settles on the surface of the megasporangium, where the male gametophyte develops further.
- Within each pollen grain are two cells. One is called the "generative" cell and will generate two sperm while the other is a tube cell that will produce a pollen tube after pollination.
- A pollen tube emerges from the grain and grows through the megasporangium toward the multicellular egg-containing structure called the archegonium.
- The megaspore and pollen grain continue to mature, the nucleus of the latter undergoing additional divisions resulting in sperm.
- The sperm are not flagellated (usually), so they remain within the tube cell and rely on the growth of a pollen tube to deliver them to the egg cell.
- By the time the pollen tube reaches the archegonium, both the egg and sperm are fully mature, and the egg is ready to be fertilized.
- When the nuclei of the two sperm meet the egg cell, one nucleus dies and the other unites with the egg nucleus to form a diploid zygote.
- The fertilized egg undergoes mitosis to begin the development of a new sporophyte generation—the multicellular embryo of the seed.
- Food for the developing embryo is provided by the massive starch-filled female gametophyte that surrounds it.
- Mature seed drops out of cone onto the ground.
- Seed germinates and seedling grows into a mature plant. When the plant is mature, it produces cones and the cycle continues.

Notes:
- The time interval between pollination, fertilization & maturation of the embryo into a new sporophyte generation varies among different groups, ranging from a few months to over one year.
- While developing, the scales of female cones are clasped together and usually held tight by resin.
- When the seeds between the scales reach maturity, the cone responds by changing color from green to brown, and separating its scales to expose the seeds that will soon fall out.
- For some species, the cones remain tightly closed until exposed to very warm temperatures.
II. Angiosperm (flowering plants):

General Characteristic:

- The largest and most diverse group within the kingdom Plantae
- The term "angiosperm" meaning "enclosed seeds"
- Ovule (egg) is fertilized and develops into a seed in an enclosed hollow ovary.
- The ovary itself is usually enclosed in a flower, that part of the angiospermous plant that contains the male or female reproductive organs or both.
- Fruits are derived from the maturing floral organs of the angiospermous plant and are therefore characteristic of angiosperms.
- The angiosperms have been divided into two groups:
  - Monocotyledons (monocots): Rice, Wheat, Maize, lilies, grasses, Onion and palm trees.
  - Dicotyledons (dicots): Legumes, mint, lettuce, tomato and oak
- Cotyledon (seed-leaf) is a significant part of the embryo within the seed of a plant
- Upon germination, the cotyledon may become the embryonic first leaves of a seedling.
- The number of cotyledons present is one characteristic used by botanists to classify the flowering plants (angiosperms)

![Figure 4.6: Monocot & Dicot Differences](image-url)
Root types:

- Root is the organ of a plant that typically lies below the surface of the soil.
- Functions: absorption of water and nutrients, anchorage, in many plants, store food.
- There are two main types of roots in the angiosperms: taproot system & fibrous system.
- The first root produced from a seed is called the radicle.
- This forms the primary root of a young plant.
- In dicotyledons, the primary root commonly grows to become a thick central root (the taproot), with minimal branching consisting of secondary, smaller lateral roots.
- In monocotyledons, the radicle is very short-lived, and before it dies, other adventitious roots have already originated from stem or leaf to become the new root system, called a fibrous root system (dense mass of slender, adventitious roots often with few or no lateral roots).
Note:
- Generally, plants with a taproot system are deep-rooted in comparison with those having fibrous type.
- The taproot system enables the plant to anchor better to the soil and obtain water from deeper sources.
- In contrast, shallow-rooted plants are more susceptible to drought but they are quick to absorb surface and irrigation water and thus have the ability to respond quickly to fertilizer application.

Figure 4.8: Taproot system & Fibrous Root system

Activates
- Show different type of conifers leaves
- Show different male & female cones
- Show tap & fibrous roots
- Show the leaves of monocot & dicot plants
- Show the Flowers of monocot & dicot plants
- Show monocot & dicot seed germination
Lab 5: Muscular & Digestive Systems

Objective:

- Identify the tools and procedures of Dissection
- Identify the muscular & digestive systems of rabbit.

Introduction

- **Dissection**: is the process of disassembling and observing something to determine its internal structure and as an aid to discerning the functions and relationships of its components.
- The term is most often used concerning the dissection of plants and animals, including humans.
- Human dissection is commonly practiced in the teaching of anatomy for students of medicine, while students of biology often engage in dissections of animals, but also of plants.

![Basic Dissection Tools](image)

**Figure 5.1: Basic Dissection Tools**

Dissection procedures:

- Take a rabbit killed by an overdose of anesthetic, like chloroform or ether, and lay it on its back on the dissecting board.
- Fix it with nails or pins in the hands & feet.
- Examine the external features.
Lift the skin of the abdomen with forceps and scissors, make a median longitudinal incision of the skin extending from the pubic symphysis to the tip of the snout.

- Cut transversally along forelimbs & hind limbs.
- Separate the skin from the muscle with the help of your finger or the handle of a scalpel and proven skin on both sides by nails.
- Cut the abdominal muscles from back to front by a forceps and scissors.
- Cut the abdominal wall behind the chest (parallel to the ribs).
- Open the chest vacuum by cut along the sternum and both sides of ribs.
- Examine internal organs ...

**Notes:**
- Do not make incisions (cuts) while holding the specimen. It should be firmly pinned down in the dissection tray.
- Never cut towards others or yourself.
- Only pins and probes can be stuck through the specimen.
- Any parts of the specimen removed need to be left in the dissection tray until the end of the dissection.
- All specimens and their parts need to be placed in a baggie for disposal.
- All tools must be rinsed (water & alcohol) and dried.
• Each lab table must be cleaned with Clorox or alcohol before a lab group can leave
• Gloves & lab coat must be worn at all times.
• Hands must be washed before leaving the classroom.

Muscular system:

Digestive system

Parts of the digestive system:

➢ rabbit's Mouth:
The first part of a rabbit's digestive system is the mouth.
✓ Bounded by 2 mobile soft lips
✓ The upper lip is divided by median cleft which connect the mouth with the nostril
✓ rabbit uses its lips to grab the plant and pass it to the teeth for cutting and grinding.
✓ It has 16 baby (deciduous) and 28 permanent teeth.
✓ The permanent teeth consist of 2 lower and 4 upper incisors, and 22 total premolars and molars.
When looking at the rabbits’ teeth, only 2 upper incisors are visible because the other 2 are smaller and placed behind the visible pair (peg teeth).

- The incisors tear and grab plants.
- Premolars and molars function: grind the food to a smaller particle size to allow for the food to be swallowed.
- Utilize saliva secreted into the mouth to moisten the food to help with lubrication and movement through the gastrointestinal tract.

**Esophagus:**
- Once food is swallowed, it passes through the **esophagus**.
- The esophagus is essentially a tube extends in the neck region dorsal to the tracheae, that transfers food from the mouth to the stomach.

**Stomach:**
- Rabbits have **larger stomach** for their size to allow them to hold large amounts of foods because they are crepuscular – actively eat during dawn and dusk.
- The esophagus enters the Stomach at its wider portion (cardiac portion), to the left of it is the **fundus**, the right portion of the Stomach is the **pyloric region**.
- The **main secretions of the rabbit stomach** are mucus, pepsin, and hydrochloric acid.
• **Mucus** offers lining to protect the stomach from acids and enzymes as well as moisturizing the food.

• **Hydrochloric acid** is important in decreasing the pH of the stomach to allow enzymes to work, and it kills or inhibits bacteria found in the food.

• **Pepsin** is a proteolytic enzyme, which breaks down proteins.

• The muscles of the stomach churn or mix the food with stomach secretions.

• At this point the mixture is called **chyme, or digesta**.

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**Small intestine:**

• Chyme or digesta passes from the **stomach** into the **small intestine**, a flow regulated by **pyloric sphincter**.

• Most of the **digestion and nutrient absorptions** occur in the small intestine.

The small intestine consist of three sections namely – the **duodenum, jejunum, & ileum**.

**Duodenum:**

- is the first section of the small intestine in the form of **U-shapes loop**, where most of digestion occurs.
- **Secretions** from the **pancreas** increase pH levels to more neutral levels. This is because stomach acids decrease pH levels in food.
- Duodenum secrete enzymes like proteolytic, amylolytic (starch digesting) and lipolytic (fat digesting) to break down the food.

**Jejunum**: is mid-section of the small intestine which absorbs glucose, amino and fatty acids.
**Ileum:**
- is the last section of the small intestine, where the remaining nutrients and B vitamins are absorbed.
- The ilium ends in the sacculusus rotundus (whitish & rounded) that open into large intestine (allow food to pass to large intestine)

Both Jejunum & Ileum are not well differentiated from each other in rabbits

- **Cecum & large intestine:**
  - Absorption of water occur in large intestine
  - **Caecum:**
    - a **blind sac, or pouch** that is located where the small intestine and the large intestine join together
    - recognized by its large size, thin-walled & visible on the external surface is a spiral constriction, ends by a thick-walled, much narrower & finger like **vermiform appendix**
    - **Large caecum** a feature of **herbivores**

**Notes:**
- Rabbits are **herbivores**, meaning that they dine only on plant material.
- A rabbit has an esophagus, stomach, and intestinal tract like other mammals.
- However, because they often dine on plants that are **high in fiber**, they have developed a strategy for dealing with this called **hind gut fermentation**.
  - This is where the **indigestible materials** break down into **manageable chemicals**
  - rabbit caecum is very large and contains a wonderfully diverse population of healthy **bacteria, yeast, and other organisms** working to help the rabbit digest his food.

- **Colon (large intestine):**
  - Extend from sacculusus rotundus and lead to narrow rectum which end in the anus
  - **Colon** has ascending, transverse and descending parts
  - **Rectum** usually contain fecal pellets
Notes:
- When the food in the small intestine reaches the cecum and large intestine, the gastrointestinal tract knows which materials to divert into the cecum for further breakdown.
- The materials that were already digested in the small intestine and that don't need to make this little side trip to the cecum pass directly into the large intestine as waste, this leaves the body as the little round droppings.

Digestive system accessory glands:
- Pancreas:
  - Lies in the mesentery between the 2 limps of the duodenal loop.
  - It is pancreatic duct open into the beginning of the distal limb of the duodenum.
- The Liver:
  - Very large, dark red in color.
  - Consists of five loops: The right and left central, left lateral caudate small spigelian loops.
  - The gall bladder: thin walled sac dark green in color present in groove in the right central loop
  - The bile duct open into the proximal limb of the duodenum near the pylorus
- Spleen: is a dark red elongate body which lies close to the posterior cardiac portion of the stomach.

Activity:
- Dissect rabbit muscular & digestive system.
Lab 6&7 : Urinogenital system

Objectives
- Identify the Urinogenitale system in both male & female rabbits (parts, functions)

I. RABBIT-EXCRETORY (Urinary) SYSTEM

- The urinary system is responsible for filtering wastes from the blood and both forming and secreting urine.
- These functions help to maintain the composition and volume of body fluids.
- In vertebrates the excretory system and reproductive system are closely associated with each other, hence some times it is called urino-genital system.

The urinary system is relatively simple anatomically and consists of:
- a pair of kidneys
- a pair of ureters
- an urinary bladder
- an urino-genital canal
- urino-genital aperture.

1. Kidneys:
- The **main organs** are the kidneys, which **filter blood** and produce **urine**. The **other parts** are simply accessory structures for the **transport & storage** of urine.
- Close to each kidney of a small yellowish rounded body. This is the **adrenal gland**.
• are two dark red bodies present on either side of vertebral column, & located outside of the peritoneum (the membrane that encloses the organs of the abdominal cavity)
• The kidney of the right side is placed slightly anterior than the left kidney.
• The kidney is enclosed by a thin outer capsule made up of connective tissue.
• The kidney has a convex outer surface and a concave inner surface.
• Each kidney is bean-shaped with a median notch called hilus on the inner side
• An elongated ureter originates from the hilus that runs posteriorly and opens into urinary bladder.
• At the emergence of ureter, it becomes dilated to form a funnel-like structure called pelvis.
• A renal artery enters & renal vein exists the kidneys through the hilus.

Anatomically the kidney is made up of two layers namely: outer cortex & inner medulla:

➢ The medulla:
  is formed of several conical lobes called pyramids. The pyramids project into cup-like structures called calyces.

The cortex opens into the medulla in between the pyramids. These extensions are renal columns
➢ The cortex:
  is where blood is actually filtered through small structures called 'glomeruli'.

Notes:
• The medulla is where the urine is concentrated through a complex system of tubules. They accomplish this by absorbing the water and electrolytes while preventing waste products from being reabsorbed.

• One glomerulus and its corresponding set of tubules are called a 'nephron' – the microscopic functional unit of the kidney.
- The tubules of multiple nephrons are grouped into larger visible portions of the kidney called 'pyramids'.
- The tips of the pyramids are called 'papillae,' and they drain urine from nephron tubules into larger vessels called 'minor calyces.'
- The minor calyces converge into still larger vessels called the 'major calyces.' These lead to the enlarged opening of the ureter, this collecting chamber is called the 'renal pelvis' from it to ureter'

Nephrons:
- The nephrons are the actual filtration elements of the kidneys.
- Each kidney contain 1 million nephron
  Neprhon consist of:
  I. Malphigian capsule:
     a cup-shaped structure called Bowman's capsule
     a mass of blood capillaries called Glomerulus.
  II. Convoluted ducts
  III. Collecting tubules

2. The ureters originating from the two kidneys open into urinary bladder
3. Urinary bladder: ovoid sac receive the genital duct and extends in the pelvis & opens into urinogenital canal lead to urinogenital open
II. Male genital system in rabbits :

The male reproductive organs include :

- a pair of testes
- a pair of epididymes
- a pair of vasa deferentia
- Urethra
- penis
- some accessory glands.

1. Testis :

- The paired testes are small, ovoid bodies of light pink color.
- Each testes lies in a special thin-walled sac of skin outside the abdominal cavity, called the scrotum.
- In the fetus and new born rabbit, the testis lie within the abdominal cavity near kidneys where they were developed.
- But at puberty, they descend through inguinal canals into scrotal sacs.
- In most species of mammals the testis remain within scrotal sacs through life, but in rabbit, rat and other rodents, they are migratory.
- They descend into the scrotum during the breeding season, but withdraw into the abdominal cavity during non-breeding periods through inguinal canals which remain open through life.
- The reason for this is spermatozoa can develop within the scrotal sacs at low temperature but cannot develop inside abdomen at normal temperature.
  - Histologically, the mammalian testis :
    - is composed of a number of wedge-shaped or cone-shaped compartments or lobules.
    - Each lobule contains long, slender, much convoluted microscopic seminiferous tubules bound together by connective tissue.
1. Function of seminiferous tubules: the production of sperms
   - All the seminiferous tubules in each testis open into a network called rete testis.
   - It opens by several fine ductus lined by cilia, called vasa efferentia, into the epididymis.
   - The spermatozoa (Sperms) produced by testis are transferred through vasa efferentia into the epididymis.

2. Epididymis:
   - The epididymis is an irregular, narrow and highly convoluted tubule of great length.
   - It forms a compact ridge-like mass all along the inner surface of the testis.
3. VASA DEFERENTIA:

- The basal end of each epididymis (cauda epididymis) leads into a yellowish-white, straight, and muscular tube, the sperm duct or vas deferens.
- It runs forward along the inner side of the scrotal sac
- Curves over the ureter, then passes backward again and open to small median sac (uterus masculinus or seminal vesicle)
- Uterus masculinus lies dorsal to the neck of the bladder & open into it
- Thus, the two (uterus masculinus & bladder) form the Urethra.

4.5. Urethra & penis:

Urethra (Urino-genital duct):
- is the common passage for both urine & semen (extend into pelvis ventral to rectum).
- It traverses & opens at the tip of the penis as the male urino-genital aperture.

PENIS:
- The copulatory organ or penis is a small, cylindrical in front of the anus.
- The penis serves to transmit sperms into the vagina of the female during sexual intercourse.

Accessory Sex Glands in male rabbit:
Several accessory sex glands (most open into urethra of male):

A. PROSTATE GLAND:
- A large prostate gland lies dorsally around the base of uterus masculinus.
- It opens into urethra by several small ducts.
- Its whitish alkaline secretion activates the passive spermatozoa.
B. COWPER GLAND:
- A pair of Cowper's glands lie posteriorly to the prostate glands
- Their secretions lubricates the passage of sperms

C. PERINEAL GLANDS:
- These are a pair of dark elongated scent glands lying behind the Cowper's glands.
- They open into the hairless perineal depressions one on either side of anus.
- Their odorous secretion gives the rabbit its characteristic smell.

D. RECTAL GLANDS:
- A pair of rectal glands of is open into the rectum.
- Secrete mucus lubricates passage for feces

III. Female genital system in rabbits:
- Include a pair of ovaries, a pair of oviducts, a pair of uteri, vagina, vestibule, vulva and some accessory glands.
1. **OVARIES**:
- The two ovaries are small, whitish, oval bodies, about 2 cm long.
- They are found behind the kidneys, each ovary attached to the dorsal abdominal wall by a double fold of peritoneum called *mesovarium*.

2. **OVIDUCTS**:
- Each oviduct opens anteriorly, close to the outer border of the ovary of its side, by a **wide funnel** called *fallopian or oviductal funnel*.
- The opening of funnel, or ostium, is provided with **many cilia** to receive the **minute ova** released from the ovary.
- Funnel leads **into the upper part of oviduct**. It is a short, narrow, coiled and internally ciliated duct called *fallopian tube*. (Ova pass through this tube by ciliary action and fertilization also occurs here).

3. **Uterus**:
- The **fallopian tube** is followed by a much wider, longer convoluted, thick walled muscular tube (**uterus**).
- It is richly vascular and highly distensible and attached to the dorsal abdominal wall by a mesentery.
- **Fertilized ova or zygotes** get implanted on the uterine wall to develop into **embryos** or fetuses.

4,5. **Vagina & Vestibule**:
- The **uteri** of both the sides **meet into** a long wide, median duct called **the vagina** that lying dorsally upon the urinary bladder.
- **Vagina** opens posteriorly into the neck of bladder, both unit to form **vestibule** (**short narrow common urinogenital canal**).
- **Vestibule** runs backwards ventral to the rectum and opens to the exterior by a **slit-like aperture** called **the vulva**.
- The **vagina serves** to receive the penis of the male during copulation.
Female Accessory Sex Glands:

- In the female rabbit, there is no prostate gland.
- A pair of small Cowper’s glands lies embedded in the dorsal wall of vestibule. Their viscid secretion lubricates the vaginal passage.
- The perineal & rectal glands are as in the male.
- The skin of the female rabbit has four or five pairs of mammary glands & nipples

Activity:
- Dissect rabbit urinogenital system in male & female
Lab 8&9 : Mammalian Circulatory & Respiratory system

Objectives

• Identifying the Mammalia Circulatory & Respiratory System

I. Circulatory System :

➢ Circulatory System Components :
  ✓ Heart
  ✓ Blood
  ✓ Vessels (Arteries, Veins, Capillaries)

A. Heart :

• The heart is conical, muscular and lies in thoracic cavity between the two lungs.
• is slightly towards left side and enclosed by a double walled pericardium
• A narrow space is left between the two pericardial layers, called pericardial cavity that is filled by pericardial fluid.
• The pericardial fluid helps in protection of the heart from external shocks and injuries.
• The heart is composed of three layers: the epicardium (outer layer), the myocardium (middle layer), and the endocardium (inner layer).
• Mammals have a double circulatory system, so the heart must pump blood to the lung and to the rest of body simultaneously.
• It is attached to four very important blood vessels: the Vena Cava (Superior & inferior), the Pulmonary Artery (2), the Pulmonary Vein (4) and the Aorta.

• Internally, the heart is made up of four main cavities: two Atria (singular: atrium) and two Ventricles.
• The atria receive blood, while the ventricles pump blood.
Blood circulation:

- There are 2 primary circulatory loops in the human body: the pulmonary circulation loop & the systemic circulation loop.
- Pulmonary circulation transports deoxygenated blood from the right side of the heart to the lungs, where the blood picks up oxygen and returns to the left side of the heart.
- (The pumping chambers of the heart that support the pulmonary circulation loop are the right atrium and right ventricle.)
- Systemic circulation carries highly oxygenated blood from the left side of the heart to all of the tissues of the body (with the exception of the heart and lungs).
- (Systemic circulation removes wastes from body tissues and returns deoxygenated blood to the right side of the heart. The left atrium and left ventricle of the heart are the pumping chambers for the systemic circulation loop).
- The vena cava supplies de-oxygenated blood from the body, which then flows into the right atrium then the right ventricle.
- (superior vena cava: large vein that carries deoxygenated blood from the upper half of the body to the right atrium of the heart inferior vena cava: large vein that carries deoxygenated blood from the lower half of the body to the right atrium of the heart)
- This gets pumped through the pulmonary artery to the lungs where it gets oxygenated, before returning to the heart via the pulmonary vein.
• This flows through the left atrium into the left ventricle, and then gets pumped to the body via the aorta, branches into other arteries, which then branch into smaller arterioles.
• It finally returns to the heart through the vena cava, and the process repeats. This is happening inside you right now, about once a second!

Valves
• The atria are separated from the ventricles by Atrioventricular Valves (specifically called Tricuspid Valves - right; and Bicuspid/Mitral Valves - left).
• The ventricles are separated from the aorta & the pulmonary artery by the Semilunar Valves (specifically called, respectively, the Aortic & Pulmonary Valves).
• These valves allow blood move only in one direction & prevent blood from flowing in the wrong direction back into the heart.

Heart walls
• The atrial walls are thin; they don't need to withstand much pressure. The ventricles walls on the other hand are much thicker. (When the ventricles contract, the blood
pressure inside becomes very high, and they need to be able to withstand this.)

- Also, the walls of the left ventricle are thicker than those of the right ventricle. This is because the left side of the heart controls the systemic circuit (blood to the whole body) while the right side controls the pulmonary circuit (blood to the lungs).

**B. Blood vessels:**

➢ **Arteries:**
- The arteries carry blood away from the heart, all arteries carry oxygenated blood except the 2 pulmonary artery
- The arteries branch and eventually lead to capillary beds.
  ➢ **Veins:**
- At the opposite side of the capillary beds, the capillaries merge to form veins, which return the blood back to the heart.
- All veins carry deoxygenated blood except the 4 pulmonary vein

**II. The respiratory system:**

**RESPIRATORY ORGANS:**
- The respiratory system starts with a pair of external nostrils
- The nostrils open into nasal passage that is situated above the buccal cavity.
- The nasal passage is separated from the buccal cavity by a palate.
- The nasal passage opens posteriorly into the pharynx by internal nostrils.
- The nasal passage helps in:
  - (a) olfactory sensation (b) Filtering the air and (c) Warming up the inhaled air.
- The pharynx in rabbit has two openings namely the gullet and the glottis.
- The gullet leads into oesophagus while the glottis leads into the trachea.
- The glottis is guarded by a cartilaginous flap like structure called Epiglottis. The epiglottis prevents the entry of food into trachea by closing the glottis.
Larynx:
- The anterior part of trachea consists of larynx or voice box.
- It encloses a cavity called Laryngeal chamber.
- Two pairs of membranous folds called vocal cords are present inside the laryngeal chamber.
- One pair of vocal cords are true and the second pair are false.
- When air is sent outside the vocal cords vibrate to produce sound.

Trachea:
- The larynx opens into trachea or wind pipe that runs along the length of neck, ventral to the oesophagus.
- The trachea enters into the thoracic cavity and divided into two branches called Bronchi.
- The trachea and bronchi are supported by incomplete cartilaginous rings called tracheal rings.
- Each bronchus enters into the lung of its side.
- The bronchus is further divided into small branches called bronchioles within the lung.
Bronchiole & Alveoli:
- Each **bronchiole** divides into number of **alveolar ducts**.
- The alveolar ducts terminate in **Air sacs or Infundibuli** formed of **many alveoli**.
- The **alveoli** are highly vascularized with blood capillaries.
- Bronchioles are lined with mucous membrane.
- The wall of air sacs is made up of thin layer of flattened cells supported by highly elastic connective tissue. It is also supplied with large number of blood capillaries.

Lungs:
- The lungs in rabbit are hollow pinkish, **spongyjobed bags**, lying in thoracic cavity or air tight pleural cavities.
- They are **surrounded** dorsally by the vertebral column ventrally by sternum, posteriorly by the diaphragm, anteriorly by the neck and laterally by the ribs.
- The ribs are operated by two sets of intercostal muscles.
- The left lung consists of two lobes namely left anterior and left posterior lobe.
- The right lung consists of four lobes namely anterior azygos, right anterior, right posterior and posterior azygos.
- **Inside** each lung the bronchiole terminates in a cluster of air sacs or alveoli.
- **Gaseous exchange** occurs within the alveoli.

**Activity:**
- Dissociation of sheep Heart & lung
Lab 10: Human Eye Anatomy

Objectives
- Identifying Human Eye parts & their functions

Eye Anatomy:

- **Eyelids**:
  - Protects eye from foreign matter (dust, dirt, debris)
  - Protects against bright light that might damage the eye
  - Help spread tears over surface of eye—moist & comfort

- **Eyelashes**:
  - Filter out foreign matter & prevent it from getting into eye

- **Lacrimal gland**:

  **Produces tears**
  - Ducts from the lacrimal gland discharge the tears onto the eye surface through openings
  - Tears leave each eye by way of upper and lower canicular ducts, which have barely visible openings, called puncta
  - The canaliculi lead to the lacrimal sac near the inner corner of each eye, which itself empties into the nasolacrimal duct (a tube-like structure that directs tears into the nasal cavity).

  **Tears**:
  - Prevent excessive drying of the surfaces of the eye (such as the conjunctiva and cornea)
  - Provide some nutrition and oxygen to surface structures
  - Possess antibacterial properties.
- **Conjunctiva (Conj):**
  - Thin, clear layer of skin
  - Covers the sclera and the inside of the eyelids
  - **Function:**
    - Keeps bacteria and foreign material from getting behind eye
    - Secretes oils and mucous that moisten and lubricate the eye

- **Sclera:**
  - Tough, opaque tissue that extends around the eye “White of the eye”.
  - **Function:**
    - Surrounds the eye and gives the eye its shape
    - The sclera is attached to the extraocular muscles

- **Cornea:**
  - Clear layer at the front & center of eye
  - Located in front of the iris (colored part of eye)
  - **Function:**
    - Focus light as it enters eye
  - **Note:** Only organ that has no blood vessels (Avascular)

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Figure 10.2, 3, 4: Conjunctiva, Sclera, Cornea respectively
- **Anterior Chamber (AC):**
  - Fluid-filled space
  - Behind the cornea & in front of the iris
  - **Function:**
    - Fluid = Aqueous humor (AH), AH helps nourish the cornea & the lens

- **Pupil (P):**
  - Central opening of iris

- **Iris (I):**
  - Ring shaped tissue & the colored part of eye
  - **Function:**
    - Controls the amount of light that enters the eye
    - Have Two muscle fibers:
      - **Contraction:** Constricts pupil in bright light
      - **Dilation:** Dilates pupil in dark

- **Anterior Chamber Angle:**
  - Located where the cornea meets the iris
  - **Function:**
    - Site where aqueous humor drains out of eye
    - If AH cannot properly drain out Pressure build up inside eye Causes optic nerve damage & eventually vision loss = glaucoma

- **Posterior Chamber (PC):**
  - Fluid-filled space (Fluid = Aqueous Humor)
  - Immediately behind the iris but in front of the lens

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**Figure 10.5,6,7:** Pupil & Iris, AC & PC, Aqueous Humor Drain Out respectively
➢ **Crystalline Lens:**
- Clear, flexible structure, lies behind the iris & pupil
- **Function:**
  - Focuses light onto the retina
  - Surrounded by a ring of muscular tissue – ciliary body

➢ **Ciliary Body:**
- Attached to the ciliary body are tiny fiber ligaments (zonules) – suspend the lens
- **Functions:**
  - Produces aqueous humor
  - Controls accommodation to light by changing the shape of the lens
    - **Ciliary body contracts** - zonules relax and lens thicken, the eye's ability to focus up close
    - **Ciliary body relaxes** - zonules contract and lens becomes thinner, adjusting the eye's focus for distance vision

➢ **Vitreous Chamber:**
- Located behind the lens & in front of the retina
- **Functions:**
  - Filled with a gel-like fluid called the vitreous humor
  - The vitreous help maintain the shape of the eye

![Figure 10.8: Eye Structure](image_url)
Retina:
- Multi-layered sensory tissue that lines the back of the eye
- Functions:
  - Acts like the film in a camera to create an image
  - Converts light signals into nerve signal then send these signals to the optic nerve & optic nerve carries the signals to the brain
  - The brain helps process the image
- Contains millions of photoreceptors cells:
  - Cones (6 million): Bright light (help us differentiate color)
  - Rods (125 million): Night vision (low light situations)

Macula:
- A small and highly sensitive part, Located in the central part of the retina
- Functions:
  - Responsible for giving sharp central vision
  - Used for reading, recognizing faces, and watching TV
  - Any disease that affects the macula will cause a change & impairment in the central vision

Choroid:
- A layer of tissue that is: Located under the retina & separates retina & sclera
- Mostly made up of blood vessels
- Functions:
  - Helps carry oxygen & nourish outer portion of the retina

Figure 10.9,10,11: Retina, Macula, Choroid respectively
**Note:**
- Behind, the retina is a blue, reflective layer known as the **tapetum**.
- Many animals have this layer, which helps them see better at night.
- Humans do not have a tapetum.
- This area on the human eye is called the choroid.

> **Optic Nerve:**
- A bundle of 1 million nerve fibers
- The optic disc is the front surface of the optic nerve
- The optic disc is visible on the retina

**Functions:**
- Responsible for transmitting nerve signals from the eye to the brain

![Figure 10.12,13: Tapetum, Optic Nerve](image)

**Activity:**
- COW EYE DISSECTION.
Lab 11: Human Ear Anatomy

Objectives

- Identifying Human Ear parts & their functions

Ear Parts:

- The ear is the organ of hearing and, in mammals, balance.
- In mammals, the ear is usually described as having three parts:
  - The outer ear
  - Middle ear
  - The inner ear.

All three parts of the ear are important for detecting sound by working together to move sound from the outer part through the middle and into the inner part of the ear. Ears also help to maintain balance.

1. The outer ear:

   The outer ear consists of:
   
   - **Pinna (auricle):**
     - Cartilage covered by skin placed on opposite sides of the head
     - The visible part of the outer ear.
     - It collects sound and directs it into the outer ear canal
   
   - **Auditory canal (external ear canal, external auditory meatus):**
     - The tube through which sound travels to the eardrum, 2.5 cm (length)
• The first part of the canal is surrounded by cartilage, while the second part near the eardrum is surrounded by bone.
• The skin surrounding the ear canal contains ceruminous and sebaceous glands that produce protective ear wax.
• The ear canal ends at the external surface of the eardrum

➢ Eardrum outer layer (tympanic membrane):
  • A thin membrane that vibrates when sound waves reach it
  • At the end of ear canal

Outer Ear Functions
• Collecting the sound
• Protection
• Localization

III. The middle ear:
• A cleft within the temporal bone.
• Lining is mucous membrane
• Tympanic Membrane separates it from EAC

It consists of:
• an air-filled cavity called the tympanic cavity, includes the three ossicles.

Middle Ear Structures:
• The ossicles are three small bones that function together to receive, amplify, and transmit the sound from the eardrum to the inner ear.
• The ossicles are the malleus (hammer), incus (anvil), and the stapes (stirrup).
  ✓ Malleus (or hammer): long handle attached to the eardrum
  ✓ Incus (or anvil): the bridge bone between the malleus and the stapes
  ✓ Stapes (or stirrup): the footplate; the smallest bone in the body
• The Eustachian tube (auditory tube) connects it to nasopharynx, it equalizes the pressure between the middle ear and the air outside.
III. INNER EAR:

Consist of:

- **oval window**: connects the middle ear with the inner ear
- **semicircular ducts**
- **cochlea**.
- **Auditory nerve** - carry nerve signals from the inner ear (the cochlea) to the brain.

- The **inner ear** contains the sensory organs for hearing and balance.
- The **cochlea** is the hearing part of the inner ear. The **semicircular canals** in the inner ear are part of our balance system.

The **cochlea**:

- is a bony structure shaped like a snail and filled with two fluids (endolymph and perilymph).
- The Organ of Corti is the sensory receptor inside the cochlea which holds the hair cells, the nerve receptors for hearing.
- The mechanical energy from movement of the middle ear bones pushes in a membrane (the oval window) in the cochlea. This force moves the cochlea's fluids that, in turn, stimulate tiny hair cells.
- Signals from these hair cells are changed into nerve impulses. The nerve impulses are sent out to the brain by the cochlear portion of the auditory nerve.
Semicircular canals:
- Also housed within the inner ear are the semicircular canals, three loops of fluid-filled tubes that are attached to the cochlea in the inner ear.
- These structures help control one’s sense of steadiness or balance.
- These balance organs share the temporal bone space with the cochlea.
- These organs also share the same fluid that is in the cochlea.

How Our Balance System Works:
- Balance and equilibrium help us stay upright when standing and know where we are in relation to gravity.
- Our balance system also helps us walk, run, and move without falling. Balance is controlled through signals to the brain from your eyes, the inner ear, and the sensory systems of the body (such as the skin, muscles, and joints). This balance system is also known as the vestibular system.
- In the inner ear, the balance system consists of three semicircular canals that contain fluid and “sensors” that detect rotational movement of the head.
- Each of the semicircular canals lies at a different angle and is situated at a right angle to each other.
- The semicircular canals deal with different movement: up-and-down, side-to-side, and tilting from one side to the other.
- All contain sensory hair cells that are activated by movement of inner ear fluid (endolymph).
- As the head moves, hair cells in the semicircular canals send nerve impulses to the brain by way of the vestibular nerve.
- The nerve impulses are processed in the brain to help us know where we are in space or if we are moving.
Activity:

- Show Human Ear Model
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