Condensed Biology curriculum

From grade 9- 11

designed for grade 11 tutorial program

Preface

Dear teachers,

Addis Ababa City administration Education Bureau has prepared this condensed Biology curriculum highlighting on the core lesson notes and selected some key questions based on the syllabus and past exam papers.

As a professional, feel free to modify, add extra explanations or include examples that you think will help students especially, if you know where the students usually struggle. Moreover, you can bring in your own teaching experiences; employ different techniques to keep the students engaged for the 8-hour tutorial classes.

Generally, the program emphasizes ensuring students' engagement in ample practices and completing the sessions with greater confidence that would enhance their readiness for the university entrance examination.

For grade 11 students

Lesson 1 (2hrs)

Topic 1. Characteristics and Classification of organisms

Objectives:-

At the end of this section, the student will be able to:

- ✓ Explain the need for classification.
- ✓ Describe the system of binomial nomenclature developed by Linnaeus
- ✓ Explain the five-kingdom classification system.
- ✓ Describe the kingdoms of the Monera, Protista and Fungi and give examples of organisms from each one.
- ✓ Describe the kingdom Animalia and explain its major phyla, giving examples.

Characteristics of living things?

- All living things are made up of one or more cells
- All living things require energy
- producers or autotrophs
- All living organisms respond to stimuli:
- All living things can grow
- All living things can reproduce
- All living things can excrete
- All living things display ordered complexity
- Most living things maintain homeostasis
- All living things possess adaptations that evolve overtime

Classification is the scientific process of organizing living organisms into a hierarchical system of groups based on their shared characteristics

1.1 Taxonomy of living things

Principles of Classifications

Questions 1.Why Scientists classify living organisms?
2. Explain the relevance of classification

Biologists classify living things for the following reasons:

1. To simplify their study.

2. To bring order out of chaos or confusion.

3. To try to understand how life originated.

Questions

1. How do biologists classify living things?

2. Why do biologists classify living things into kingdoms?

3. List the rules for scientifically naming of organisms?

4. Write some Ethiopian animals and plants with their scientific names.

1.2 The classification system

The process of classifying living organisms is known as taxonomy, and the system we use groups living things into categories called taxa. The main taxonomic categories are kingdom, phylum (or for plants, division), class, order, family, genus and species.

The largest groups into which living organisms are divided are the kingdoms.

The species is the smallest unit of classification.

A group of organisms that can breed successfully with one another to produce fertile offspring.

Simple rules for writing scientific names

1. The first name is the name of the genus to which the organism belongs. It is written with a capital letter. Sometimes the name of the genus is reduced to just the capital letter, e.g. H. sapiens, C. simensis.

2. The second name is the name of a species to which the organism belongs. It is written with a small letter.

3. The two names are underlined when handwritten or in italics when printed

. 1.3. Linnaean system of nomenclature

Linnaeus refined and popularized the binomial system of naming organisms, in which the first name represents the genus and the second name the specific epithet.

This system is still the official starting point for naming or revising the names of organisms

Binomial nomenclature

Species must be named in such a way that the name is recognized all over the world. For example, maize is named *Bekolo* in Amharic, *Boqqollo (Badallaa)* in Afan Oromo and *Baddela* in Sidaamu Afoo and corn in American English etc. If you are not aware of these names, it could lead to confusion. If the botanical name, *Zea mays*, is used, however, there is no chance of error

1.4 Common Ethiopian animals and plants

Ethiopia is endowed with high biological diversity (biodiversity) due to its geographical location, topographical diversity and diverse climatic features. The country is a hot spot for a diversity of wild plant and animal species with a high degree of endemicity. Furthermore, Ethiopia is a primary centre of diversity for field crops such as noug (*Guizotia abyssinica*), tef (*Eragrostis tef*) and the Ethiopian mustard (*Brassica carinata*). Besides, field crops such as barley, sorghum, durum wheat, finger millet, faba bean, chickpea, lentil, and cowpea have wide diversity in Ethiopia. Also Ethiopia has served as a gateway to domestic animals from Asia to Africa and its diverse ecology favored diversification of these resources.

The scientific and common names of some plants and animals in Ethiopia

Table 1: Scientific names of some common plants and animals in Ethiopia

Common name	Taxon						
	Kingdom	Phylum/ Division	Class	Order	Family	Genus	Scientific Name
Elephant	Animalia	Chordate	Mammalia	Proboscidea	Elephanti-dae	Loxodonta	*Loxodonta africana*
Ethiopian Wolf	Animalia	Chordate	Mammalia	Carivora	Canidae	Canis	*Canissimensis*
Gelada	Animalia	Chordate	Mammalia	Primate	Cercopithe-cidae	Thero-pithecus	*Theropithecus gelada*
Lion	Animalia	Chordate	Mammalia	Carivora	Felidae	Panthera	*Panthera leo*
Walia	Animalia	Chordate	Mammalia	Artiodactyla	Bovida	Capra	*Capra walie*
Ostrich	Animalia	Chordate	Ave	Struthioni-formes	Struthion-idae	Struthio	*Struthio camelus*
Watled Ibis	Animalia	Chordate	Ave	Pelecani-formes	Threskior-nithidae	Bostrychia	*Bostrychia carunculata*
Enset	Plantae	Angio-spermata	Monocylo-doneae	Zingiberales	Mussaseae	Ensete	*Ensete ventri-cosum*
Maize	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Zea	*Zea mays*
Noug	Plantae	Angio-spermata	Eudicots	Asterales	Asteraceae	Guizotia	*Guizotia ab-yssinica*
Tef	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Eragrotes	*Eragrstos tef*
Wheat	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Triticum	*Triticum aes-tivum*

Hierarchy of groups

Hierarchy	Human	Honeybee	Teff	Mushroom
Kingdom	Animalia	Animalia	Plantae	Fungi
Phylum	Chordata	Arthropoda	Angiospermophyta	Basidiomycot
Class	Mammalia	Insecta	Liliopsida	Basidiomycetes
Order	Primates	Hymenoptera	Cyperales	Agaricales
Family	Hominidae	Apidae	Poaceae	Agaricaceae
Genus	Homo	Apis	Eragrostis	Agaris
Species	sapiens	mellifera	Teff	campestris

1.5 The five kingdoms

What is a **kingdom?**

A kingdom is the largest taxon and consists of all the other taxa. In the modern classification, there are five kingdoms namely:

1. Monera (bacteria)
2. Protista (also known as the protoctista)
3. Fungi
4. Plantae
5. Animalia

i. Kingdom Monera

- ✓ Includes eubacteria and archaebacteria
- ✓ Simple prokaryotic unicellular organisms
- ✓ Lack a well-defined nucleus or any membrane bound organelles
- ✓ Most have rigid cell wall
- ✓ Have various mode of nutrition. Could autotrophs or heterotrophs
- ✓ Known as decomposers and mineralizes in the biosphere

ii. Kingdom Protista

- ✓ Contains the most diverse organisms of all the kingdoms
- ✓ Single-celled as well as multicellular
- ✓ Some are microscopic and others are very large
- ✓ Some can make their own food, some can not
- ✓ All are eukaryotic

iii. Kingdom Fungi

General characteristics of Fungi:-

- ✓ Fungi are eukaryotic organisms
- ✓ Most fungi are filamentous multicellular ; some are unicellular e.g. yeast
- ✓ Their body consists of long, slender, thread-like structures called hyphae.
- ✓ Possess a cell wall made up of chitin and polysaccharides
- ✓ Heterotrophic in nutrition
- ✓ Most fungi absorb soluble organic matter from dead substrates called saprophytes.
- ✓ Fungi can also live with different living as parasites or mutualists

- ✓ Reproduce either vegetative means (fragmentation, fission, budding), asexually through spore formation and sexually.

Lesson 2 (2hrs)

iv. Kingdom Plantae

The kingdom Plantae – the plants – includes a great variety of organisms, which range from tiny mosses to giant trees. So far botanists have identified around 300 000 living plant species, and over 80% of these are flowering plants.

The main characteristics of all plants include:

- They have eukaryotic cells.
- They are multicellular organisms.
- They contain chlorophyll and carry out photosynthesis.
- They are predominantly land dwelling.
- Most have a waxy cuticle that helps to prevent drying out.

The kingdom Plantae consists of non-flowering plants and flowering plants. The kingdom is split into a number of divisions. Plant divisions are the same as animal phyla. The four most important divisions are:

I. Division Bryophyta: mosses and liverworts

ii. Division Pteridophyta: (also known as the Filicinophyta) – the ferns

iii. Division Gymnospermae (also known as the Coniferophyta) – the conifers

IV.Angiospermae (also known as the Angiospermophyta) – the true flowering plants

I. Division Bryophyta:-

- ✓ The simplest land plants.
- ✓ They do not have a true root system
- ✓ They are non-vascular (do not have xylem and phloem)
- ✓ They are small — the largest species is less than 60 cm tall
- ✓ found in damp places.
- ✓ A moss plant has a simple, slender stem.
- ✓ They also have thin simple leaves.
- ✓ Mosses also have simple root-like structures called rhizoids

II. Division Pteridophyta:

- ✓ have true leaves, stems and roots
- ✓ Fern stems have rhizomes, which grow horizontally just below the surface of the soil.
- ✓ Their stems contain vascular tissue
- ✓ Most ferns live in damp, shady places

The next two groups of plants are **seed bearing plants** or **spermatophytes**

These are the most successful of all land plants. They form the most common plants on earth. Spermatophytes are the most successful because of the following characteristic features that they possess:

They have well-developed roots, stem and leaves.

- They have well-developed vascular tissues.
- The male gametes are contained within pollen grains and the
- Female gamete is contained within the embryo sac
- The product of fertilisation in sexual reproduction is a seed that may or may not be enclosed in a fruit.
- The spermatophyta are divided into two divisions, namely, gymnospermae and angiospermae

Division Gymnospermae

The main characteristics of the gymnospermae are:-

- Their seeds are not enclosed in fruits.
- They have small needle-shaped leaves with a thick waxy cuticle that reduces water loss and minimises damage by excess heat or cold.
- They are evergreen so they can photosynthesize all year long.
- The reproductive structures are found in cones

A conifer tree produces two different types of cone. The male cone forms huge numbers of pollen grains that are blown by wind to a female cone. Fertilisation results in a small winged seed.

The genus Pinus (for example, Pinussylvestris, Pinusresinosa, Pinusradiata) is a good example of a conifer

IV. Division Angiospermae:

T he flowering plants are the biggest group of land plants on the Earth. Their reproductive structures are carried in flowers. The biggest flowers in the world belong to Rafflesiaarnoldii and

they can be as much as a metre across. The smallest belong to Wolffiaglobosa and they are less than 2 mm across. Whatever the size of the flowers, they carry the reproductive parts of the plant. The main characteristics of the angiosperms are:

- They have flowers as reproductive organs.
- They have their seeds enclosed in a fruit.
- They have well-developed xylem and phloem tissue

Subdivisions of angiosperms:

Angiosperms are subdivided into two main classes according to the number of cotyledons they have in their seeds. These classes are monocotyledons and dicotyledons

Class Monocotyledons (monocots)

The main characteristics of the monocotyledons are:-

- The embryo has a single seed leaf (cotyledon).
- Leaves are generally long and thin with parallel veins.
- The stem contains scattered vascular bundles
- In general, monocots do not reach great sizes (palms are the exception to this)
- They are often wind pollinated.
- Common examples of monocot plants include the grasses, orchids and maize

Class Dicotyledons (dicots)

The main characteristics of the dicotyledons are:-

- The embryo has two seed leaves (cotyledons).
- The leaves are often relatively broad and have a network of veins.
- The stem contains a ring of vascular tissue.
- Some dicots reach great sizes.
- They are often insect pollinated.

Some common examples of dicots include sunflowers, peas, roses and beans. Most trees, such as Jacaranda, Eucalyptus, Cassia and mangos are dicotyledons. Shrubs include Hibiscus, Lantana camara, Bauhinia and oranges.

v. Kingdom Animalia

This kingdom includes the animals. There are 33 animal phyla, but here we shall only consider the main ones.

- Porifera (sponges)
- Coelenterata (cidaria)
- Platyhelminthes (flatworms)
- Nematoda (roundworms or nemathelminthes)
- Annelida (segmented worms)
- Mollusca (soft-bodied animals)
- Echinodermata (spiny-skinned animals)
- Arthropoda (joint-footed animals)
- Chordata

The first eight phyla are also called invertebrates.

Phylum Porifera – the sponges

- The sponges are the simplest invertebrates
- Only the young move about – the adults are permanently attached to a surface on the sea bed.
- They are hollow filter feeders
- Supported by a series of calcareous spicules.

Phylum - Coelenterata

- include some exceptionally beautiful creatures and also some very poisonous ones.
- Sea anemones, hydra, jelly fish and coral are among the members of this phylum
- They have soft bodies with a ring of tentacles for capturing prey.
- They have only one opening, the mouth
- Their bodies have radial symmetry

Phylum Platyhelminthes – flatworm

- The flatworms show a relatively high level of organization
- They range from 1 mm to 30 cm in length.
- They have flattened bodies with a mouth but no anus
- They have no body cavity and rely on diffusion for everything.
- They are hermaphrodites – they contain both male and female sex organs

Phylum Nematoda (nemathelminthes) – roundworms

- ✓ the most numerous animals in the world.
- ✓ the most numerous animals in the world.

- ✓ Nematodes have narrow, thread-like bodies, which are pointed at both ends and bilaterally symmetrical
- ✓ They don't have a circulatory system
- ✓ They don't have a circulatory system
- ✓ They do have a complete digestive system with both mouth and anus.

LESSON 3 (2hrs)

Phylum Annelida:-

- ✓ body divided into regular segments
- ✓ They have a closed blood circulatory system.
- ✓ They are hermaphrodites.
- ✓ The common earthworm, Lumbricus terrestris, is a good example

Chaetae: bristle-like structures that help segmented worms to move.

Phylum Mollusca

- ✓ have a wide range of lifestyles and include the most intelligent of the invertebrate species
- ✓ Octopi and squid have well- developed brains.
- ✓ Their bodies are divided into head, foot and visceral mass and they are not segmented
- ✓ They breathe through gills

Examples of molluscs include slugs and snails like the giant East African land snail (Achatinafulica), bivalves like Mytilisspp, the marine mussel and octopuses and squids

Phylum Echinodermata

- ✓ They have a mouth (on the lower side), a gut and an anus (on the upper side).
- ✓ They are all marine animals, and move around using tube feet
- ✓ The adults have five arms, but the larval stages do not.
- ✓ Examples include Asteris, the common starfish, Echinus

Phylum Arthropoda

- ✓ T his phylum gets its name from two Greek words, arthron – joint, and podos – foot.
- ✓ The arthropods are the most varied animals on the Earth, with around a million different species.
- ✓ They have an external exoskeleton made of chitin that prevents excessive water loss

Arthropods are animals with segmented bodies and jointed limbs. They have a well-developed nervous system and a complete gut from the mouth to anus.

The phylum Arthropoda is divided into a number of classes according to the number of limbs, presence and number of antennae and number of body parts. These include insecta, crustacea, arachnida, diplopoda and chilopoda.

Phylum Chordata

A notochord is a flexible rod-like structure, made of cartilage, which runs along the dorsal side of the body. It provides support to the body.

Animals in the phylum Chordata have the following three features in common:-

- ✓ They have notochord at some stage of their lifecycle.
- ✓ They have a hollow nerve cord, which is a group of nerves • forming a hollow tube. This is located above the notochord.
- ✓ They have gill slits during early stages of development that are • later replaced by lungs and gills.

Vertebrates

- ✓ The invertebrates make up more than 99.9% of the animals alive on earth today.
- ✓ An internal skeleton (endoskeleton) made of bone or cartilage.
- ✓ A well-developed nervous system.

Explain about the following classes of vertebrates

- Pisces – the fish lateral line
- Amphibia – the amphibians
- Reptilia – the reptiles
- Aves – the birds
- Mammalia – the mammals

Questions

1. What are the characteristics of living things?

2. Who proposed the five kingdom classification?

3. Describe the characteristics of kingdom Monera?

4. Differentiate Eubacteria and eubacteria?

5. What ecological roles do fungi play?

6. Describe the kingdom Animalia and explains its major taxa giving examples.

7. What are the major divisions of plants?

8. What are the similarities between monocotyledonous and dicotyledonous plants?

9. List five major groups of animals and give example for each.

10. What is the phylum of Kingdom Animlia characterized by a segmented body, jointed limbs and external chitin –origin exoskeleton?

11. Write at least two examples for each of the plant division?

12. What is the phylum of kingdom Animalia characterized by a segmented body, jointed limbs and external chitin-origin exoskeleton?

13. Assume that you have encountered different animals when you come to school on foot. The animals accessible in your observation were: honeybees, bats, snails, flies, fishes, birds, and lizards. Based on this clue, which animals can be categorized under vertebrate group?

Topic 2. Cell

2.1. Cell structures and function

Objectives :

At the end of this section you should be able to:

- State the cell theory.
- List the structures of cells and describe their function

Cell is the basic structural and functional unit of living organisms

Brain storming question Explain the theory of cell?

Structures and functions in unspecialized animal cells

All cells have some features in common and we can see them clearly in typical unspecialised animal cells (like the ones on the inside of your cheek).

They contain small units called **organelles**. Many of these organelles contain enzymes and chemicals to carry out specialized jobs within the cell.

- The **nucleus** controls all the activities of the cell. It also contains the instructions for making new cells or new organisms in the form of long threads known as **chromosomes**.
- The **cytoplasm** is a liquid gel in which most of the chemical reactions needed for life take place.

About 70% of the cytoplasm of a cell is actually water!

The cytoplasm contains all the other organelles of the cell where most of the chemical reactions take place.

• The **cell membrane** forms a barrier like a very thin 'skin' around the outside of the cell.

The membrane controls the passage of substances such as carbon dioxide, oxygen and water in an out of the cell. Because it lets some substances through but not others it is known as selectively permeable.

• The **mitochondria** (singular: mitochondrion) are the powerhouse of the cell.

They carry out most of the reactions of respiration, whereby energy is released from the food in a form your cells can use. Whenever cells need a lot of energy –such as muscle cells and secreting cells – you will see a lot of mitochondria.

• The **endoplasmic reticulum** is a three-dimensional system of tubules that spreads right through the cytoplasm. It links the nucleus with the cell membrane.

• The **ribosomes** are found on the endoplasmic reticulum in your cells. They are vital for protein synthesis, the process by which your body makes all the enzymes that control the reactions of your cells.

Question

1. Write the major structures of cell with their specific function/s.
2. List the structural features that prokaryotic and eukaryotic cells have in common.
3. Differentiate osmosis and active transport?
4. List the organelles which are common to both animals and plants
5. list the organelles which are found only in plants and explain their function
6. Unlike animal cells, plant cells have…. (2016)
7. The cell theory states that…. (2014⁄15)
8. From the following alternatives select the common features that are found both in plants and animals (2017)

2.2 Types of cells

Table 3.1 Comparison of prokaryotic and eukaryotic cells

Structure	Eukaryotic cells	Prokaryotic cells
Organelles	Membrane-bound organelles (for example, nucleus, ER)	No Membrane-bound organelles
Ribosomes	relatively large	relatively small
Chromosomes	DNA arranged in long strands, associated with proteins	DNA present, not associated with proteins, circular plasmids may also be present
Cell wall	always present in plant cells, made of cellulose, never present in animal cells	always present, primarily made of Peptidoglycan
Cilia and flagella	sometimes present	some have flagella, but these have a different structure from those in eukaryotic cells

2.3. The Cell and Its Environment

Objectives:

At the end of this section you should be able to:

- Describe the permeability of the cell membrane.
- Describe the process of diffusion and its importance in living organisms.
- Explain the process of osmosis and its importance in living organism
- Explain plasmolysis and turgor pressure.
- Explain passive and active transport across cell membranes.

Brain storming questions;

1. Briefly describe diffusion , osmosis and active transport

Dissolved substances can move into and out of our cells across the cell membrane in three different ways – by **diffusion**, **osmosis** and **active transport**.

A .Diffusion: the net (overall) movement of particles from an area of high concentration to an area of lower concentration.

It is passive transport—does not require energy

It takes place because of the random movements of the particles of a gas or of a substance in solution in water.

Concentration is a way of measuring how much (how many particles) of a substance is in one place.

The overall /net movement = Particles moving in - Particles moving out

Rate of Diffusion

What factors affect the rate of diffusion and how they affect?

A number of different factors affect the rate at which it takes place.

- Temperature: higher temperature increases the kinetic energy of temperature
- Concentration gradient: a steeper difference in concentration leads to a faster rate of diffusion
- Surface area: a larger surface area increases the rate of diffusion.
- The size of diffusion molecules: smaller molecules diffuse faster than larger ones.

B. **Osmosis**: a special type of diffusion where only water moves across a partially permeable membrane, from an area of high concentration of water (low concentration of solute)to an area of lower concentration of water(high concentration of solute).

Types of Osmotic conditions includes: isotonic solutions, hypertonic a solution and hypotonic solution

If the concentration of the solutions on both sides of a cell membrane are the same they are **isotonic.**

If the concentration of the solution on the outside of the cell membrane is higher than the concentration of the solution inside the cell it is **hypertonic**.

If the concentration of the solution on the outside of the cell membrane is lower than the concentration of the solution inside the cell it is **hypotonic**.

Osmosis in animals

- Osmosis causes animal cells to gain or loss water and change shape, potentially leading to bursting or shivering if the external solution is too dilute (hypotonic) or too concentrated (hypertonic), respectively

Question: What will happen on the animal cell if the conditions in a) isotonic b) hypertonic c) hypotonic

Osmosis in Plants

- Osmosis in plants causes water to move into the roots from the soil and travel up the stem to the leaves. When a plant cell is in a solution with a higher water concentration, it takes in water, becomes firm (turgid), and maintains structural support. If a plant loses too much water, its cells become flaccid and the plant wilts.
- If water continues to leave the cell by osmosis, eventually the cytoplasm pulls away from the cell walls and the cell goes into a state known as **plasmolysis.**

Question:

1. When the plant cell gain water continually by osmosis , they become swell and turgid . Here in ,the turgidity leads the plant cell to….. (2017)
2. Consider the following two experiments which show the process of osmosis.

   Experiment A; 3cm of two potato cylinder were added to test tube contained 10ml of distilled water

   Experiment B. 3cm of two potato cylinder were added to test tube contained 10ml mixed solution 0.8M sucrose and distilled water .The final weight of potato cylinder in experiment A will be…..(2017)

3. Suppose a student conducted an experiment using onion epidermal cells. He placed it on a slide and added a drop of salt solution more concentrated than the cell sap. After an hour, he observed the specimen under a microscope. What would happen to the onion cells? They would become…. (From ESSLCE)

4. Classes of grade 11students were given two solutions A and B of unknown concentration separated by a semi permeable membrane. The teacher instructed them to observe any changes in

the water levels of the two solutions. After few minutes, the students observed the water level in solution A has decreased. What could the students conclude from their observation? (From ESSLCE)

C. Active transport: the movement of molecules from region of lower concentration to region of high concentration

Importance of Active transport

- Mineral absorption
- Cellular balance
- Nerve function…etc

Question Explain how active transport is used in mineral absorption

Lesson 4 (2hrs)

3 . Human Biology

3.1 The digestive system

Objectives :-

At the end of this section you should be able to:

Describe the functions of the structures of the human digestive system
.• Define enzymes and describe their role in the process of digestion
.• Describe the structure of the teeth and explain their importance.
• Describe the processes of digestion in the mouth, stomach and small intestine
• Explain how the products of digestion are absorbed and assimilated by the body.

Brain storming question 1. Describe the type of digestion

The digestive system is the process of breaking down complex and insoluble foods in to simple and soluble forms (nutrients)that the body can use for energy , growth and repair

The working of your digestive system is based on two things:

The physical (or mechanical) breakdown of the food:

The food you eat is physically broken down into smaller pieces in two main ways.

The chemical breakdown of the food: The large insoluble food molecules must be broken down by hydrolysis reactions into small, soluble molecules so they can be absorbed into your body.

Brain storming question . 1. Describe the following words briefly

i. Ingestion
ii. Digestion
iii. Absorption
iv. Assimilation
v. Defecation (egestion)

The teeth

The teeth are important structures for physical digestion.

There are 4 types of teeth:

Incisors: are eight chisel-shaped teeth at the front of your mouth specialized for cutting.

Canine: teeth that are sharp, dagger-shaped specialized for tearing.

Premolar: teeth that are broad flattened specialized for grinding.

Molars: teeth tend to be even broader and have cusps that are even more flattened.

They are designed for crushing and grinding food. The last set of molars is the wisdom teeth, so- called because they usually do not emerge until we reach about 16 to 20 years of age

Each tooth is covered with enamel, which is the hardest substance in the human body.

External and internal structures of teeth

The teeth are the hardest substances in the human body. Besides being essential for chewing, the teeth play an important role in speech. Parts of the teeth include:

Enamel: the hardest, white outer part of the tooth. Enamel is mostly made of calcium phosphate, a rock-hard mineral.

Dentin: a layer underlying the enamel. It is a hard tissue that contains microscopic tubes. When the enamel is damaged, heat or cold can enter the tooth through these paths and cause sensitivity or pain.

Pulp: the softer, living inner structure of teeth. Blood vessels and nerves run through the pulp of the teeth.

Periodontal ligament- tissue that helps to hold the teeth tightly against the jaw.

Roots- is the part of the tooth that extends into the bone and holds the tooth in place. It makes up approximately two-thirds of the tooth

Gums. Gums, also called gingiva, are the fleshy, pink connective tissue that's attached to the neck of the tooth and the cementum.

Crown: the crown of a tooth is the top portion of the tooth that is visible.

Human dentition

The conventional way of expressing the total number of teeth in the human beings are represented: incisor(I), canines(C), molars(M) and premolars(P). It gives a set like I:C:P:M. For example, if it is given 2:1:2:3 for upper teeth then, it indicates 2 incisors, 1 canine, 2 premolars and 3 molars of the upper mouth on one side. Include the dental formula

The dental formula of human beings (adults):

$(2123/2123) \times 2 = 32(2123/2123) \times 2 = 32$

Moving the food on gut

The breaking down of your food into smaller pieces by the chewing of your teeth isn't the only part of digestion that takes place in your mouth.

Your food is also coated in saliva from the salivary glands.

Saliva contains a carbohydrase enzyme called **amylase**.

Carbohydrases break down carbohydrates.

The **amylase** in your saliva begins the digestion of the starch in complex carbohydrates such as bread or potatoes, turning it into simpler sugars.

The saliva coated chunk of food (known as a **bolus**) moves to the back of your throat to be swallowed. **Swallowing** is a **reflex** action that takes place when food reaches the back of your throat.

As you swallow, your epiglottis closes over the trachea, preventing food going down into your lungs; you can't swallow and breathe in at the same time. If you try to, you will choke and your body will produce violent coughing and heaving movements to make sure the food doesn't get down into your lungs, where it can cause serious problems.

When your food is swallowed it travels down the **oesophagus** or gullet, squeezed along by muscular contractions known as **peristalsis**.

As a result you can eat at any angle you like – even standing on your head – because food does not rely on gravity to arrive in your stomach. Peristalsis is not confined to your oesophagus – it is important all the way through your gut to move the food through as it is digested, to mix the food

with the digestive enzymes produced in the various parts of the gut and to continue the physical break-up of the food.

Stomach churning activity

At the lower end of the oesophagus your food passes through a ring of muscle called a **sphincter** into your **stomach**. This sphincter is usually closed except when you are swallowing food, or being sick. The stomach is a muscular bag that produces protease enzymes to digest protein.

The main protease made in the stomach is **pepsin**. The stomach also produces a relatively concentrated solution of **hydrochloric acid**. This acid kills most of the bacteria that are taken in with our food.

After a time – usually between one and four hours – a paste of partly digested food is squeezed out of the stomach through another sphincter into the first part of the small intestine known as the duodenum

Bile

• It neutralizes the acid from the stomach and makes the semi digested food alkaline.

This is ideal for the enzymes in the small intestine, which work most effectively in an alkaline environment.

• Bile also **emulsifies** the fats in your food – it breaks down large drops of fat into smaller droplets.

This provides a much bigger surface area of fats for the **lipase** enzymes to work on to break down the fats completely into fatty acids and glycerol

The rest of the small intestine is a long (6–8 m) coiled tube that produces carbohydrase, protease and lipase enzymes of its own. The tube is coiled up to fit inside the body cavity.

Your food, which is rapidly becoming completely digested in the alkaline environment, is moved along by peristalsis.

Throughout the small intestine enzymes speed up the breakdown of large molecules into smaller molecules

Once the food molecules have been digested, giving glucose, amino acids, fatty acids and glycerol, they are absorbed by your body (**absorption**).

They leave the small intestine by diffusion and go into the blood supply to be carried around the body to the cells that need them. The lining of the small intestine is specially adapted to allow as much diffusion as possible and as rapidly as possible.

It has many finger-like projections of the lining (called **villi**) to increase the surface area for diffusion, and each individual villus in turn is covered in even smaller projections called micro-villi.

The villi also have a rich blood supply that carries away the digested food molecules and maintains a steep diffusion gradient. The diffusion distances are very small, and the whole process takes place in a water-based solution

Once the digested food molecules have all been taken into the blood they are taken in the **hepatic portal vein** to the liver, which processes some of the food

. The remaining products of digestion are carried around the body to the cells where they are needed. They are built up into the molecules required by the cells. This is known as **assimilation**.

The end of the story

After the digested food molecules have been absorbed into the blood, a watery mixture of enzymes, undigested food (mainly cellulose), bile pigments, dead cells and mucus is left in the small intestine and is moved along by muscle contractions into the large intestine. In this wide, thin-walled tube water is absorbed back into bloodstream by diffusion. By the end of the large intestine the thick paste that remains is known as the faeces. The journey ends as the faeces leave the body through the rectum and the anus as a result of a final set of muscle contractions.

This removal of the faeces from your body is called **egestion**.

Table 5.2 Summary of digestion in human alimentary canal

Region of gut	Glands and secretion	Enzymes and optimum pH	Food digested, products and other activity
Mouth: mastication by jaws and tongue	Salivary glands :saliva 1-2 liters/daily	1. pH-7, slightly acid in adults, slightly alkali to neutral in children 2. amylase	1.mucin lubricates food bolus 2.(A) starch(amylase)----dextrins (B) cooked starch ----maltose
Oesophagus	None	None	Food bolus moves by peristalsis
Stomach churning action. Temporary storage 1 to3 hrs	Gastric gland, stomach wall-gastric juice 2-4L; stores daily	1. pH 1, strongly acidic 2. rennin(in young children) 3. lipase(in young children) 4. pepsin	1. Hydrochloric acid (HCl) is bacteriocidal 2. clots milk protein-caesin 3. lipids---fatty acids and glycerine 4. proteins—amino acids Absorption: water, salts, vitamins and ethanol
Duodenum(Accessory organ secretions)	1.liver- bile juice, 700CM3-1.2 litres daily 2 pancreas-pancreatic juices, 700Cm3 daily	1. pH 7-8, slightly alkaline 2. no enzyme	1. alters pH of stomach contents 2. bile salts emulsify or cream lipids
		1. pH 7-8,slightly alkaline 2. amylase 3. lipase 4. Trypsin 5.nuclease	1.food as chime propelled by peristalsis 2. starch(amylase)------maltose 3. lipids---- fatty acids and glycerol 4. peptones---- short peptides 5. nucleic acids----nucleotides
Small intestine and duodenum	Glands in intestine and duodenum wall-intestinal juice, 200cm3	1. pH 7-8 2. entrokinase changes trypsinogen into trypsin 3.lipase 4.glycosidases-maltase, lactase, sucrase	1---------- 2. dipeptides, peptides-------amino acids 3. lipids---fatty acids and glycerol(propanetriol) 4. maltase----maltose into glucose molecules Lactase-----lactose into glucose and galactose Sucrose---sucrose into glucose and fructose Absorption: large surface area, villi, and microvilli, main region of absorption of vitamins, minerals, amino acids, glucose, fatty acids and glycerol
Large intestine	Lining with mucous glands	pH 6-8 no enzymes	1. mucous lubricates faces 2. water absorbed from faces 3. bacteria synthesis vitamin B groups 4. faces mainly water 75%, bacteria, 8%, lipids, 6%, dietary fiber cellulose, 2% etc

Questions

1 .List what are the main parts of digestive system and give at least one enzyme it secretes?

2. How human digestive system works in the body?

3. List the types and function of each enzyme
   i. In the mouth
   ii. Stomach
   iii. Small intestine

4. Identify the enzymes responsible for the conversion of starch to glucose (2016)

5. Describe the function small intestine in digestive system? (2017)

6. Write the correct path way of digestion in our alimentary canal (2017)

……THE END……