BIO 101.

Biology

LECTURE ONE

THE CELL

Plant and animal cells

All animals and plants are made of cells. Animal cells and plant cells have features in common, such as a nucleus, cytoplasm and cell membrane. Plant cells also have a cell wall, chloroplasts and a large vacuole.

INTRODUCTION

The cell can be defined as the basic unit of structure and function of a living thing, whether of plants or animals

Important Events in the Discovery of Cells

1665 - Robert Hooke looks at cork under a microscope. Calls the chambers he see "cells"

1665 - 1675 Antoni van Leeuwenhoek, studies organisms living in pond water. He calls them "Animalcules."

1830 - German scientists Mathias Schleiden (Botanist) and Theodor Schwann (zoologist) summarized the findings of many scientists and concluded that all living organisms are made of cells. This forms the basis of the Cell Theory of Biology.

The Cell Theory

1. All organism are composed of cells.
2. The cell is the structural and functional unit of life. Any unit smaller than a cell is not alive.
3. Cells arise by division of pre-existing cells. Spontaneous generation does not exist.

4. A Cell contains the information for its structural and functional development in its nucleic acids. This information is usually passed down from parents to their off-springs.

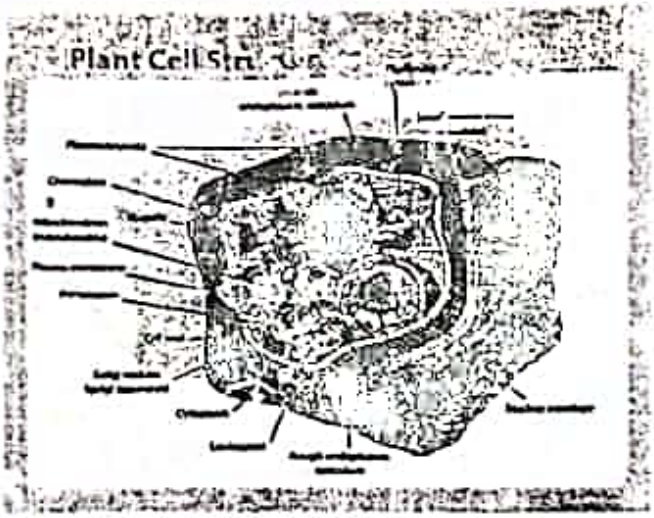


Figure 1.1: A Plant cell (Source: Wikipedia .org)

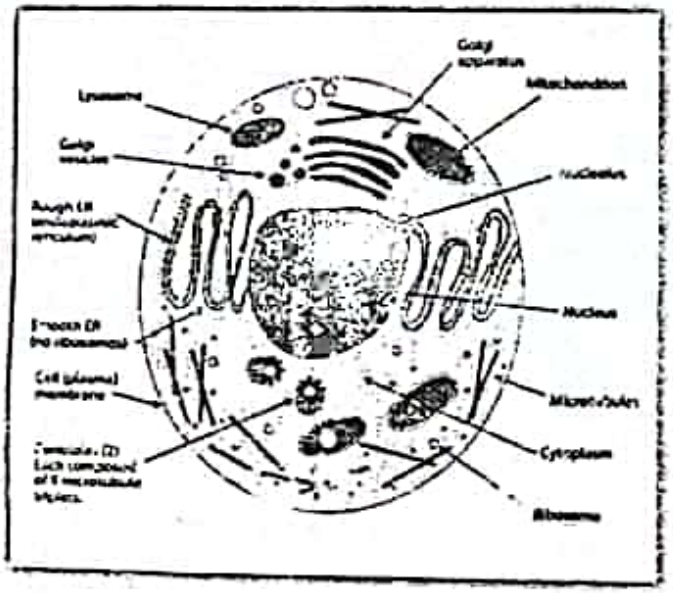


Figure 1.2: An Animal Cell. (Source: bp.blogspot.com)

Functions of the parts of a cell

1. Cell membrane – A partially permeable barrier .It controls exchange between the cell and its environment.

2. Nucleus- contains the chromosomes that have the DNA .The DNA is organized into genes. These control all the activities of the cell.
3. Endoplasmic reticulum (ER). Rough ER transports proteins made by the ribosome. Smooth ER is the site for lipid and protein synthesis.
4. Ribosome- Protein synthesis.
5. Mitochondria- also known as the power house of the cell. It is the site for energy production.
6. Golgi apparatus- internal processing transport system. Makes the lysosomes.
7. Lysosomes- also known as suicide squads. Concerned with the breakdown of structures or molecules. Gets rid of old organelles, digest bacteria.
8. Cell wall -Middle lamella- provides mechanical support and protection, cements neighbouring cells together.
9. Chloroplast-It is the organelle in which photosynthesis takes place.
10. Large central vacuole- storage of various substances including waste products.

TYPES OF CELL

There are two types of cells (i) Prokaryotic and (ii) Eukaryotic.

Characteristics of Prokaryotic Cell

Pro = before; karyon = nucleus

They are relatively small in size about 5 to 10 um.

They do not have membrane-bound organelles .The DNA lies free in the cytoplasm (Nucleoid).

They do not have a true nucleus.

They are the earliest and most primitive cell type.

Characteristics of Eukaryotic Cells

Eu = true; karyon = nucleus

They have membrane-bound organelles.

Their De-oxyribonucliec acid (DNA) is found inside the nucleus.

The DNA is associated with protein to form chromosomes

Evolved from prokaryotes by endosymbiotic association of two or more prokaryotes

Examples include Protists, Fungi, Animals, and Plants.

COMPARISON OF PLANT AND ANIMAL CELL

Part	Animal cell	plant cell
Cell wall	Absent	Present
Shape	Round/irregular	Rectangular
Vacuole	One or more (small)	One (Large)
Chloroplast	Absent	Present
Centrioles	Present	only in lower plants
Cytoplasm	Present	Present
Endoplasmic reticulum	Present	Present
Ribosomes	Present	Present
Mitochondria	Present	Present
Plastids	Absent	Present
Golgi apparatus	Present	Present
Plasma membrane	Cell membrane	Cell membrane and wall
Nucleus	Present	Present
Lysosomes	Found in cytoplasm	Not found
Cilia	Seen in some	Not seen
Flagella	Present in some cells	Present in some cells
Microtubules	Present	Present

REVISION QUESTIONS

1. What is a cell?
2. Differentiate between a plant and animal cell
3. State the cell theory.
4. Differentiate between the prokaryotic and Eukaryotic cell.

(1) Cell is the basic unit of structure and function of a living thing.

(2)

Plant cell	Animal Cell
Presence of cell wall	Absence of cell wall
Rectangular shape	Irregular shape.
Presence of plastids	Absence of plastids.
presence of chloroplast	absence of chloroplast

(3) (i) Every living thing has cell

(ii) The cell is the structural and basic unit of life

(iii) Cells arise by division of pre-existing cell

(4)

Basic

LECTURE TWO

MOVEMENT OF MATERIALS IN AND OUT OF THE CELL

OSMOSIS

Introduction

Osmosis was first documented by a man called Jean -Antoine Nollet in 1748. French physician René Joachim Henri Dutrochet (1776–1847) coined the word osmosis. It is defined as the movement of water molecules across a semi-permeable membrane from region of low concentration to one of high concentration. This movement is aimed at equalizing the solute concentrations of the two solutions. In other words, create a balance. It is the solvent molecules that moves and not the solute molecules.

Basic explanations:

Osmosis is the movement of a solvent across a semipermeable membrane towards a higher concentration of solute. In biological systems, the solvent is typically water, but osmosis can occur in other liquids, supercritical liquids, and even gases. When a cell is submerged in water, the water molecules pass through the cell membrane from an area of low solute concentration to high solute concentration. For example, if the cell is submerged in saltwater, water molecules move out of the cell. If a cell is submerged in freshwater, water molecules move into the cell.

When the membrane has a volume of pure water on both sides, water molecules pass in and out in each direction at exactly the same rate. There is no net flow of water through the membrane.

Osmotic pressure is the main cause of support in many plants. The osmotic entry of water raises the turgor pressure exerted against the cell wall, until it equals the osmotic pressure, creating a steady state.

When a plant cell is placed in a solution that is hypertonic relative to the cytoplasm, water moves out of the cell and the cell shrinks. In doing so, the cell becomes flaccid. In extreme

cases, the cell becomes plasmolyzed– the cell membrane disengages with the cell wall due to lack of water pressure on it.

When a plant cell is placed in a solution that is hypotonic relative to the cytoplasm, water moves into the cell and the cell swells to become turgid.

Osmosis can be demonstrated when potato slices are added to a high salt solution. The water from inside the potato moves out to the solution, causing the potato to shrink and to lose its 'turgor pressure'. The more concentrated the salt solution, the bigger the difference in size and weight of the potato slice.

USES OF OSMOSIS

1. Osmosis is responsible for the ability of plant roots to draw water from the soil. Plants concentrate solutes in their root cells by active transport, and water enters the roots by osmosis.

2. Osmosis is also responsible for controlling the movement of guard cells.

3. Reabsorption of water by the proximal and distal convoluted tubules of the nephron.

4. Reabsorption of tissue fluid into the venule ends of the blood capillaries.

5. Absorption of water by the alimentary canal — stomach, small intestine and the colon.

In unusual environments, osmosis can be very harmful to organisms. For example, freshwater and saltwater aquarium fish placed in water of a different salinity than that to which they are adapted to will die quickly, and in the case of saltwater fish, dramatically. Another example of a harmful osmotic effect is the use of table salt to kill leeches and slugs.

Summary of Activities in Osmosis

If the medium is hypotonic relative to the cell cytoplasm — the cell will gain water through osmosis.

If the medium is isotonic — there will be no net movement of water across the cell membrane.

If the medium is hypertonic relative to the cell cytoplasm — the cell will lose water by osmosis.

OSMOSIS AND FOOD PRESERVATON

Food can be preserved by causing any microorganism that comes in contact with it to become plasmolysed and, therefore, shrivel and die. To do this food is placed in a high salt or sugar medium. The salt or sugar concentration is higher than the cytoplasm of the bacteria or fungi. Bacteria or fungi that contaminate the food, will lose water by osmosis and their metabolic rate will reduce. Many will die but some bacteria may survive by forming dormant resistant endospores. Meat and fish are often preserved in salt. Fruit is commonly preserved in sugar as in jam or syrup.

DIFFUSION

Diffusion is the movement of particles (atoms, ions or molecules) from a region in which they are in higher concentration to regions of lower concentration. If you put a drop of iodine or potassium permanganate crystals in a beaker of water eventually the entire beaker of water will have a bluish purple tint. Iodine solution molecules or those of the potassium permanganate moved through the water until it was equally distributed throughout the beaker. Diffusion takes place along a concentration gradient. A concentration gradient exists until the diffused substance is evenly distributed. The same thing happens when you spray perfume or insecticides.

Uses of diffusion

A) Entrance of carbon dioxide into leaf stomata.

B) Oxygen diffusing out of the stomata and lenticels of leaves.

Plasmolysis

Plasmolysis is the process in which cells lose water in a hypertonic solution. The reverse process known as cytolysis occurs if the cell is in a hypotonic solution resulting in a lower external osmotic pressure and a net flow of water into the cell.

Plasmolysis is also the separation of plant cell cytoplasm from the cell wall as a result of water loss. Plasmolysis can be induced in the laboratory by placing a plant cell in a strongly saline or sugary solution, so that water is lost by osmosis.

If onion epidermal tissue is immersed in a solution of calcium nitrate, cells rapidly lose water by osmosis and the protoplasm of the cells shrinks. Plasmolysed cells die unless they are transferred quickly from the salt or sugar solution to water.

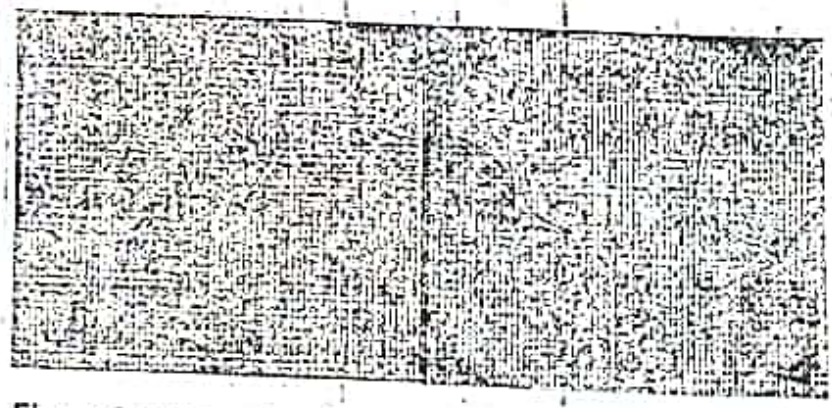


Figure 2.1: Normal cell Figure 2.2: Plasmolysed cell

Source: "https://en.wikipedia.org/w/index"

Revision Questions.

1. Differentiate between osmosis, diffusion and plasmolysis.
2. Mention the roles of osmosis and diffusion in biological systems.

LECTURE THREE

ECOLOGY

Ecology is the study of the interactions between organisms and the environment. The Environment broadly embraces everything external to an organism that affects it, including physical (abiotic factors such as light, temperature, rainfall, humidity, various pollutants, and topography) as well as biotic factors such as parasites, predators, mates and competitors. The biotic environment include all the living part of the environment, while the abiotic environment include the non-living part of the environment.

LEVELS OF ECOLOGY

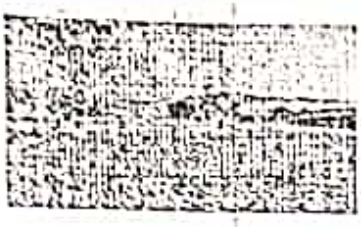
There are two main levels of ecology: (i) Autecology (ii) Synecology.

Autecology: This refers to the study of an individual species in relation to its environment. It entails the study of its structure, morphology, physiology and its niche (ways it utilizes its resources and roles it plays in the environment.

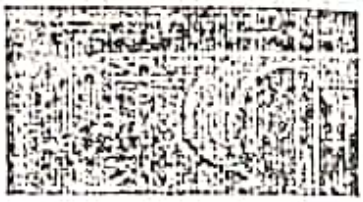
Synecology: This is the study of different groups of organisms or species in relation to their environments. Aspects of synecology include the qualitative and quantitative nature of a population. It is also known as community ecology. Factors that influence the population are also studied under synecology.

SOME ECOLOGICAL TERMS

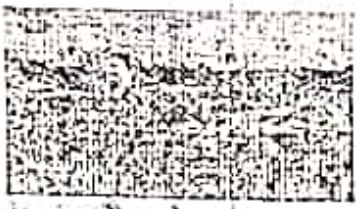
1. Population: These are group of individuals belonging to the same species living in a particular geographic area at a particular time. E.g. A group of fish, herd of cattle etc.
2. Community: This is a unit composed of all the populations of all the species living in a given area. This include population of different species of plants and animals. It also comprises the entire living component (biotic) and their interactions with one another
3. Ecosystems: These are communities and their physical environments considered together. This may apply to a local area or a widespread one, for example, the sycamore tree in a given wood lot may be regarded as a population, and so many sycamore trees in a county. Similarly a small pond and its inhabitant or the pond and the forest in which it is located may be treated as an ecosystem. Different ecosystems are linked to one and another by biological, chemical and physical processes. Inputs and outputs of energy, gases, inorganic and organic chemical compounds can cross ecosystem boundaries by



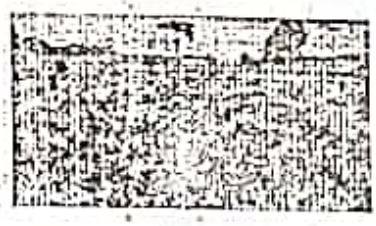
Desert



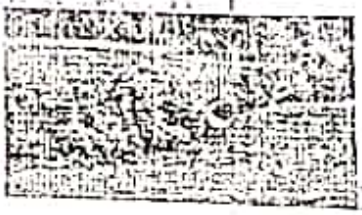
Farmland



Flooded grassland

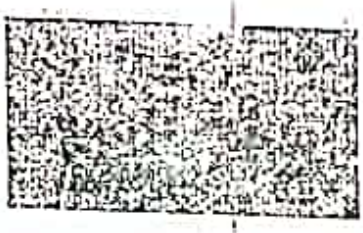


Heathland

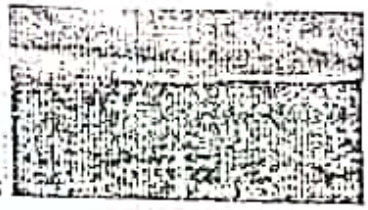


Hedgerows

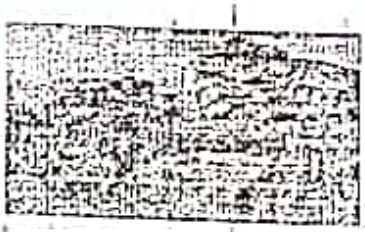
Limestone pavements



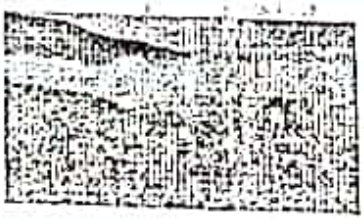
Mangroves



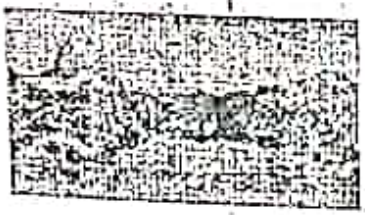
Mediterranean forest



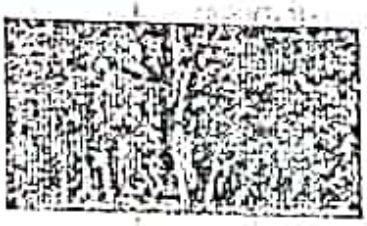
Moorland



Mountain grassland

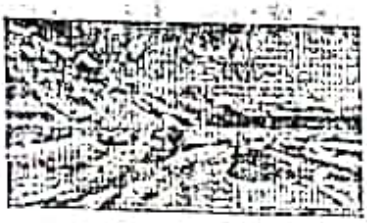


Mountains

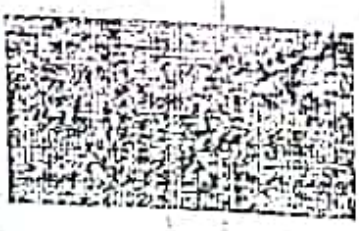


Oak wood

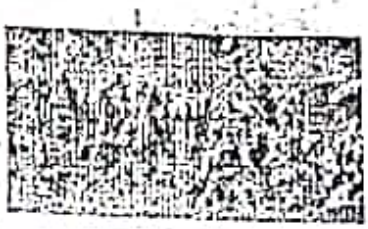
Parkland



Polar



Rainforest

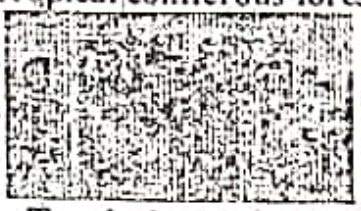


Taiga

Temperate grassland

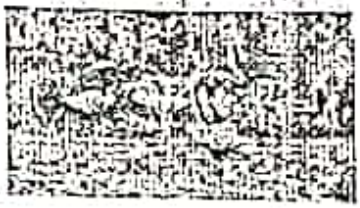
Tropical coniferous forest

Tropical dry forest

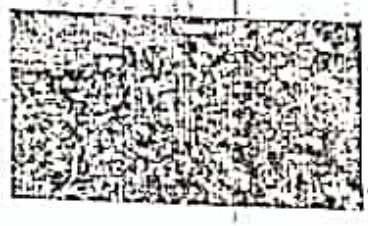


Tropical grassland

Tundra

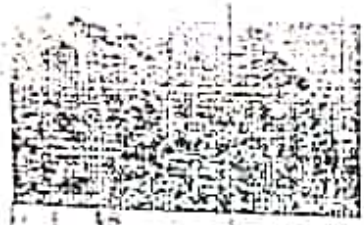


Urban

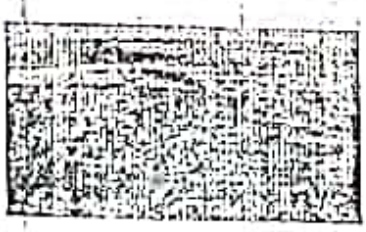


Wildflower meadow

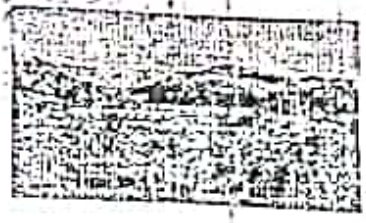
Freshwater Habitats: Freshwater habitats include bogs, ponds, lakes, rivers and streams. About 3% of earth's water is freshwater, but this includes the water locked up in the ice caps and trapped in rocks and soil as groundwater. Only a tiny fraction (0.014%) is surface water in the form of rivers, lakes and swamps.



Bog



Brackish water



Lakes and ponds

Marsh

6. Niche: A species niche refers to the ecological role of a species in the community i.e. the way an organism uses its environment to make a living. The niche includes such factors as what it frequently focus on, important variables of an organisms niche such as food, time and sites of activity and a few key physical variables like temperature. It can also be termed the biological status of an organism within its community.

EXERCISES

1. What is a habitat?
2. Classify habitats based on size and fluid medium
3. Outline examples of terrestrial and aquatic habitats

LECTURE FOUR

INTRA AND INTER RELATIONSHIPS BETWEEN ORGANISMS

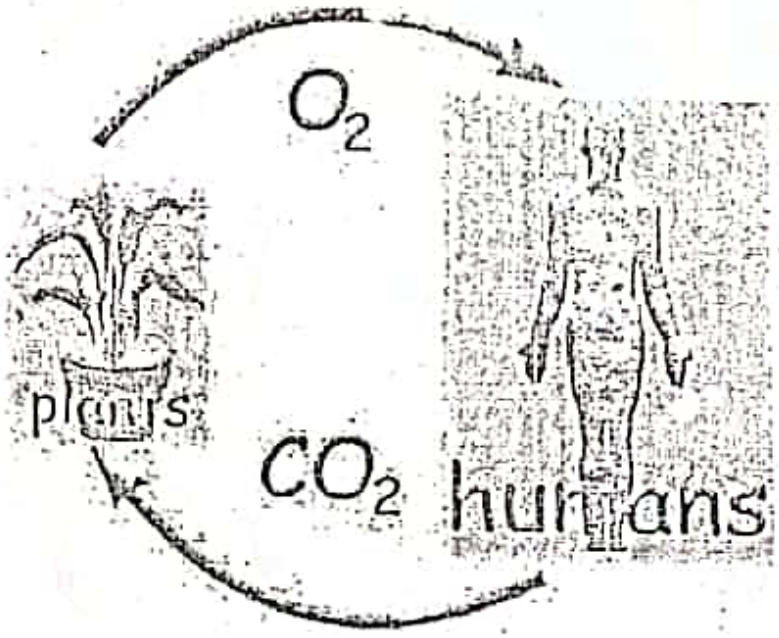
Species of organisms influences its ecosystems in various ways. The mode of life, ecological status of a particular organism may affect the other organisms living within the same environment. These form of interaction influences the ecosystem. Organisms relate with one another in the course of their daily activities such as breeding, obtaining essential nutrients and basic requirements. This include food, shelter, oxygen, space and even physical support. There are two basic form of interactions or relationship which are intra and inter specific relationships, whichever category a relationship falls, it may be beneficial to one or both organisms involved. It can also be harmful to one or both while some others may neither be beneficial nor harmful.

INTERSPECIFIC RELATIONSHIP

This involves organisms of different species intimately associated in a relationship. Some of these interspecific relationship include the following:

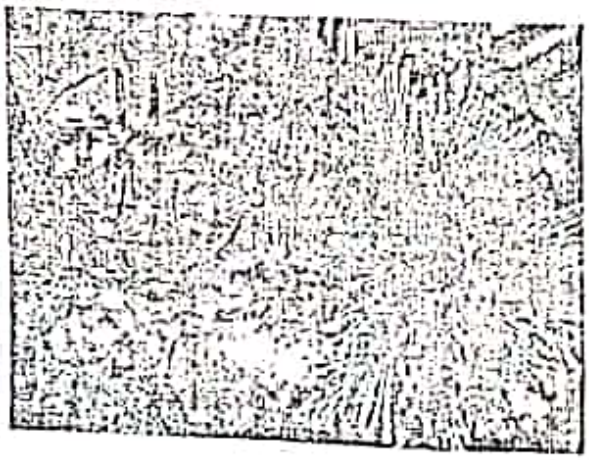
1. MUTUALISM OR SYMBIOSIS: This is often denoted (++), which implies that in this relationship, both species of organisms benefit. It is common and widespread. It can be illustrated by cleaning symbiosis. For example a grouper being cleaned by a cleaner fish. The cleaner fish actually enters the mouth of the predatory grouper and removes parasites. Other examples of mutualism include the relationship between the cellulose digesting microorganisms in the digestive tracts of a termite or cow and even between humans and the bacteria in the intestine that synthesize vitamin K. The plant called lichens are actually formed of an alga and a fungus united in such close mutualistic symbiosis that can give the appearance of being one plant. The fungus benefits from the photosynthetic activity of the alga and the alga benefits from the water retaining properties of the fungal walls. One common example is the relationship between the nitrogen fixing bacteria in the root nodules of leguminous plants. The bacteria helps to fix nitrogen while it benefit by receiving essential nutrients necessary for growth and shelter.

Mutualism



What does the arrow going to human and plant show?

Like humans, other living species, such as animals, plants and other bacteria too, help each other for better survival. No living organism can survive in isolation. All the living organisms depend on each other for food or shelter. In mutualism, both living organisms benefit from one another. They have a give and take relationship in a way that both organisms benefit. As shown in the picture above, humans benefit from the plant as it gives off *oxygen* needed by human beings for breathing. In return, plants receives *carbon dioxide* that plants need in the food processing called ***photosynthesis***. Other examples of mutualism are shown below:



A remarkable 3-way mutualism appears to have evolved between an ant, a butterfly

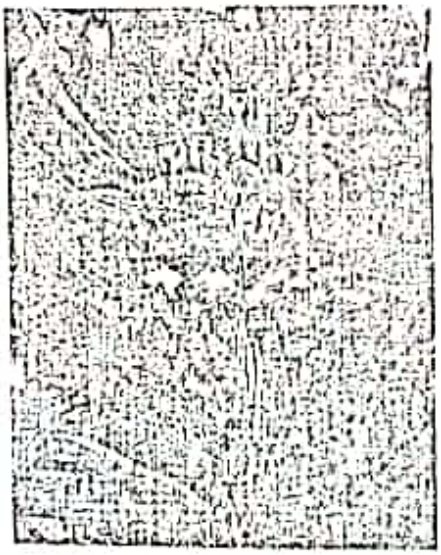
caterpillar, and an acacia in southwest American The caterpillars have nectar organs which the ants drink from, and the acacia tolerates the feeding caterpillars. The ants appear to provide some protection for both plant and caterpillar.

Clown Fish and Sea Anemones demonstrate mutualism because Anemones provide the Clown Fish with protection from predators while Clown fish defend the Anemones from Butterfly fish who like to eat Anemones.

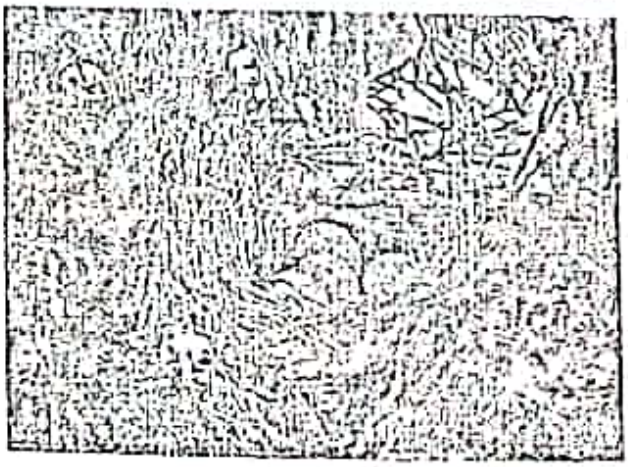
2. COMMENSALISM: In commensalism, one species benefits from the association while the other is neither benefiting nor harmed. It is denoted by (+0). The advantages derived by the commensal species from its association with the host often involves shelter, support, transport or food, or several of these. For example, in the tropical forests, numerous small plants called epiphytes, usually grow on the branches of larger trees or forks of their trunks. They use the host trees as a base of attachment and do not obtain nourishment from them. They do not harm the host. A similar type of commensal relationship is the use of trees as nesting places for birds. A more dramatic type is that of the relationship between the sea anemones and certain species of fish. These fishes obtain shelter, protection and sometimes steal some of their food, but the sea anemones neither benefits nor is harmed. In commensalism, one of the organisms benefit and the other is neither nor helped or harmed. As shown in the picture, the orchid is attached to the tree. The orchid

being benefited without harming the tree. The orchid is being benefited because it was able to grow as it is being attached on the tree. Other examples of commensalism are shown below:

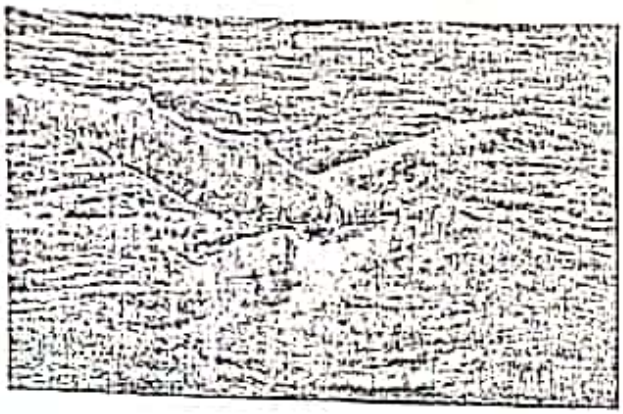
Commensalism



What does the orchid do to the tee? Does it harm the tree?



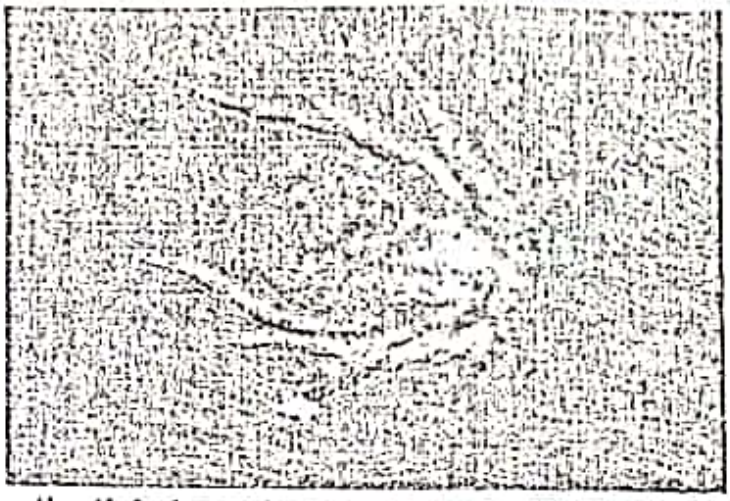
The nest is placed on the tree serves as a place where the birds live and lay eggs. The birds now are being benefited from the tree without harming it.



Adhering to the skin of a whale or shell of a mollusk: Barnacles are crustaceans whose adults are sedentary. The motile larvae find a suitable surface and then undergo a metamorphosis to the sedentary form. The barnacle benefits by finding a habitat where nutrients are available. (In the case of lodging on the living organism, the barnacle is transported to new sources of food.) The presence of barnacle populations does not appear to hamper or enhance the survival of the animals carrying them.

3. **PARASITISM:** In this kind of relationship, one species benefits while the other is harmed. It is denoted by (+ -). The one who benefits is called the parasite while the species which suffers is called the host. Parasites often passes much of its life on or in the body of a living host from which it derives food in a manner harmful to the host. Generally, they do not kill their hosts and those who eventually do are called parasitoids. There are external (ectoparasites) and internal (endoparasites). An example of an ectoparasite is the blood sucking lice in mammals. Endo parasites include tapeworm in the human intestine. Human beings play host to several parasites. When a host dies, the parasites loses it means of survival as it depends physiologically on the host which tries to develop immunity against it.

Parasitism



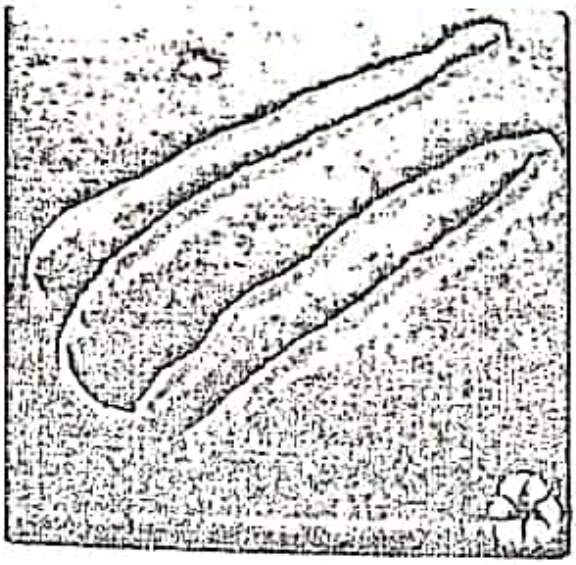
What does the tick do to the dog? Does the dog benefit from it?

In parasitism, one organism is harmed which is the *host* and the other organism benefits which is the *parasite*. The tick gets the blood it needs to survive, but the dog is harmed by the tick transmitting disease into its blood.

Therefore, the host is the dog and the parasite is the tick. It is only the tick is being benefited and the dog is being harmed. Other examples of parasitism is shown below:

A caterpillar of the geometrid moth *Thyrinteina leucocerae* with pupae of the *Braconid* parasitoid wasp *Glyptapanteles sp*. Full-grown larvae of the parasitoid egress from the caterpillar and spin cocoons close by their host. The host remains alive, stops feeding and moving, spins silk over

the pupae, and respond to disturbance with violent head-swings (supporting information). The caterpillar dies soon after the adult parasitoids emerge from the pupae.

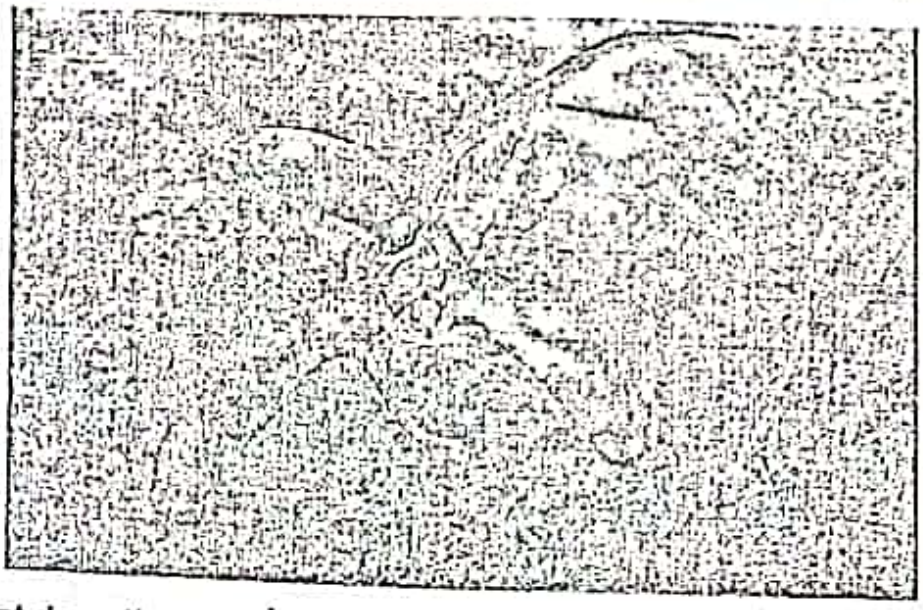


Tapeworm, can live in the small intestine of a human being and may grow as long as 10 m. They benefit by absorbing the nutrients from the human's food. The hosts, the humans are harmed because they do not get the nutrients that they eat from the food.

4. PREDATION: There are no sharp boundaries between parasitism and predation. The common definition suggest that a predator eats its prey quickly and goes on its way, but does not depend on the its prey physiologically. In this form of relationship, one organism (predator) benefits while the other (prey) is harmed. An example of a prey-predator relationship is that between most carnivores e.g lion and other smaller animals e.g antelope. The hawk and the domestic fowl is another example.
5. COMPETITION: This occurs when there are two populations utilizing the same resources such as shelter, food, space, nesting place etc. Often times these resources are inadequate and results to strife or struggle for available resources for organisms to survive. When this take place between two different population of organisms, it is called

interspecific competition, but if it occurs between the same populations of organisms, it is known as intraspecific competition.

Competition

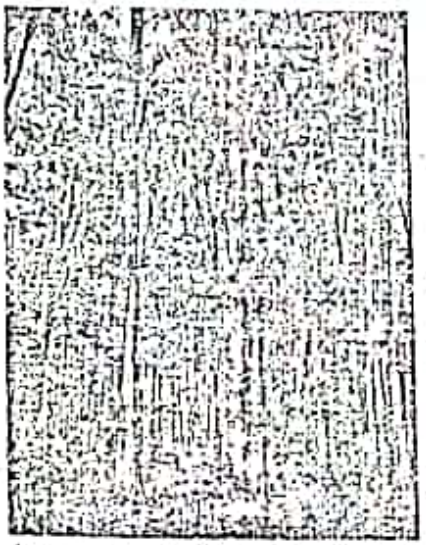


What does the two animals do? Do they benefit from each other?

In competition, two or more organisms 'fight' or 'compete' with each other for the same resource. Animals could compete for mates, territory or food. A shortage of a needed resource could increase the competition between organisms, and some of the losers may even starve to death if the resource is food. There are two recognized types of competition. There is *contest competition* and *scramble competition*. *Contest competition* is when a physical fight or confrontation is involved. Deer do this by locking their antlers together and pushing, and the one who gives in is the loser.

Scramble competition is when each organism competing tries to gather the most of the resource available for itself. Other examples of competition is shown below:

After warm spring rains, large congregations of toads assemble and begin a frantic competition for mates. Males greatly outnumber their female counterparts and competition for females is fierce. Males actively search for mates and engage in bouts of wrestling.



Green plants cannot survive for very long without sunlight and they become unhealthy if they do not obtain minerals and water. When plants are growing close together, in a forest for example, the tallest plants will receive most sunlight. The smaller plants will receive

less sunlight because the taller plants shade them from the sun's rays. Ecologists say that all of the plants in the forest are in competition with each other; they are competing for the sunlight. In a dense forest, many seedlings which germinated in the spring may not survive the winter because they did not receive enough sunlight to make and store food.

6. PROTOCOPERATION: It is like mutualism except that it is not obligatory i.e individual organism can exist without the association. An example is the relationship between the hermit crab and some coelenterates. Coelenterates provide protection and camouflage for the hermit crab which in turn are transported about and also obtain food particles from the crab.

INTRASPECIFIC RELATIONSHIP

This refers to a relationship between members of the same species. Competition is more acute in intraspecific relationship due to an overlap of ecological niche.

1. AMMENSALISM: This relationship involves inhibition of growth and survival of a species by a substance secreted by another species, which remains unaffected. It is the opposite of commensalism. For example many fungi and bacteria synthesize antibiotic substances which inhibit the growth of other bacteria. Another example is the allelopathic inhibition of the growth of a weed or plant by another weed.

   There are a variety of relationships that occur between different species all over the world. In nature, no organism lives its life in complete isolation. They must interact with other organisms and their environment in some manner. One type of relationship that has been classified by biologists and ecologists is amensalism. Amensalism is any relationship between organisms of different species in which one organism is inhibited or destroyed while the other organism remains unaffected.

Examples of Amensalism

There are basically two types of amensalism: competition and antibiosis. In competition, a larger or more powerful organism excludes another organism from its source of shelter or food. In antibiosis, one organism secretes a chemical that kills the other organism, while the one that secreted the chemical is unharmed.

Two examples of antibiosis amensalism are provided by the bread mold *Penicillium* and black walnut trees. You probably do not like to think about it, but many types of bacteria and fungi are perfectly capable of growing on bread under the right conditions. The bread mold *Penicillium* commonly grows on any bread that has passed its shelf life. This mold is capable of producing penicillin, which destroys many of the forms of bacteria that would also like to grow on this bread. It is this understanding of the bacteria-killing properties of penicillin that led to the use of it as an antibiotic medicine. The *Penicillium* does not benefit from the death of the other bacteria, making this an example of antibiosis amensalism.

Large, towering black walnut trees can be found growing in many areas of the United States. If you have ever been around walnut trees or have them in your yard, you may have noticed that there is no grass growing under the trees. This is because they have evolved to secrete a chemical known as Juglone. This chemical acts as a natural plant and weed killer and kills most plants living in the root zone of the walnut trees. Since the plants are prohibited from living under the trees, and the walnut trees do not really benefit in any way, this is a perfect example of amensalism.

2. NEUTRALISM: This implies that any two species population under consideration do not directly interact. Species neutral to one another do not directly compete for any resources of the habitat. For example, an antelope and millipede in the same habitat.

References

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1 reference found in Britannica articles

In community ecology: The effects of competition

Source: www.youtube.com
www.google.com
http://fany.savina.net/2010/03/ecological-relationships-in-nature-populations/

LECTURE FIVE

ADAPTATION

Adaptation may be defined as any genetically controlled characteristics which increases an organism's fitness i.e. individual genetic contribution to succeeding generations. It enhances an organism's chances of perpetuating its genes meaning an ability of leaving descendant. Adaptation does not increase an organism's chances of survival. It only increases the probability of an individual genetic contribution to the next generation. Adaptation may be structural, physiological or behavioural. The different types of adaptation may be complex or simple genetically. They may be very specific or of benefit under limited circumstances. When they are not specific, they are generally beneficial under many and varied conditions.

Have you ever wondered how plants survive in areas with very little water? Xerophytes have adapted over thousands of years to live in harsh conditions. This lesson will introduce you to the characteristics that enable xerophytes to survive.

What Are Xerophytes?

Plant life on Earth is nothing if not resilient. Have you ever taken a moment to think about the wide variety of differing habitats that exist on the planet? It's incredible, and yet from outer space the earth appears just blue and green. How can plants colonize every corner of the globe? Especially in those extremely dry climates.

Well, there is a specialized group of plants called xerophytes that survive in very dry regions. Xerophytes can live in these environments because they contain specialized features that help them prevent water loss.

It's also worth noting that dry environments are not always hot. People tend to think of deserts being very dry, and they are, but so is Antarctica and it is bitterly cold. So remember that dry areas can be hot or cold depending on geographical location.

Adaptations

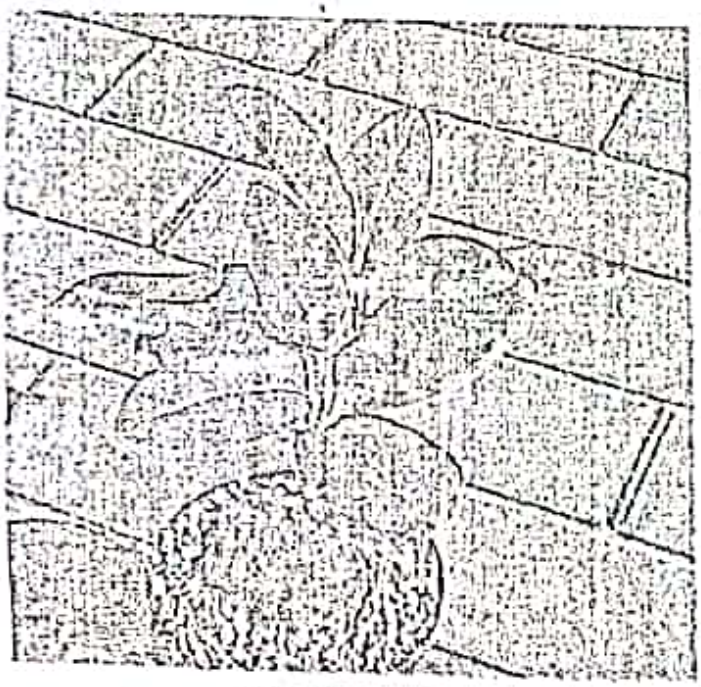
The types of adaptations possessed by xerophytes are extensive! We'll focus here on broad adaptations shared by several different species. The first adaptation has to do with their stomata and limiting water loss. Stomata are the microscopic openings in leaves that permit gas exchange. Think of them as pores for plants. And just like human pores release sweat, plant stomata release water in the form of water vapor. Certain xerophytes have a waxy covering over their stomata, thus curbing water loss. Others contain very few stomata, or stomata that only open at night when it's cooler. Each of these adaptations limits water loss and allows the plant to survive in dry environments. An example of this type of plant is Adam's Needle (*Yucca filamentosa*). This plant can survive in harsh dry desert environments because of its waxy covering.

The second type of adaptation is focused on storing water instead of just limiting water loss. To do this plants have developed succulent leaves, plant stems, or tubers that can store water when it cannot be obtained directly from the environment.

Xerophytes

- Plant adapted to live in dry conditions. Common adaptations to reduce the rate of transpiration include;
- Thick waxy cuticle: The cuticle cuts down water loss in two ways: it acts as a barrier to evaporation and also the shiny surface reflects heat and so lowers temperature.
- Sunken stomata: Stomata may be sunk in pits in the epidermis; moist air trapped here lengthens the diffusion pathway and reduces evaporation rate.

- Leaf rolled with stomata inside: The inner surface is covered in hairs. The rolled leaf and hairs both serve to trap moist air so reducing transpiration. In addition, a smaller surface area of leaf is exposed to the drying effects of the wind.
- Small leaves: Many xerophytic plants have small, needle shaped leaves which are often circular in cross section. This reduces the surface area and hence the evaporating surface. Spines protect the plant from animals, shade it from the sun and also collect moisture.
- Extensive Shallow Root System: Extensive shallow root systems tend to be circular in shape, allowing for the quick absorption of large quantities of water when it rains.



Raphionacme

Hydrophytes

- Plant adapted to live in extremely wet conditions. Common adaptations to increase the rate of gaseous exchange:
- Leaf Shape: The submerged leaves are often highly dissected or divided to create a very large surface area for absorption and photosynthesis. It also minimizes water resistance and hence potential damage to the leaves. In many cases, the submerged leaves are totally different to floating or emergent leaves on the same plant. The emergent leaves are

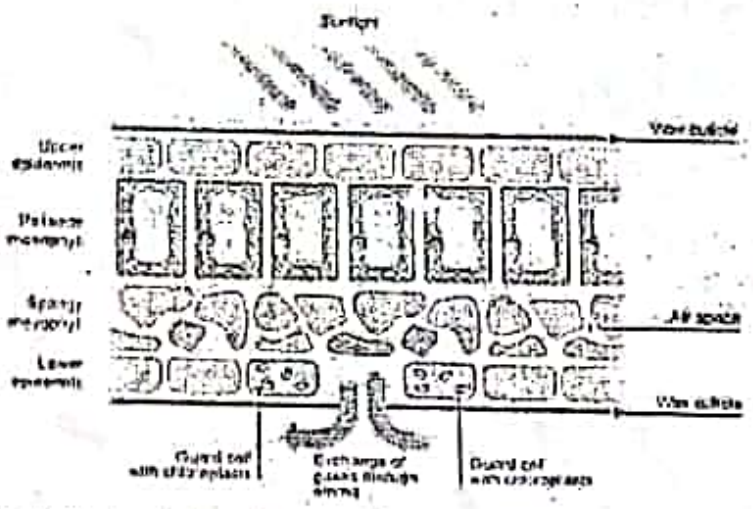
usually much less divided, if not entire and have a more similar internal structure to those of land plants.

- Lack of protective layer: The epidermal layer shows very little, if any, sign of cuticle formation, as water loss is not a problem. All the surface cells appear to be able to absorb water, nutrients and dissolved gases directly from the surrounding water. As a result, the xylem tubes is often greatly reduced, if not absent. *There are also no stomata on the underside of the leaves.
- Location of Stomata: The green pigment-containing chloroplasts important for photosynthesis are restricted to the upper surface of the leaves which are the only surface to be well lit. Stomata are also found only on the upper surface of the leaf. This upper surface often has a thick waxy cuticle to repel water and help to keep the stomata open and clear.
- Presence of Aerenchyma: They allow diffusion of oxygen from the aerial portions of the plant into the roots. Thus the roots don't have to depend on getting oxygen from the soil. "Regular" plants may have porosity (% air space in roots and stems) of 2-7% of their volume, while a wetland plant may be up to 60% pore space by volume. For a typical hydrophytic plant, air moves into the internal gas spaces of young leaves on the water surface and is forced down through the aerenchyma of the stem to the roots by the slight pressure caused by the heating of the leaves. The older leaves lose their capacity to support pressure gradients so gas from the roots returns out through the old leaves.
- Stem and Lenticel Hypertrophy: The presence of little or no mechanical strengthening tissue in stems and leaf petioles. If these plants are removed from the water, they hang limply. They are normally supported by water all around them and so have no need of mechanical strengthening. Mechanical support would be disadvantage as it would limit flexibility in the event of changes in water level or water movements.
- Roots: Roots are often also reduced and their main function is anchorage. The root hairs which function in absorption are often absent and roots themselves may be entirely gone.
- Rapid Early Shoot Growth: Under flooded conditions, several herbaceous and woody species exhibit this which gets the shoot above the surface of the water quickly to facilitate gas exchange.

Mesophytes Adaptations

Mesophytes

Since Mesophytes are plants that are exposed to an environment where it is neither too dry too wet they have not needed any extreme adaptations although they do have a hardship of losing water by evaporation from all aerial parts. Mesophyte plants have both physiological and structural features that allow them to cope with terrestrial habitats. The presence of a waxy cuticle in mesophytes is important as it plays a simple but yet very important role in the survival if a plant the waxy cuticle traps the moisture inside the plants leaves its function is to lessen water loss it does this by not letting the water diffuse out so easily. The cutile is like a protective film covering the epidermis of the leaves it works as a protective waxy covering and tends to be thicker on the top of the leaf. Without it the sun would evaporate all the moisture leaving the leave dry shrivelled and worth less. Also stomata on mesophytes are only present on the lower epidermis, the stomata close in extreme heat or wind to prevent transpiration, this is due the guard cells around the stomata which close when the plant starts to wilt and therefore force the stomata closed and prevent an water loss.



http://www.bbc.co.uk/schools/gcsebitesize/science/images/addgateway_leafinternal.gif

Meophyles generally have leaves that are large and thin compared to xerophytes sometimes having a large amount of stomata on the undersides of the leaves and a dark green colour. The roots of mesophytes are well developed they are branched and provided with a root cap. Since the roots of meophytes are well developed this allows absorption of water and minerals form the soil and also anchors the body of the plant so it can stay stable and therefore survive. The roots work by absorbing water and minerals to be from the soil and transported by the xylem

and phloem (vascular bundle) to be used for photosynthesis and respiration. The roots also have tiny root hairs that maximize the water and minerals that roots can take in or absorb. The shoot system on mesophytes is well organized and the stem is generally straight, branched, thick, broad and aerial. Mesophytes such as deciduous trees and shrubs that live in areas which often experience cold weather and often snow, the trees lose their leaves during winter and then become dormant (in extremely cold weather) and because the water in the soil is often frozen due to the weather so therefore cannot be absorbed by the plant also by losing their leaves they reduce the rate of transpiration so therefore reduces water loss.

http://www.thester330.com/wp-content/uploads/2012/09/Tree-In-summer-and-winter.jpg

- Article by TSR Community on Wednesday 29 March 2017

EXERCISE

1. Outline the basic adaptations of xerophytes, hydrophytes and mesophytes to their environment

LECTURE SIX

EVOLUTION

Darwin's theory of evolution combated the view of static universe. The idea that living organism change over time explains evolution as opposed to prior phenomenon. Evolution is the slow and gradual change by which living organisms acquire their various distinguishing characteristics. This theory tends to explain how present day plants and animals came to existence. According to evolutionary theories, life on earth began in a relatively simple form through series of gradual and small changes over millions of years. These changes resulted in succeeding generations of organisms which become more complex and varied. Evolutionary theories are simply theories, but not established facts. However, its hypothesis is acceptable to account for diversity of organisms and distribution on earth. The different forms of life on earth is an outcome of natural processes i.e. descent with modification, which implies that all living organisms are related to one another and thus originated from a simple unified ancestry by a long sequence of divergent differentiation of descendant lines from their ancestry forms. Resemblances and differences among living organisms is explained by evolution.

CAUSES OF EVOLUTION

Several factors are responsible for evolutionary change and these include the following: (a) Migration (b) Mutation (c) Breeding.

EVIDENCES OF EVOLUTION

These are sources to prove that organism have become more complex through ages and that changes have occurred in organism over time. Some of these sources include the following:

1. **Fossil Record:** Fossil record itself made interpretation to the theory of evolution. A fossil is any trace or impression of plants and animals of past geological ages preserved within the earth crust. Fossils may not complete, but few organisms that have become fossils gave useful clues to life in the past ages. For example, an investigator studied fossils in one rock layer and then studied the fossils in a slightly more recent layer would often find out that those in more recent layer, though very similar to the older ones, showed slight differences. Subsequent structure in successive rocks will enable him reconstruct the sequence of changes in the characteristics of the fossil detected. The study of fossils is known as paleontology. The notion of catastrophic extinction and recreation hardly

derived adequate to explain such fossil sequences. It was more likely that changes in fossils were the result of accumulation of many small alterations as the generations passed.

2. **Comparative Anatomy:** This means similarities in features of some parts of diverse plants and animals. It has revealed a striking resemblance between some parts of plants animals' features. Such features are traced to common origin at one point or the other. A good example is the Pentadactyl limb system in most animals. The bones in some vertebrae form /limbs also alike. Most of the bones in the human skeleton are clear equivalent to bones found in some other vertebrate animal e.g. birds, reptiles, fishes, and other mammals. These similarities is due to common descent diversification and modification in the different organisms. However, the differences within and among species are as a result of special adaptations of species to peculiar environmental conditions.

3. **Embryological Evidence:** This study reveals that embryos of all organisms often, goes through stages in which they resemble ancestral types and that individual development repeat evolutionary lineage. For instance, the development of gill porch in the human embryo was explained by reference to the time when common ancestors were fishes. It then does not mean that gill porches are derived from fishes, but are part of a developmental system that has been inherited ultimately from fishes. There is always striking similarities in the embryos of species.

4. **Biochemical Evidence:** There are marked similarities in the biochemical and physiological activities of living organisms. For example, many of the digestive enzymes present in different vertebrate animals are essentially alike in their physiological activities and properties. Hormones produced by the endocrine glands in most animals are also similar in their activities in different animals, their differences notwithstanding.

THEORIES OF EVOLUTION AND NATURAL SELECTION

DARWINISM AND LAMARCKISM

LAMARCKISM (JEAN BAPTISTE DE LAMARCK 1744-1829)

Jean Baptiste De Lamarck was the first to offer the major alternative explanation of the fossil record evolution. Lamarck concluded that present day organisms evolved from the same simple ancestor in the sea, which eventually moved into land. He also noted that the change was continuous and gradual under the influence of the organism's environment. This theory is summarized thus:

All organisms tend to evolve along a graded series from the most simple to the most complex.

This linear cause of evolution is acted upon by environmental conditions.

The influence of the environment on organisms is an indirect one, by changing the needs of organisms consequently resulting into changes in actions and actions gradually becoming habits.

Habitual (continuous) use of organs result in their development and habitual disuse causes weakness of the organ and gradual disappearance of such organ i.e. organs are active as long as they are used. For example, coccyx in man which has become reduced or almost absent due to disuse. This part of the theory is called the law of use and disuse.

Habits acquired are transmitted as hereditary traits to the next generation of organism e.g. one of the evidences of evolution is that of giraffes. Giraffes were believed to have long necks by Lamarck through such habitual acquisition. The ancestors were animals with short neck developed as they have to stretch their necks to reach the leaves of trees. The continuous stretch of the neck over time led to an acquired habit of long neck which was eventually passed on to several generations of giraffes and today, we have giraffes with long neck.

However, Darwin's theory of evolution contends Lamarck's theory, supporting his proof of natural selection by giraffe which survived to contribute to the next generation, while those ~~with~~ short neck perished, been unable to reach the leaves of trees. This is the survival of the fittest.

DARWIN'S THEORY OF EVOLUTION (DARWINISN)

Charles Darwin (1809-1882) published the origin of species in presenting the theory of evolution by natural selection. This suddenly provided a coherent organizing framework for the whole of Biology. The theory of natural selection as proposed by Darwin states that nature selects those organisms that best fitted to survive and struggle for existence. Organisms differ from one and other with different characteristics which makes the better able to survive than others or less able to survive. The longer lived organism have the ability of contributing to the next generation by producing offspring. Beneficial characteristics are passed unto succeeding generation or descendants. Diversity among living organisms arises from arises from the basic principle that gradually organisms become different from their ancestry generation and thus classified as distinct species.

THE THEORY OF NATURAL SELECTION

- Offspring may differ from one and other in many varied ways. This is known as variation. It is a characteristics of every living organisms and some of these variations are advantageous in a way over some individuals of the same species.
- More offspring produced by living organisms are capable of obtaining food and survival. The number of individuals produced are often larger than the available resources. There is always a competition for such available resources such as water, space, food, breeding sites etc. Essentially, there is a struggle for existence with individuals having better genetic variation succeeding in this completion (Survival of the fittest).

- Favourable variations or traits from survivors are passed on or transmitted to the next generation of organisms. Successive variations are passed on to succeeding generations. This process continues over a long period of time until those successfully adapted individuals become new species, whilst the less fit ones are eliminated before they are able to produce offspring.

EXERCISE

1. Outline Darwin's theory of evolution.
2. State the law of use and disuse.

LECTURE SEVEN

Boylekoche

HEREDITY

Heredity is the transfer of traits or characteristics from parents to off springs from generation to generation. It deals with differences and resemblances on organisms that are related by descent or ancestry. *Heredity* is the passing on of characteristics from one generation to the next. It is the reason why offspring look like their parents. It also explains why cats always give birth to kittens and never puppies. The process of heredity occurs among all living things including animals, plants, bacteria, protists and fungi. The study of heredity is called *genetics* and scientists that study heredity are called *geneticists*.

Through heredity, living things inherit *traits* from their parents. Traits are physical characteristics. You resemble your parents because you inherited your hair and skin colour, nose shape, height, and other traits from them.

Cells are the basic unit of structure and function of all living things. Tiny biochemical structures inside each cell called *genes* carry traits from one generation to the next. Genes are made of a chemical called *DNA* (deoxyribonucleic acid). Genes are strung together to form long chains of DNA in structures known as *chromosomes*. Genes are like blueprints for building a house, except that they carry the plans for building cells, tissues, organs, and bodies. They have the instructions for making the thousands of chemical building blocks in the body. These building blocks are called *proteins*. Proteins are made of smaller units called *amino acids*. Differences in genes cause the building of different amino acids and proteins. These differences cause individuals to have different traits such as hair colour or blood types.

A gene gives only the potential for the development of a trait. How this potential is achieved depends partly on the interaction of the gene with other genes. But it also depends partly on the environment. For example, a person may have a genetic tendency toward being overweight. But the person's actual weight will depend on such environmental factors as how what kinds of food the person eats and how much exercise that person does.

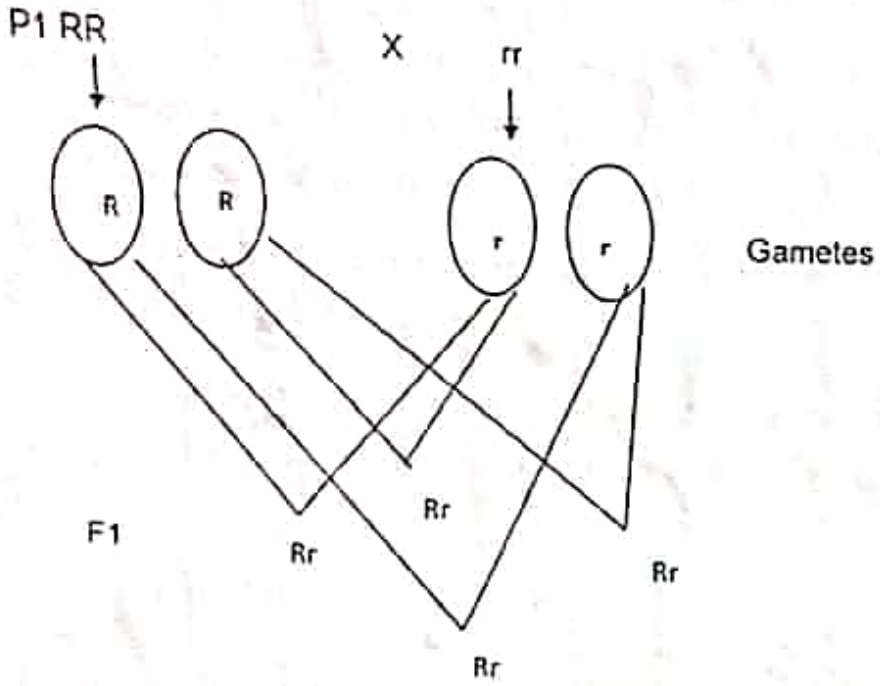
In heredity, the two parents are very important as each contributes its hereditary material to the hereditary units of offspring. The study of resemblance and differences in organisms related by ancestry is known as Genetics. Environment and inheritance are important in producing

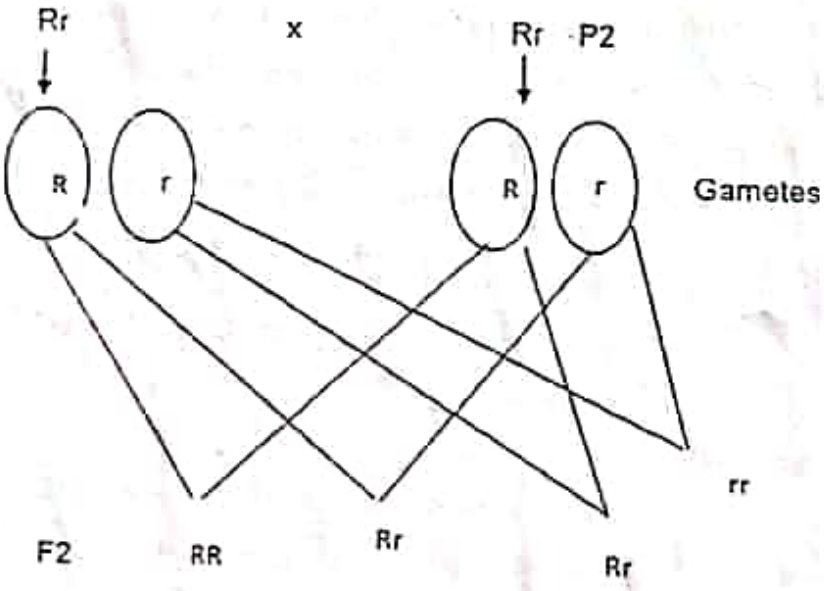
differences which exist between individuals. The chromosomal theory of inheritance began with Mendel's work.

MENDEL'S EXPERIMENT

Gregor Mendel is an Austrian Monk, who pioneered the study of genetics and so called the father of genetics. He published his results in 1866. He began with several dozen strains of peas (*Pisum sativum*). He raised each variety for several years to discover, which strain have recognizable variations i.e. produce true breed meaning mating such strains produce organisms like their parents). Of the numerous characteristics of garden peas studied by Mendel, seven were particularly of interest to him. He noticed each of this seven characteristics occurred in two contrasting forms. The seeds were either round or wrinkled, the flowers were either red or white, pods either green or yellow etc. When Mendel cross pollinated plants with contrasting forms of these characteristics, all offspring usually referred to as the first filial generation (F1) were alike and resembled one of the two parents. (P1 or first parental generation). When these offspring were crossed among themselves, some of the offspring of the second filial generation (F2) showed one of the original contrasting traits and some showed the other. In other words, a trait that had been present in the grand parental generation, but not in the parental generation reappeared. For example, when a true breeding plant with red flowers were crossed with those of white flowers, all of the F1 offspring had red flowers. In the F2 generation, both red and white flowers occurred. Apparently in the F1 generation, one form of each characteristics was usually expressed while the other was not. I.e. the red colour was expressed rather than the white flowers. Mendel termed the traits that appeared in the F1 offspring of such cross as dominant character and the traits that were not expressed in such crosses as recessive characters.

Red flower =RR White flower =rr





Mendel concluded that during gamete formation, each of the hereditary factor for each trait separate into different gametes. This principle is referred to as Mendel's 1st law- the law of segregation. He drew important conclusion from his experiment as follows:

1. Inherited traits are controlled by factors occurring in pairs and that offspring inherit one member of the pair from the male parent and the other from the female parent. Mendel's factor is today known as genes.
2. That one factor in a pair may mask the other thus preventing it from having effect. Mendel called these traits dominant characters, while the one that is masked recessive character.
3. Paired factors separate during gamete formation and offspring inherit one member of each pair from each parent.
4. That each factor is transmitted as a distinct unit i.e. factors do not blend or become diluted in future generation. This give rise to Mendel's second law of independent assortment.

Monohybrid Cross

This is the simplest cross, where only one pair of contrasting trait is considered. For example, the garden pea studied by Mendel had a red flower allele (R), which was dominant over the white flower allele (r). A cross between the red flowered plant and the white flowered plant is described as a monohybrid cross. The parents are homozygous red (RR) Band homozygous white (rr). The monohybrid offspring all have (Rr) because the allele for red is dominant, so all the F1 offspring were red. The recessive allele for white reappeared in the F2 generation to produce a phenotypic ratio of 3:1.

Some Genetic Terms

Variation: This refers to the differences among organisms. No two living organisms are exactly alike. During sexual reproduction, certain characteristics of parents are passed onto their offspring, but not all are inherited. Differences in organisms is often due to the influence of the environment. There are two types of variation namely: (i) Continuous (morphological) variation and (ii) Discontinuous (Physiological) variation.

Continuous variation: Hereditary characteristics (i.e. those that can be inherited from parents) that can be graded from one extreme to the other is known as continuous

variation. E.g. height, weight, heart beat etc. which can be arranged from the shortest to tallest, lightest to heaviest or from slowest to fastest.

Discontinuous variation: Inherited characteristics that have no graded series i.e. have no intermediate forms is called discontinuous variation e.g. the ability to roll the tongue, blood group, finger prints etc.

Chromosomes and genes: Chromosomes are threadlike or rod shaped bodies bearing the genes. Chromosomes are found in the nucleus during cell division. They are vehicles, which carry hereditary materials from parents to offspring. Genes being the basic unit of inheritance are located on the chromosome. Genes are expressed in pairs and each member of the pair is known as allele.

Dominant and recessive genes: When an allele in a pair of genes mask the other, thus preventing it from showing any effect, such allele is said to be dominant over the other. The allele whose effect is masked is known as the recessive allele. For example, the trait for tallness in a cross between a tall and short parent. Tall offspring s often appear in the first filial generation, while traits for shortness appear in the second filial generation. Dominant characters often express themselves even in the presence of the opposite contrasting character.

Genotype and Phenotype: Genotype refers to the sum total of all the hereditary materials or genes received from parents and can be transmitted to the offspring., while phenotype is the external physical appearance of an individual , which is the sum total of all the effect of interaction between the environment and the genotype. When genotypes are alike, phenotype will also be alike if environmental conditions remain the same.

Homozygous and Heterozygous: Individuals with similar gene pairs e.g. TT or tt are said to homozygous, while heterozygous refers to individuals in which paired gene for a particular trait are different e.g. Tt.

Applications of Genetics and Heredity

Genetics and hereditary studies have found applications in many aspects of Biology and Science in general. The following include some of those areas of application.

1. Genetic Counselling: It is the giving of information and advice about the risks of genetic disease and their outcome. Patients can be referred to genetic counsellors by their local doctors or other health services alerting patients to risks before problems arise. Genetic counselling is often carried out in special clinics in hospitals. The Counsellor is a part of a team, which include specialist laboratory workers. Counsellors are often doctors or paediatrician specialists in childhood conditions, who have gone to specialize. Some of the issues involved in genetic counselling include working out or diagnosis of family history, calculating risk, and explaining cause, qualify of life, options, genetic screening and responsibility. Examples of some genetic diseases include sickle cell anaemia, colour blindness, haemophilia and others include diabetes and hypertension.

2. Genetic finger and DNA profiling: There are about 100, 000 genes in the human genome (the genome being the total DNA on a cell). It has been discovered too that a great deal of variation exist between individuals in the number of repeats of these short sequences of DNA. Genetic finger printing and profiling is a way of analyzing the lengths of the mini-satellites of a given individual. These are used to detect criminals, settle issues of disputed paternity etc.

3. Forensic science: Just as finger printing, forensic work is also used in detecting criminals. DNA can be extracted from small samples of cells found at the scene of a crime, for example in traces of blood, hair roots or saliva. In cases of rape, semen may be used. An even more routine use of the technique is to settle paternity cases. Genetic finger printing revolutionized forensic science.

4. Hybridization: This technique has found wide application in the field of agriculture to produce healthier or improved breeds of plants and animals.

5. ABO blood groups: The human red blood cells do not show the same variation in MHC antigens that is shown by other cells (unlike the red blood cells of some animals such as mice and chickens). The most important antigens include A, B, O alleles of the gene. By this knowledge, blood transfusion is made easy especially in finding a suitable blood donor.

6. Transplant surgery: The knowledge of histocompatibility complex (MHC) plays an important role in organ transplant since a familiar problem with transplant surgery is that of rejection of the transplanted organ. The body recognizes the transplanted organ as foreign and mounts an immune response against it which gradually destroys it.

EXERCISES

1. What is the relationship between genetics and evolution?

LECTURE EIGHT

DIVERSITY AND CLASSIFICATION OF ORGANISMS

According to fossil record the most primitive organism known- the bacteria and the blue green algae date back over three billion years, the first plants and insects dates back over 400 million years, the first birds and mammals over 180 million years. Since the simplest forms of life arose, innumerable different kinds of organisms, increasing complex and adapted to widely varying environment evolved. Different groups of organisms have come into being generally beginning with geographic separation of a population that before its separation could interbreed.

Natural selection has also brought about significant changes in the characteristics of a population as its members breed together generation after generation. The repeated processes of geographic separation and natural selection over billions of years under varied conditions and in the course of time profoundly altered conditions of terrestrial life that has given rise to the radically different groups of organisms that inhabit the earth today.

Living organisms are classified on the basis of the evolutionary relationships thought to exist among the various groups. Since the relationships are often far from clear, a number of different systems of classification are possible. The five kingdom system of classification by Whittaker is the most recently used. This system recognizes five broad categories or kingdom viz: Kingdom Monera, Kingdom Protista, Kingdom Fungi, Kingdom Plantae and Kingdom Animalia.

CLASSIFICATION

Classification simply refers to putting living organisms into classes or groups according to the order of increasing evolutionary trend or relationship. The science of biological classification is known as taxonomy. There are various unit of biological classification. These various units are called taxonomic categories making up the taxonomic hierarchy. The kingdom is the largest unit of classification in both plants and animals. The species is the basic unit of classification which contains organisms which are closely related and can interbreed. Other units include the following: phylum (phyla) in animals but represented as divisions in plants, subphylum, classes, subclasses, order, suborder, families, sub-families, genus (genera), and species.

Examples (Man)

Kingdom: Animalia

Phylum: Chordata

Sub-Phylum: Vertebrata

Class: Mammalia

Order: Primates

Family: Hominidae

Genus: Homo

Species: *Homo sapiens*

Housefly

Kingdom: Animalia

Phylum: Arthropoda

Sub-Phylum: Mandibulata

Order: Diptera

Sub-order Cyclorrapha

Family: Muscidae

Genus Musca

Species: *Musca domestica*

Maize

Kingdom: Plantae

Division: Spermatophyta

Class: Angiospermae

Sub-class: Monocotyledoneae

Order: Graminale

Family: Poaceae

Genus: Zea

Species: *Zea mays*

BINOMIAL NOMENCLATURE

This was introduced by Carl Linnaeus better known by the Latinized form of his name *Carolus Linnaeus*. In this system of nomenclature, the generic name begins with a capital letter while the specific name begins with a small letter and both are italicized or underlined. For example, the human species is written as *Homo sapiens*.

SUGGESTIONS FOR FURTHER READING

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