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ADAPTATIONS

The structural and functional characteristics which, organisms have developed during the course of evolution enabling them to survive and reproduce in particular environment are called adaptation. Thus adaptations include adjustments by which an organism accommodates itself to its environment.

I. Aquatic adaptations: - aquatic animals acquired certain characters to live in water. The aquatic animals are classified into **primary** and **secondary** aquatic animals depending upon their certain specific characters.

A. Primary aquatic animals:- These are those in which phylogenetic history is restricted to water as habitat. So, all their adaptations are originally designed to meet the necessities of aquatic life. Examples are protozoans, sponges, coelenterates, some arthropods, mollusks, some annelids, echinoderms and chordates such as cephalochordates (amphioxus), urochordates (Herdmania), cyclostomata (Petromyzon, Myxine), fishes.

The primary aquatic adaptations of shark:-

1. The body is streamlined to provide least resistance while it swims.
2. The median or unpaired (Dorsal, ventral and caudal) and paired (pectoral and pelvic) fins are organ of swimming. The dorsal and ventral fins help to keep the body vertical, pectoral and pelvic fins help in propulsion and making changes in direction. Caudal fin helps in propulsion.
3. Gills are the respiratory organs.
4. Lateral sense organs are present along the body, which act as rheoreceptors (detection of pressure changes in surrounding water.
5. The entire surface of the body contains scale (Placoid), which prevent the heat loss in aquatic condition

Secondary aquatic adaptations: These have a record of terrestrial life in their phylogeny (i.i., these are descended from ancestors which led a life on land). Examples: Whales, dolphins, porpoises, seals, frog, turtle etc.,

Secondary aquatic adaptations in turtle:-

1. In turtle, the body is dorsoventraly flattened, by which it becomes easy to float on the surface of water. Because of the hydrostatic pressure exerted by the water column on turtle, the body becomes flat.
2. The soft body is enclosed within the shell (doral carapace and ventral plastron) which, protect the turtle from the hydrostatic pressure, enemies and other unfavorable conditions.
3. The neck, tail and limbs are withdrawn inside the shell to get protection against predators and environmental fluctuations.
4. The limbs (fore limbs and hind limbs) are modified into paddles or flippers, which is a swimming organ in the water.

5. Nostrils are at the tip of the head, which is an adaptation to respire while it is swimming or in float.
6. Shell and skull are porous to reduce weight.
7. Store green fat, which serves as food source and in thermoregulation.
8. Due to developed capacity to submerge, the lungs are large to carry large quantity of air, which is used while it is diving deep in to the aquatic body.
9. External ears disappear, which is hinder while swimming.

Volantal or aerial adaptations

Volntal adaptations are required for the flight. The aerial adaptations include modifications to reduce body weight and formation of organs capable of executing flight. The flight may be passive (gliding) and active (true flight).

Adaptations for passive flight: - In the passive flight no flapping (no upstroke and down stroke) of wings or petagia.

1. The passive flight or gliding is carried out by flying lizard or flying dragon (Draco volans), flying fish (Exocoetus), flying frog (Racophorus), flightless birds (Ostrich, Emmu, Cassowary, Kiwi etc).
2. For gliding wing like petagium is developed in the case of Draco. Petagium is a fold of skin, which lies between fore limbs and hind limbs can be folded like a fan against the body when is not in use. In Draco, petagium is supported by the ribs. Ribs give protection to the petagium against the air force while gliding. There are three hooks in the neck region or gular spines help to have firm grip after gliding.
3. In flying fishes (Exocoetus) pectoral fins are large and highly inserted to become parachute like structure. The lower lobe of tail is long, helping in leaping. It can fly up to 200-300 meters to escape from the enemies.
4. In flying frog (*Rhacophorus paradales*), the feet are webbed, which sustain the prolonged leaps. Flying frogs digits terminate in adhesive pads, which help in adhesion to trees.

Adaptations to true flight or active flight:- Active flight or true flight is achieved by the action of wings (down stroke and upstroke). True flights are found in insects, birds and bats. The nature, development and structure of wings are quite different. The structures or organs of different animals of different species are differ in structure but perform similar function, such organs or structures are known as analogus organs/structures.

1. **In insects a pair of wings** developed, which is an extension of body wall. It is made up of cuticle and strengthed by thickening called veins. Flight is affected by the flapping movements of the wings.
2. **In Bats**, lateral extension of the skin, **petagia** includes fore limbs and hind limbs in macrochiroptera, but in microchiroptera, in addition to fore and hind limbs tail also

included in the petagia. All the digits of hind limbs and 1st or first 2 digits of fore limbs bear claws.

3. **In birds**, forelimbs are modified in to **wings**, which are organs of flight.
4. In insects (especially in dragon flies and may flies) body is ideally suited for the evolution of **aerostatic adaptation**, because of the tracheal system, which reduces the body weight providing **buoyancy in air**.
5. **In bats** all the **bones are slender** to reduce the body weight.
6. In Birds the body is stream lined or boat shaped or spindle shaped, encountering least aerial resistance
7. Feathers (birds) are light, water proof and also provide buoyancy in air. **Remiges** (wing feathers) increase wing span. **Retrices** (tail feathers) act as radar to change the direction of flight.
8. Pneumatic bones are fused to provide lightness and rigidity.
9. **Keeled sternum** helps to pierce the air while flying.
10. **Flight muscles** (pectoralis major and pectoralis minor) are involved in the flight.
11. Air sacs help in double respiration and provide buoyancy.
12. Presence of **single ovary** (left), absence of **urinary bladder** and excretion of **uric acid decreases** the **body weight**.

Arboreal adaptation

Adaptation to climbing and living on trees is called arboreal adaptation. Examples are tree Frogs, **Chameleon**, tree Snakes, tree Kangaroo, **Loris**, Squirrels, Wood pecker, Monkeys and Apes.

1. The pectoral girdles (shoulder bone) are very well developed.
2. The feet may be prehensile (capable of grasping) or non-prehensile (which have claws).
3. Digits have adhesive pads; enable the animals to get a firm grip on trees.
4. Syndactyly (fusion of digits) found in chameleon. Syndactyly perfectly suited for clasping. Tail is also prehensile in chameleon, which is an excellent organ of grasping in these animals.
5. The hind limbs are comparatively longer than forelimbs. The limbs are comparatively longer than the limbs of other animals.
6. In wood pecker 4th toe is reversed for the purpose of grasping.
7. According to mode of locomotion, arboreal forms are divided in to three groups. They are, 1. Branch runners: these live and move on the branches of trees, eg: chameleon, squirrels, lemurs etc., 2. animals suspended from the branches of trees, eg: sloths and 3. Brachiators: these are arboreal animals which swing from branch to branch or from tree to tree, with the help of their forelimbs, eg: monkeys and apes.

Desert adaptation

Desert constitute about one fifth of the land area of the earth's surface. Very low rainfall and extreme temperature are two important characteristic features of desert. Temperature is very high during day time and the nights are cooler. In sandy deserts and semi deserts extreme temperature and dust storms are common occurrence. Deserts and semi deserts are exist in many parts of Rajasthan in north western India. Among vertebrates certain species of lizards (**phrynosoma**) and snakes, **camels**, rodents like kangaroo-rats, jack rabbits etc., are adapted for desert life. These animals are able to withstand both drought and heat. Desert adaptations in animals are oriented to fulfill three important requirements in desert life. These are, 1. Moisture getting, 2. Moisture conservation and 3. Defence against environmental hazards.

1. **Moisture getting:** i. Surface dwellers in certain deserts may utilize the water available in water springs or water holes.

ii. Many desert animals depend upon juices of their food like the sap of plants or the blood of their prey for water.

iii. The skin of spiny lizard, *Moloch horridus* found in Australian deserts, is capable of absorbing water.

2. **Moisture conservation: i.** Thick body coverings provided with spines, prevent the evaporation of water.

ii. Spines are present all over the body as in the case of spiny lizard, *Moloch horridus* in Australian deserts or the spines are present on the tail of spiny tailed lizard, *Uromastix*, present in the semi deserts of Rajasthan.

iv. Desert lizards and snakes excrete uric acid, which is an adaptation to conserve the water.

v. Camels store water in the water cells or **diverticula** present in the rumen of their stomach. This can live without water for 5- 10 days at temperature 34° Cto 41° C. This can drink 50 liters of water in one gulp. It produces concentrated urine and low perspiration occurs.

vi. Nocturnal habits of many animals help to prevent evaporation of water.

vii. Certain animals close their burrows during day time to prevent water loss.

3. **Defence to environmental hazards:** i. many desert reptiles are provided with thick coverings which are provided with spines. Presence of spines (spiniscence) on the body of *Moloch horridus* (spiny lizard), *uromastix* (spiny tailed lizard), *phrynosoma* etc., hard surface and spines are protective in function.

ii. Some desert animals (rodents) burrow in to the sand to avoid high temperature.

iii. Many animals of deserts are nocturnal because nights are cooler than day time.

iv. Dust storms are common in deserts. So desert animals have to protect their sense organs from dust and sand. The nostrils in many desert animals are protected by valves. In the case of camels, the nostrils can be closed and the eyes are protected by long eyelashes.

v. In the case of typhlops the eyes are over hung by head shields. In the case of mabuya, the lower eye lid is enlarged with a transparent portion in it, so that even when the eye is completely closed by the lower eyelid the animal can see through the transparent window of the lower eye lid

vi. In the desert lizard ablepharus, the lower eye lid is entirely transparent and completely fused with reduced upper eyelid.

viii. Ear openings are usually small in desert animals and in many lizards these openings are protected by fringes of scales.

ix. The coloration of desert animals is protective, i.e. the color usually matches with the color of sand or rock in the deserts. Many desert animals are thus grey or brown colored.

x. Swift movement is another feature of desert animals, which enables them to travel far, wide and fast in search of food, to protect against enemies and too hot surface.. Kangaroo-rat (dipodomys) found in the North American desert, provided with long hind limbs for speedy movement. In camel, the feet are provided with soft pads for movement on sand.

xi. Desert animals are provided with keen senses of sight, hearing and smell.

xii. Venom is another feature in desert adaptation. Many desert reptiles are poisonous and help them to defend from enemies. The poisonous lizard ***Heloderma*** is found in the arid regions of Mexico. Rattle snakes are poisonous, found in the North American deserts.All the spiders in deserts are poisonous.

xiii. Intelligence is another conspicuous feature in defenceless nonpoisonous desert animals.

xiv. The kangaroo-rat, when attacked by the poisonous rattle snake, tries to escape by throwing sand in to the face of rattle snake with the help of its long hind limbs.

COLOURATION AND MIMICRY

COLOURATION : The coloration in animals has biological significance. Based on the type of coloration production two types of colors is classified, 1. Chemical colors, 2. Physical colors.

1. **Chemical colors:** the color is produced by chemicals or colored pigments. The beautiful hues and changing colors on the body of the **chameleon** is due to different kinds of colored pigments present in the special cells in their skin called **chromatophores**. These cells present deep in a relaxed condition. During contraction these come to the surface and the pigments spread out producing the desired character. Chemical coloration is useful in adaptation and natural selection.
2. **Physical colors:** Some structures in the body of animals split the light, reflecting some of them and absorbing others. These structures act like prisms. The scales of insect wings, the feathers of birds are variously colored because of this nature.

Biological significance of color: Depending upon the adaptive and survival value, coloration classified in to **seven types.**

1. **Sympathetic colors**
2. **Alluring colors**
3. **warning colors**
4. **Mimetic colors**
5. **signal and recognition colors**
6. **Confusing colors**
7. **Sexual colors**

1. **Sympathetic color or cryptic color:** The body color of an animal which blends with its surroundings and help the animal to escape or conceal from the notice of others is called **Sympathetic coloration.** Such coloration on the prey is called **protective coloration** and on the predatory animal is called **aggressive coloration.** Sympathetic colors are classified in to two types, i. Local colors and ii. Seasonal colors.

i. **Local colors:** One or same species exhibit different colors in different localities called local colors. Ex: The gazelle living in sandy plain desert have white color whereas in volcanic lava desert fields have dark grey color.

ii. **Seasonal colors:** One or same species exhibit different colors in different seasons called seasonal colors.

Protective colors are also called as Standard Faunal Colors. These colors match the type of surroundings or habitats.

a. Desert animals, in general dark grey as in Gazelle and camel
b. Plain-dwellers have the color of the dry grasses as in wild horse.
c. Forest living or jungle living animals often have stripes and colored patches as in tigers and Panthers.
d. Forest living insects and the caterpillars are usually green.
e. Arctic animals are white.
f. Nocturnal animals are black.
g. Birds near the sea bluish above, whitish below.

2. **Alluring colors:** Some animals highlight their colors in order to lure their prey. The spider living in orchid flower resembles its body color to that plant. In order to attract insects and lure these insects the color of the mouth becomes attractive. So, the insects become prey to this spider.
3. **Warning colors:** Non-poisonous and palatable animals to predators posses the color of poisonous and unpalatable animals. This is a warning color so that the predators can think that these may be poisonous and unpalatable. Such animals have bright colors as can seen on coral snakes, Gila monsters, Tiger salamanders, certain caterpillars and butterflies.

4. **Signal colors:** The **Virgenia deer** lives in a herd. When any one senses danger, it throws up its tail like flag exposing the white under parts which were till then covered. This is a signal for others to flee the area or to escape from that area.
5. **Recognition colors:** The color of one individual recognized by another member of the same species. These are marks or colors which help the other members of a population to recognize each other when they are resting or moving at a common plane. Fishes have markings on their side which other members of the same species can easily recognize.
6. **Confusing colors:** The butterflies are beautifully colored and conspicuous but during rest these fold their wings, the color disappears so suddenly that we lose sight of it. This is because the insect now exposes a color which harmonizes with the background
7. **Sexual colors:** Male animals and female animals are distinctly colored and both sexes can be distinguished so easily. In domestic fowls, peacock and pheasant males are beautifully colored and exhibit this during courtship behavior.

MIMICRY: Any resemblance of an animal to others or even inanimate objects called as mimicry. Mimicry may be classified in to **protective mimicry, aggressive mimicry** and **simulation to death** mimicry.

1. Protective mimicry: Large number of animals protects themselves from predators and enemies by warning others either by their imitation of a harmful or unpalatable animal. Protective mimicry includes two types: - concealment and warning

a. Protection by concealment: The mimicking animal is called mimic while the animal or object which it mimics is called model. By developing a body similar to the objects around them the mimic gets easily camouflaged with the surroundings. Examples are

i) Changes in color and texture to match the background: The white crab Cryptolithodes matches its body color with the background consisting of similar shaped pebbles on the beach.

ii) Changes the places to match the background: An insect which produces a green colored caterpillar rests on green leaves, while the adult which is colored rests where there is color. Changing the places helps the animal to protect itself in different stages of its life according to the situation.

iii) Mimicking the inanimate objects: The Indian dead leaf butterfly *Kallima paralecta* has brilliantly colored dorsal region. But at rest the wings are folded so that the color is covered. The shape of the insect resembles a dead leaf.

Leaf insect Phillum (also known as walking insect) is green colored leaf like insect resembling fresh leaf.

The stick insect (phasmidae) matches the color and nodes of a stick.

Geometrid (Caterpillar) larva attaches its posterior part to a twig by apair of posterior pair of prop-legs. The caterpillar throws its body in an angle resembling a twig. By lying

their motionless anterior body almost becomes a part of the plant. In fact some of its part of the body resemble axiillary and terminal buds of a twig.

The Australian sea Horse (Phillopteryx equus) which lives among the water plants in the bottom of the sea mimics the leaves by developing thin leafy structures of its body.

2. **Warning mimicry:** In this case the mimicking animal imitates a living animal which is harmful or distasteful.

Certain non-poisonous coral snakes mimic the color patterns of poisonous snakes. Some non-poisonous snakes raising their hood with hissing sound which is the mimicry of poisonous snakes.

There are some spiders live among ants. These spiders have similar body imitating the ants. Other animals do not approach them fearing that they are ants.

Viceroy Butterfly (*Basalarchia archippus*) is edible while another variety *Anoxia plexippus* which is non-palatable and not preferred by predators. The viceroy butterfly mimics Anosia and escapes from predators.

3. **Aggressive mimicry:** This is exhibited by spiders and deep sea fishes. These animals adapt two methods to catch their prey-i) concealing mimicry and ii) alluring mimicry.

i) Concealing mimicry: The predator conceals itself in a background imitating a model. Some spiders imitate the shape and color of a flower, some other resembles oak galls and yet others resemble bird droppings. When a prey comes closer it is caught and eaten.

ii) Alluring mimicry: Angler fish which lives in the abyssal regions of the sea has blob at the end of a long fin ray. It can rotate freely. The movement of this structure attracts smaller fishes. It acts as bait for them. As soon as the smaller fish falls for the bait it is immediately swallowed.

3. **Simulation of death mimicry:** Some animals pretend to be dead on seing an attacking animal. They save their life by playing dead. The American opossum, a marsupial mammal suddenly curls around and lies still as if dead. The intended killer leaves it free. This kind of mimicry is also noticed in some beetles.

Batesian mimicry: The concept of mimicry in animals was introduced by Bates in 1862. When an animal which is defenseless and palatable to predators, mimics the variety which is non palatable and poisonous it is called Batesian Mimicry.

Mullarian Mimicry: Muller described a mimicry in which two or more different animals, all of which are unpalatable resemble each other. For example a moth (ctenuchid) which is it self non palatable mimics a wasp which is also a non palatable to its predators. This is called Mullerian mimicry. A bird which has learnt by experience that the wasp is unpalatable will spare the mimicking moth without testing it because it mistakes it for the wasp.