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SECOND TERM E-LEARNING NOTE

SUBJECT: BIOLOGY **CLASS: SS 3**

SCHEME OF WORK

WEEK TOPIC

1. The fruit (Structure, types, dispersal of fruits and seeds)
2. Variation in population (Morphological, physiological, application)
3. Adaptation for survival (Competition)
4. Adaptive colouration and behavioural adaptation
5. Theories of evolution
6. Biology of heredity (Genetics)
7. Chromosomes (Location, structure, roles in genetics), probability and application of genetics

REFERENCES

- Modern Biology for Senior Secondary Schools by S.T. Ramlingam
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- Biology practical text

WEEK ONE
THE FRUIT

CONTENT

- Structure of a fruit
- Types of fruits
- Dispersal of fruits and seeds
- Features that aids methods of dispersal

STRUCTURE OF A FRUIT

A fruit is a matured fertilized ovary of a flower containing one or more seeds. Contrary to this, some plants do not undergo fertilization for the formation of their fruit. Such fruits are called **parthenocarpic** fruits e.g. banana and pineapple. Such fruits are seedless.
A typical fruit has the following parts

1. The fruit wall called pericarp which is made up of three layers from the inside to the outside (epicarp, mesocarp and endocarp).
2. The seed or seeds
3. The fruit stalk-the point of attraction between the fruit to the plant.

EVALUATION

1. What is a fruit?
2. Describe the structure of a typical fruit

TYPES OF FRUITS

Fruits are classified based on their origin or structure. Common ways of classifying fruits are

Name_____ Date_____

- True and false fruits
- Simple, aggregate and composite fruits
- Fleshy and dry fruits
- Dehiscent and indehiscent fruits

True and false fruit: -
A true fruit develop from a fertilized ovary and it contains a pericarp and seed(s) e. g. mango, cowpea while a false fruit develop from the ovary and other floral parts e. g. apple, cashew.

Simple, aggregate and composite fruits
A simple fruit develops from a single flower with a single ovary e. g. cowpea, maize. An aggregate fruit develops from a single flower with several ovaries (each ovary develops into a fruitlet to form a cluster). The fruitlets have a common fruit stalk e. g. custard apple, strawberry. A composite fruit develops from an inflorescence e. g. fig, breadfruit.

Fleshy and dry fruits
Fleshy fruit is a fruit that has the whole pericarp or at least one of the pericarp thick, soft and succulent is a fleshy fruit. There are six types of fleshy fruits:

1. Drupe: - A true, simple fruit with a thin epicarp, fleshy or fibrous mesocarp and a hard and woody endocarp which encloses the seed(s) e. g. mango, coconut, oilpalm fruits.
2. Berry: - A true, simple fruit with a thin epicarp and succulent, edible mesocarp and endocarp e. g. tomatoes, guava etc.
3. Hesperidium: - A special type of berry in which the epicarp and mesocarp are fused together and the endocarp form distinct chambers filled with succulent hairs e. g. oranges, lemon, grapes etc.
4. Pome: - A simple, false fruit in which the fleshy edible part is derived from the receptacle and the core enclosing the seeds from the ovary e. g. apple and pear
5. Sorosis: - A composite, false fruit formed from a dense inflorescence e. g. breadfruit, pineapple
6. Synconium: - A composite false fruit that develop from a cup-like inflorescence enclosing numerous tiny male and female flowers e. g. fig

Dry fruit is atype of fruit in which the pericarp becomes dry, hard, woody or fibrous when the fruit ripens. Dry fruits can be grouped into dehiscent or indehiscent fruits

Dehiscent fruits split open to release the seeds when ripe. Four main types are

1. Legumes: - The pericarp split open longitudinally along both side to release the seeds e. g. cowpea. Flamboyant etc.
2. Follicle: - The pericarp split open longitudinally on one side only to release the seeds e. g. silk cotton, kola
3. Capsule: - The pericarp slit along many sides to release the seeds e. g. okro, cotton etc
4. Schizocarp: - Breaks up into units enclosing one seed each e. g. desmodium, cassia etc.

Indehiscent fruits fall to the ground when ripe, eventually decayed to release the seeds. Five main types are

1. Achene e. g. clematis

2. Cypsela e. g. tridax, sunflower, marigold
3. Caryopsis e. g. maize, rice
4. Nut e. g. cashew nut
5. Samara e. g. combretum

EVALUATION

1. Differentiate between a) true fruits and false fruits b) simple, aggregate and composite fruits
2. Mention five types of dry dehiscent fruits with one example each

DISPERSAL OF SEEDS AND FRUITS

This is the transfer of the seed or fruit from the parent plant to other places where such seed may germinate. The essence of dispersal includes the following:

1. To avoid undue competition for nutrients ,light space and water
2. To prevent overcrowding of plants
3. To prevent spread of disease
4. To encourage colonization of new area for such plants

Agents of dispersal

These are the means by which seeds and fruits are removed from parents to other places. These agents include:

1. wind
2. water
3. animals and man
4. explosive mechanism

Features that aids methods of dispersal

1. WIND – (i) Fruits or seeds are light. (ii) Fruits or seeds may have floss, tuff or pappus e. g. tridax, cotton, combretum etc.
2. WATER – (i) Light fruits or seeds that can float in water (ii) Waterproof epicarp (iii) Fibrous mesocarp that can trap air to keep it afloat e. g. coconut
3. ANIMALS AND MAN: - (i) The fruits or seeds may have hooks or hairs to attach to the animal skin (ii) The fruits are edible and the seeds indigestible e. g. pepper, desmodium
4. EXPLOSIVE MECHANISM: - (i) Presence of one or more lines of fission or weakness e. g. cowpea, flamboyant, okro etc.

EVALUATION

1. Mention five importance of fruits and seeds dispersal
2. State two features each that aids wind and water dispersal

GENERAL EVALUATION

1. What is a fruit
2. Describe the structure of a fruit
3. Differentiate between a simple, an aggregate and a false fruit
4. Differentiate between a true and a false fruit
5. Classify fruits into dehiscent and indehiscent fruit giving one example in each case
6. Give two features each of fruits dispersed by water, wind and animals
7. Differentiate between a drupe and a berry

READING ASSIGNMENT

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College Biology: - Chapter 16, page 326 – 336

WEEKEND ASSIGNMENT

1. A fruit that develop from the ovary and other floral parts is called a ---------- fruit A. true B. aggregate C. false D. simple
2. A fruit that develops from an inflorescence is known as a ---------- fruit A. aggregate B. simple C. composite D. true
3. Which of these is not a class of dry dehiscent fruits A. legumes B. follicle C. capsule D. cypsela
4. The following except one belong to the same class of fleshy fruits A. coconut B. apple C. oil palm fruit D. mango
5. The following are dispersed by explosive mechanism except A.tridaxB. cowpea C. flamboyant D.okro

THEORY

1. Differentiate between a fruit and a seed
2. With the aid of labeled diagram, differentiate between a drupe and a berry

WEEK TWO
VARIATION IN POPULATION

CONTENT

- Definition of variation
- Types of variation
- Application of variation

VARIATION IN POPULATION

Population is a group of organisms of the same specie living in a specified area within a given period of time. Variation refers to the differences which exist between individuals of the same species

Types of variations

a. Morphological variation
b. Physiological variation.

Morphological variation is the noticeable physical appearance of individuals of the same species. This physical appearances change gradually within a population. The feature observed shows a gradual transition between two extreme forms (continuous variation) e.g. size (height or weight), colour and finger prints.

Physiological variation is the difference in the ways individuals of the same species behave or react to conditions in their environment. It is not visibly apparent like morphological variation. It relates to the functioning of the body. In physiological variation, organisms can be grouped into two or more classes within a population without any graduation or intermediate between or among them (discontinuous variation). Examples of such variation are behaviour which can be temperamental, accommodating, excited or calm, blood groups, ability to roll the tongue, ability to taste phenylthiocarbamide etc.

EVALUATION

1. What is variation?
2. Differentiate between morphological and physiological variations.

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CAUSES OF VARIATION

There are two causes. They include:

1. Genetic differences
2. Environmental influence.

Genetic differences

A sudden change in a gene called mutation can be inherited when sex linked. This then brings about variation e.g. a gene responsible for green fruits in plants may be altered to produce a yellow fruit in the same plant

Environmental differences

Environmentinclude housing, food, healthcare, educational facilities, parental care etc. e.g. an intelligent person exposed to an unfavourable environment becomes dull.

EVALUATION

1. What are the major causes of variation?
2. Give three examples each of continuous and discontinuous variations

APPLICATIONS OF VARIATION

1. Crime detection: Use of finger prints which can be arch, loop, whorl or compound.
2. Determination of paternity using blood group
3. Development of hybrids of desired traits in agriculture
4. Classification of human race based on skin colour, shape of nose, texture of the hair into Caucasoid (European), Negroid (Black African) Mongoloid (Chinese and Japanese), Australoid (Australian)
5. Blood transfusion: The blood group of the donor must be compatible with that of the recipient. If not, the donor's RBC will clump in the recipient's blood vessels causing serious harm to the recipient. Each blood group is characterized by specific proteins in the blood which are antigens in the RBC and antibodies in the blood plasma. The table below shows antigen-antibody reactions between donor and recipient bloods.

DONOR / RECIPIENT	A (Antigen a)	B (Antigen b)	AB (Antigen a + b)	O (None)
A (Antibody b)	+	-	-	+
B (Antibody a	-	+	-	+
AB (None)	+	+	+	+
O (Antibody a + b)	-	-	-	+

\+ means positive reaction (no clumping)

\- means negative reaction (clumping)

Note: O is a universal donor while AB is a universal recipient

EVALUATION

1. State four application of variation
2. How is variation used to determine paternity?

GENERAL EVALUATION

1. Define population, hereditary and variation
2. Define morphological and physiological variation. Give two examples in each case.

3. Differentiate between continuous and discontinuous variations
4. State two causes of variation.
5. What is gene mutation?
6. Outline five applications of variation

READING ASSIGNMENT

College Biology: - Chapter 18, page 428 – 433

WEEKEND ASSIGNMENT

1. The differences which exists between individual of the same species is known as A. hereditary B. mutation C. variation D. population
2. Which of these is not a continuous variation A. height B. skin colourC. intelligence D. ability to roll tongue
3. The differences in the way individual behaves or reacts to changes in the environment is termed ---------- variation A. morphological B. physiological C. continuous D. discontinuous
4. The following are group of human finger print except A. loop B.simpleC. compound D.arch
5. Variation factor used in determination of paternity is A. fingerprint B. skin colourC. blood group D. behavior

THEORY

1. Outline five application of variation
2. In a tabular form, state five differences between continuous and discontinuous variation

WEEK THREE
ADAPTATION FOR SURVIVAL

CONTENT

- Competition and Types of competition
- Relationship between competition and succession
- Modes of adaptation
- Structural adaptation

COMPETITION

Competition is the process by which living organisms in the habitat struggle with one another for limited essential needs in the environment. Such scarce resources in plants include; light, space, nutrient and water while animals complete for food, space or mate.
Competition finally results in survival of the fittest and elimination of the unfit.

Types of competition

a. **Intraspecies competition**: competition between organisms of the same species. e.g. many maize seedlings grown in a small area.
b. **Interspecies competition**: that between different species of organisms. e.g. many maize and pepper seedlings growing in a small area.

Relationship between competition and succession

Succession is the change in a population caused by the replacement of the old members with new ones as a result of competition. The newly formed habitat is gradually colonized

by different species of plants in a stepwise manner until a relatively stable community is established and later the habitat will be inhabited by animals. As soon as a habitat is established, competition sets in. The early inhabitant modify the habitat by their activities while the later arrivals compete and outgrow the previous inhabitants which gradually loss out.

EVALUATION

1. Define competition
2. Differentiate between intraspecies and interspecies competition.

ADAPTATION

Adaptation is the possession of special features which improve the chances of an organism to survive in its environment. All organisms have adaptive structures which could be structural or morphological and behavioural in nature. These enable them to live successfully in their habitat.

There are three modes of adaptation:

1. Structural Adaptation
2. Adaptive colouration
3. Behavioural Adaptation

STRUCTURAL ADAPTATION

This is a special modification of structures which help organisms to survive better in their environment. Examples include;

1. **Structural adaptation to obtain food** e.g. a toad has a long tongue to catch its prey; birds have sharp, strong and curved claws for catching their prey; Insects have modified mouth parts for feeding; Insectivorous plants (e.g utricularia sp i.e. bladderwort, Droseria sp i.e. sundew, etc) have special structural adaptive features.
2. **Structural adaptation for escape and defence**. Escape adaptation can be grouped into camouflage (concealing ccolouration), individual and group responses e.g. caterpillars taking the colour of leaves. Defence adaptation may be inform of physical structure e.g. spines and shell, scales etc, chemical defence e. g. snakes attack their enemies by spitting venom, bees and scorpion have stings and mimicry (looking like an uninteresting objects) e. g. stone plant.
3. **Structural adaptation to attract mates**e.g. Adult male agama lizard displays its bright colour to attract its mates, flowering plants attract insects for pollination, bright coloured feathers of male domestic fowls and peacock etc.
4. **Structural adaptation to regulate body temperature** e.g. mammals have fat layer, sweat gland, feathers and subcutaneous fat in birds in birds etc. All serve to regulate heat loss.
5. **Structural adaptation for water conservation**: e.g. some plants have small needle like leaves (conifers), thick bark (acacia), waxy cuticles etc to reduce the rate of transpiration. Likewise some animals possess scales, exoskeleton, feathers etc. to reduce water loss.

EVALUATION

1. Give three examples of structural adaptation for obtaining food in animals.
2. Give five examples of structural adaptation for escape and defence in animals and plants.

GENERAL EVALUATION

Name_____ Date_____

1. Define the following terms a) adaptation b) competition c) succession
2. Discuss the relationship between competition and succession
3. Differentiate between inter-species and intra-species competition
4. Give two examples each of structural adaptation in animals and plants for i) obtaining food ii) attracting mates iii) water conservation

READING ASSIGNMENT

College Biology: - Chapter 27, page 591 – 604

WEEKEND ASSIGNMENT

1. The following are scarce resources competed for by plants except A. light B. space C. mate D. water
2. Possession of special feature by an organism to improve its chances of survival in its environment is referred to as A. competition B. adaptation C. succession D. shading
3. Which of these is not a structural adaptation for protection A. mimicry in stone plant B. sting in bees C. shell in tortoise D. bright colour in cock
4. The following except one are structural adaptation for obtaining food A. thick bark in acacia B. long sticky tongue in toad C. modified beaks in birds D. sucker in mistletoe
5. The following are structural adaptation for conserving water in plants except A. shell B. conifers C. thick bark D. waxy cuticles

THEORY

1. Classify birds based on their structural adaptation for obtaining food
2. Give five examples of structural adaptation for obtaining mates

WEEK FOUR
ADAPTIVE COLOURATION AND BEHAVIOURAL ADAPTATION

CONTENT

- Adaptive colouration in plants and animals and their functions
- Behavioural adaptation
- Social animals

ADAPTIVE COLOURATION

This is the possession by an organism of a colour which enables it to catch its prey, avoid its predators or enemies, secure mates and ensure their survival. Adaptive colouration may be grouped into

1. **Concealing (cryptic) colouration** to help organisms blend with their background and remain unnoticed by predators
   i. **Colour blending**with the environment e. g. green cuticles of grasshopper, green snakes etc.
   ii. **Counter shading** by animals possessing a dark dorsal surface and light ventral surface as in tilapia fish to remain unnoticed by predator above and below.
   iii. **Colour change(camouflague)**to match the environment as in chameleon, grasshopper etc.
   iv. **Disruptive colouration** as patterns to break the body outline of animals against the dark and light shades of their backgroung as in giraffe, leopard, tiger, lady bird beetle etc.

2. **Warning colouration** to announce the presence of the organism(s) to potential predator to avoid them because they have some unpleasant features e. g. variegated grasshoppers, black and yellow bands of wasps.
3. **Mating colouration** as in male agama lizard, peacock.
4. **Mimicry** in harmless organisms resembling a distasteful or harmful one for the enemies to avoid such e.g. stick insects, swallow tail butterfly.
5. **Bright colouration** of insect pollinated flowers and pitchers of insectivorous plants.

EVALUATION

1. Give five types of adaptive colouration in animals.
2. Give five examples of animals and their adaptive colouration

BEHAVIOURAL ADAPTATION:

Behaviour is basically adaptive, everything used by organisms to promote their survival. Examples include:

1. Behavioural adaptation in predators e.g. Lion with high speed chases its prey; spider spins its webs for its prey
2. Behavioural adaptation to protect prey from predators e.g bats hold tree branches with heads upside down (which is described as **swaying** in the air), Antelopes escape with speed, beetles secreate offensive odour, toad puffs itself up
3. Behaviuoral adaptation for avoiding harsh weather conditions e.g. **aestivation** i.e. passive period of existence. It is practiced by crocodiles; **Hibernation** i.e. sleep period to survive food scarcity or winter (low temperature) exhibited by insect-eating bats; **migration** of certain animals (e.g cattle egrets) to favourable habitats
4. Behavioural adaptation in plants: e.g some plants shed leaves in dry season (deciduous plants); some like yam tuber, potatoe die down and survive as underground stem; plant seeds can remain dormant, plant shoot moves towards light (Positive phototropism)
5. Gregarious behaviour (movement in groups) is expressed by elephants zebra, birds, fishes, social animals (bees, termites) etc.

EVALUATION

1. Define hibernation and aestivation
2. Give four examples of animals and their adaptation to escape from predators.

SOCIAL ANIMALS

Social animals are those in which individuals of the same species live together cooperatively in organized communities known as societies (colonies). Examples of social animals are: social insects (like termites, honey bees or wasps, ants etc), wolves, foxes, baboons etc.

Characteristics of Social Insects

1. They live together
2. They display division of labour
3. They show distinct castes
4. Members communicate with one another within the colony.

TERMITES

Habitats of termites: They are found living together in large communities in nest which may be tunnels in dead wood or ant hills (termitaria).

Note- Termites are blind: they communicate through touch and smell.

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Castes of termites:

They have three castes: The reproductive, soldiers, workers.

1. **The reproductive** are of three types: king, queen and winged reproductive. The king has no wing, is smaller than the queen and it fertilizes the queen. The queen has a small head, small thorase and large abdomen. It is the largest of all the castes. Only one queen at a time is found in a colony. The queen lays eggs. The winged reproductive are fertile and are potential kings and queens of new colonies.
2. **The soldiers** are sterile, wingless and blind. They have big heads with stony maxillae and mandibles. Soldiers are of two types: **(i)** The mandibulate soldiers with strong mandibles and **(ii)** Nasute soldiers with projective mouth paths. The soldiers defend the colony against enemies.
3. **The workers** are wingless, blind, and sterile. They form the majority in the colony and possess well developed mouth paths. They build and repair the termitaria; provide food for colonial members; look after the eggs laid by the queen and baby termites (nymphs).They feed the nymphs and the queen and cultivate fungus gardens.

Life history of termites

Termites exhibit incomplete metamorphosis i.e.

Egg ⟶ nymph ⟶ adults

The nymphs develop into soldiers and reproductive. And those which fail to develop become workers. When the winged reproductives are mature, they exhibit **nuptial or wedding flight** i.e. swarming out from the existing colony to build new ones.

Behavioural adaptation of termitesfor survival

1. They move in groups to ward off their enemies
2. They have a wide variety of diet; feeding on both living and dead plants.
3. They burrow into the soil or wood to build tunnels for protection against their enemies.
4. The habit of feeding on dead members helps to keep the colony clean.
5. Their ability of massive production of off springs promotes their survival.

Economic importance of termites

1. Termites while building their tunnels help in loosening and mixing the soil.
2. They decompose wooden materials as they feed.
3. They add humus to the soil through their decomposition activities.
4. They act as good source of protein and fat.
5. The ant hill clay can be used to build the surface of tennis court.

EVALUATION

1. Mention the three castes of termites and their functions.
2. What are the characteristics of social insects?

HONEY BEES

Habitat of Honey bees – These are social insects living in hives made up of chambers or cell.

Castes of honey bees

The bee colony has 3 castes, namely:

- The drone (in hundreds per colony)
- The queen (only in 1 per colony)
- The workers (in thousand per colony)

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1. **The drone** is the winged with shorter abdomen than the queen but bigger than the workers. The drone mates with the queen during the nuptial flight after which it dies.
2. **The queen** is a fertile female, winged and much bigger than the workers. It is fed with royal jelly and lays egg.
3. **The worker** is a sterile female, winged and is smaller than the queen or drone. It possesses eyes and a sting. Also with modified mouth paths for collecting nectar and building the hive. The workers legs are also modified for collecting pollen grains from flowers. The workers perform a special dance called rail wagging as it locates a food source. The workers secrete wax for building the hive, ventilate the hive and clean the cells, guard the hive, make honey from nectar and pollens and feed the larvae with royal jelly or honey.

Economic importance of honey bees

1. They help to pollinate flowers.
2. They produce honey which has high nutritive and medicinal value.

EVALUATION

1. What is tail wagging in a beehive community?
2. Mention two economic importance of honey bees.

GENERAL EVALUATION

1. Use snakes and flowering plants to describe structural adaptation.
2. Illustrate adaptive colouration using two examples each for plants and animals.
3. Use aestivation, hibernation and migration to describe bahavioural adaptation.
4. What are social animals? State two attributes of social animals
5. State the castes involved in a termite community
6. State the three types of reproductives present in a typical termitarium
7. What is nuptial flight?Which caste undergoes nuptial flight?
8. State three ways by which termites are relevant to life in the society.
9. State the castes involved in a beehive and their roles.
10. What is tail waggling? Which caste performs tail waggling?

READING ASSIGNMENT

College Biology chapter 16, page 361 - 366

WEEKEND ASSIGNMENT

1. The following except one are behavioural adaptation mode to avoid harsh weather condition A. aestivation B. swaying C. hibernation D. migration
2. Concealing colouration exhibited by some organisms to remain unnoticed is referred to as A. mimicry B. hibernation C. camouflage D. wagging
3. The following except one are social animals A. fowl B. honey bee C. ants D. wolves
4. What king it to a termitatium is what _____ is to a beehive
5. Which of these group of animals does not exhibit gregarious behaviourA. termites B. lions C. zebras D. snakes

THEORY

1. State the roles of the castes found in: (a) a termitarium (b) a beehive
2. Differentiate between aestivation and hibernation.

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WEEK FIVE

THEORIES OF EVOLUTION

CONTENT

- Organic evolution
- Evidences of evolution
- Lamarck's theory
- Darwin's theory
- Modern theories

ORGANIC EVOLUTION

Organic evolution is the sum total of adaptive changes from pre–existing or old forms that has taken place over a long time resulting in diversity of forms, structures and functions among organism. The basis of evolution is that all organisms have pre–existing ancestors.

Evidences of evolution

1. **Fossil record:** A fossil is an impression of a plant or an animal that lived a very long time ago. The age of fossil is determined using radioisotope dating. Fossils are normally preserved in sedimentary rocks. Depending on the source, fossil records can be referred to as geological or paleontological or archaeological or historical record.
2. **Geographical distribution:** Based on the effect of climate on all living things, variations in their forms, structures and functions can occur. After several years of isolation, organisms of one climate tend to differ slightly from organisms of another climate.
3. **Comparative anatomy:** Evolution is obvious in anatomical comparison of vertebrates. The Pisces or fishes have simple heart with one auricle and one ventricle. The amphibians have two auricles and one ventricle. Reptiles have two auricles and a partially divided ventricle. Aves and mammals have two auricles and two ventricles.
4. **Embryological evidence:** The embryo of man in the womb at different stages of development resembles the embryo of fish, amphibians and reptiles.
5. **Evidence of vestigial organ:** Vestigial organs are minute and incomplete organs that have no special function. Evolutionarily, these organs are believed to be once functioning e.g. appendix and rudimentary tail in man.
6. **Evidence from domesticated animals:** These include cats, dogs, hensetc which live with humans for many years.

EVALUATION

1. What is organic evolution?
2. State five evidence of organic evolution.

THEORIES OF EVOLUTION

There are three prominent theories

1. **Jean Lamarck's theories of use and disuse** which states that
   a. Changes in the environment lead to changes in the species of organism.
   b. The changes cause the organisms to form new structures or habits to adapt to environmental changes.
   c. The organisms then develop specialized characters by use and disuse of organs.
   d. Frequently used organs become well developed and the unused ones degenerate or become useless.
   e. The well developed or dominantly acquired characters are inheritable.

Lamarck's theory is unacceptable to modern scientists who have proved that only characters represented on genes are inheritable not physical ones got through use and disuse.

2. **Charles Darwin's theory of natural selection (survival of the fittest)** which states that
   a. Species of organisms can produce large number of offspring to the environment with limited resources.
   b. This then results in competition among the offspring.
   c. The survivors must have inherited the useful traits which are passed on to the offspring at reproduction.
   d. Those that could not survive the competition die off. As the population gradually becomes better adapted to the environment, new species emerge.

This theory is widely acceptable to many scientists till date.

NOTE: Both Lamarck and Darwin recognized the importance of environment.

3. **Modern theories of evolution:** Based on the combination of natural selection (Darwin's) and genetic origin of variation. This theory states that:
   a. There exist variations in the species population.
   b. Some of the variations have special survival advantages.
   c. Individuals with favourable variations are more adaptive to their environment than others.
   d. The individuals have to struggle for existence inthe environment.
   e. The fittest contribute more offspring to the next generation than the unfit ones.
   f. The main causes of variations are mutation and recombination of genes.

Roles of mutation in evolution

Mutation is a sudden change in DNA structure leading to a change in the phenotype of the species concerned. When mutation occurs in the gene of gametes, it leads to production of new species.

EVALUATION

1. Differentiate between Lamarck's and Darwin's theories of evolution.
2. Why is Lamarck's theory unacceptable to modern scientists?

GENERAL EVALUATION

1. What is organic evolution?
2. Describe three of the evidences of evolution.
3. State the three theories of evolution
4. What is the disadvantage of Lamarck's theory of evolution?

READING ASSIGNMENT

College Biology, chapter 26, page 579 – 589

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WEEKEND ASSIGNMENT

1. The sum total of adaptive changes from pre-existing forms that has taken place over a long time to form diverse organisms is called ----------
2. The environment plays most active roles in the following theories except A.theory of use & disuse B. theory of natural selection C. modern theory of evolution D. Jean Lamarck's theory.
3. A sudden change in DNA structure leading to a change in the phenotype of a species is known as A. adaptation B. mutation C. evolution D. competition
4. Which of these is not a vestigial organ in animals A. rudiment tail in man B. appendix C. clitoris in woman D. wings in birds
5. Jean Lamarck's theory of use and disuse was not accepted because A. only characters on genes are inheritable not physical ones B. it fails to recognize the importance of environment C. individual have to struggle for existence D. it recognizes the importance of environment

THEORY

1. Differentiate between Jean Lamarck's and Darwin's theories of evolution
2. Use plants and animals to explain evolutionary trends in organisms.

WEEK SIX
BIOLOGY OF HEREDITARY AND VARIATION (GENETICS)

CONTENT

- Definitions of genetic terms
- Hereditary variationand causes of variation
- Transmittable / transmissible characters
- How characters get transmitted
- Mendel's work in genetics

DEFINITIONS OF GENETIC TERMS

Genetics is the scientific study of heredity and variation in all living things. The word genetics was coined by Dilliam Bateson (1906).

Hereditary/Inheritance is the transmission and expression of characters or traits from parents to offspring. It accounts for the usual resemblance between a parent and its offspring.

Variation isthe differences which exist between parents and offspring and among the offspring.

Genes are hereditary or basic units of inheritance located in chromosomes and responsible for the transmission of characters from parents to offspring. The hereditary units were named genes by Johannsen in 1909.

Chromosomes are rod or thread like bodies found in the nucleus of a cell which house the genes.

Characters are inheritable features possessed by an organism e.g height, complexion, colour etc.

Gamete is a mature sex cell which takes part in sexual reproduction. If is of two types male and female gamete e.g pollen grains and ovules in plants, sperms and ova in man. Gamete is usually haploid.

Zygote is a single cell formed as a result of the union of male and female gamete. It is diploid.

Allelomorphs (alleles) are pairs of genes on a particular position of chromosomes. They control contrasting characters.

Locus is the site or location of a gene in the chromosome.

Genotype is the sum total of the genes or the genetic make up of an individual inherited from both parents. It includes both dominant and recessive traits.

Phenotype is the sum total of all observable features of an organism. It includes the physical, physiological and behavioural traits e.g. height, skin colour etc.

Dominant trait is expressed in an offspring when two individuals with contrasting characters are crossed. Dominant trait is controlled by dominant gene e.gTt

Recessive trait is masked, with no effect in the presence of a dominant character. This trait is controlled by a recessive gene

Homozygous is when an individual has two similar genes for the same character i.e. the individual has two identical alleles at a locus as a pair of chromosomes e.g. TT, tt.

Heterozygous is when an individual has different or contrasting alleles located on the locus as a pair of chromosomes e.g. Tt.

Filial generation is made up of offspring of parents. The generations are represented as F1, F2, F3, e.t.c one giving rise to the other.

Hybrid is an offspring from a cross between parents that are genetically different but of the same specie.

Hybridization is the crossing of plants with contrasting characters. This can be monohybridization (i.e. two pure traits crossed) or dihybridization (two pairs of contrasting characters crossed).

Haploid is when an organism has one set of chromosomes in the gamete (23 in number). It is represented by small letter n.

Diploid is when an organism has two sets of chromosomes in the body cell (46 in number). It is represented by 2n.

Mutation is the change in the genetic makeup of an organism resulting in a new inheritable characteristic.

EVALUATION

1. Define the following terms a) Hereditary b) Variation c) alleles d) locus
2. Differentiate between a) genotype and phenotype b) Homozygous and Heterozygous being.

HEREDITARY VARIATION AND CAUSES

Hereditary variation is the differences among individuals which can be passed from the parents to their offspring (progenies).

NOTE: No two offspring inherit exactly the same set of characteristics from parents except in identical twins. Hereditary variation arises because of

a. Genetic reshuffling during meiosis due to independent assortment and segregation before the final combination results in a totally new individual
b. Crossing over during meiosis, the chromatids get in contact with powder at the prophase stage of cell division. The homologous chromosomes break and rejoin at a point called **chiasma.** This results in crossing over of genetic materials hence, variation in the off spring.

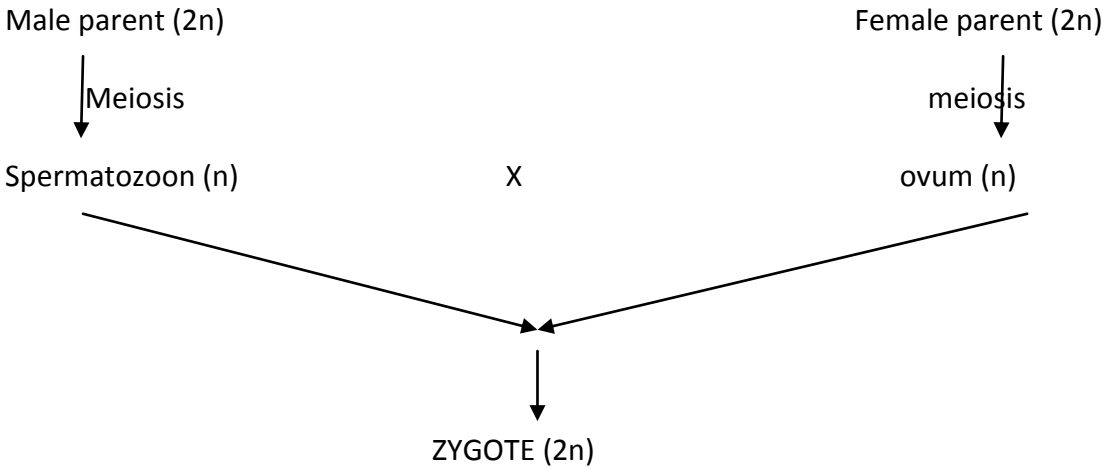
Transmittable characters in animals

These include: body stature, shape or size of the head, nose and ear, colour of skin, hair colour, eye colour, intelligence, height, and characteristic voice of speech, blood group,

baldness, tongue rolling, sickle cell anaemia, haemophilia, colour blindness, finger prints and ability to taste phenylthiocarbamide (PTC)

Transmittable characters in plants
These include height, weight or shape of plants, its fruit, leaf, fruit taste, food content, colour of leaf or flower, fruit or seed, resistance to environmental factors like disease, pest and wind, leaf texture, life span etc.

How characters get transmitted
Only characters controlled by genes are transmissible. Diploid organisms produce gametes by meiosis in their reproductive organs, therefore the male gamete (sperm cell) and the female gamete (ovum) are haploid organisms containing one set of chromosomes in their cell (one copy of each gene from homologous pair.
When fertilization takes place during sexual reproduction, the gametes (spermatozoon and ovum) fuses together to form a zygote.
Each zygote is a diploid organism having two set of chromosomes. Hence two copies of each gene (a copy donated by each gamete)



Hence, characters determined by genes are transmitted from parents to offspring through gamete
EVALUATION

1. Mention five transmittable characters each in plants and animals.
2. Discuss briefly how characters get transmitted in organisms

MENDEL'S WORK IN GENETICS
In the study of genetics, Gregor Mendel (1866) worked with the garden pea (**Pisumsativum**) because of three unique properties present in it. These are

1. Peas are self pollinating
2. They have a very short lifespan
3. They have several unique genetic characteristics e.g round or wrinkled seeds, tallness or shortness, seeds /pods/ flowers colouration, pod texture etc.

The Mendel's methods of studying genetics are two:

a. Monohybrid inheritance
b. Dihybrid inheritance

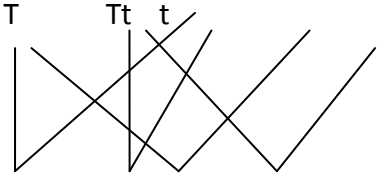
Monohybrid inheritance
Mendel crossed two different plants which differ in one pair of contrasting characters e.g. tall and short plants. The procedures he followed are as follows:

a. He planted tall plants for several generations and got all tall plant offspring. Likewise, the short plants he planted yielded all short plant offspring.
b. He then planted tall and short plants. When the flowers were produced, he cross pollinated the pollen grains (male gamete) of the tall plant with the stigma (female gamete) of the short plant.
c. He then planted the seeds of the cross in the procedure (ii) above and obtained all tall plants. This he called the first filial generation(F1,)
d. He then crossed the F1 plants, collected their seeds and sowed them. He got tall and short plant in ratio 3: 1. This he called second filial generation (F2)

Diagrammatically:

Parents' genotypes: TT x tt
(Tall plant) (Short plant)

Gametes: T Tt t

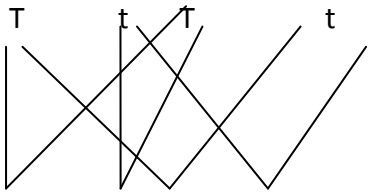


F1 :

TtTtTtTt (All tall)

Self pollinating: Tt x Tt

T t T t



F2 :

TT TtTttt

Genotypic ratio (GR) => 1: 2: 1
Phenotype ratio (PR) => 3: 1

This experiment resulted into Mendel's first law of inheritance which is based on the principle of complete dominance.

Mendel's first law of inheritance otherwise known as the **law of segregation of genes** states that paired alleles segregate from each other when the homologous chromosomes on which they reside separate during meiosis. Each gamete receives one of the two alleles. The actual segregation occurs in F2 generation.

EVALUATION

1. State three reasons why Gregor Mendel used Pisumsativum for his experiments on genetics.
2. State Mendel's first law of inheritance.

DIHYBRID INHERITANCE

Gregor Mendel crossed plants which differ in two pairs of contrasting characteristics e.g seed shape (round or wrinkled seeds) and seed colour (yellow or green seeds). He crossed plants having round and yellow seeds with these having wrinkled and green seeds. The F1 seeds were having round and yellow seeds. Self pollinating F1 plants produced the F2 plants of four (4) types

i. Round and yellow seeds : 9

ii. Wrinkled and yellow seeds : 3
iii. Round and green seeds : 3
iv. Wrinkled and green seeds : 1

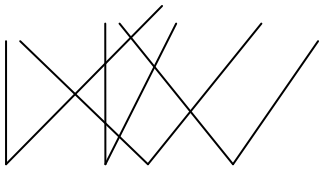
This experiment resulted into Mendel's second law of inheritance

Mendel's second law of inheritance otherwise known as **law of independent assortment of genes** state that alleles of genes on different chromosomes assort independently during meiosis

Diagrammatically:

Parents' genotypes: RYRY X ryry
(Round yellow seed) (Wrinkled green seed)

Gametes: RY RYry ry



F1: RYryRYryRYryRYry (all round yellow)

Self pollinating:

RYry x RYry
RY rY Ry ry

	RY	Ry	Ry	Ry
RY	(1) RYRY	(2) RYrY	(3) RYRy	(4) RYry
rY	(5) RYrY	(6) rYrY	(7) RyrY	(8) rYry
Ry	(9) RYRy	(10) RyrY	(11) RyRy	(12) Ryry
Ry	(13) RYry	(14) RYry	(15) Ryry	(16) ryry

Round and yellow seeds: (1), (2), (3), (4), (5), (7), (9), (10), (13) : 9
Wrinkled and yellow seeds: (6), (8), (14) : 3
Round and green seeds: (11), (12), (15) : 3
Wrinkled and green seeds: (16) : 1

EVALUATION

1. State the phenotypic ratios of F2 generation offspring of monohybrid inheritance and dihybrid inheritance.
2. State Mendel's second law of inheritance.

DETERMINATION OF THE GENOTYPE OF A DOMINANT PHENOTYPE

A dominant phenotype has the genotypic patterns RR, Rr. The genotype is determined using test cross or back cross

Test cross is the crossing of an organisms with an homologous recessive organism

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Back cross is the crossing of an organism with an homologous recessive organism from the original parental generation

PRINCIPLE OF INCOMPLETE DOMINANCE

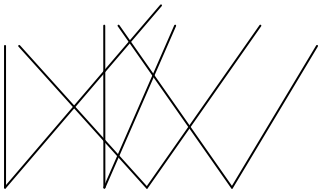
This deal with the ability of two contrasting alleles to interact and produce a heterozygous phenotype that is different from the two homologous phenotypes: Examples of organisms exhibiting incomplete dominance include: Mirabilisjalapa,4 o'clock plant, Audlausian fowl. This principle opposes Mendel's principle of complete dominance.

Diagrammatically:

Parent genotypes: RR X rr

Phenotypes: (red flower) (white flower

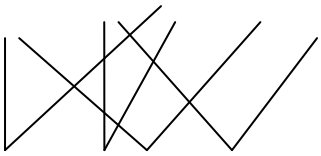
Gametes: R Rrr



RrRr Rr Rr (All pink flowers)

Self pollinating: Rr x Rr

R rRr



RR RrRr rr

Red Pink White

PR = GR = 1: 2: 1

CO – DOMINANCE

In co-dominance both alleles in the heterozygous individuals are fully expressed. The effect of one is not modified by the presence of the other. Therefore, three distinct phenotypes are produced e.g Inheritance of human "ABO" blood group

Genotype	**Phenotype (Blood group)**
1^A1^A or	Group A
$1^A\ 1^O$	
1^B1^Bor	Group B
$1^B\ 1^O$	
$1^A\ 1^B$	Group AB
1^O1^O	Group O

Allele 1^A implies the addition of antigen A to the cell surfaces of red blood cells resulting in a person with group A blood. Likewise Allele 1^B implies the addition of antigen B to the cell surfaces of red blood cells resulting in a person with Group B.

In a heterozygous individual, ($1^A\ 1^B$) both antigens A and B are added to the cell surfaces of red blood cells. So the individual has blood group AB.

NOTE: 1^A and 1^B are co-dominants while $1^O$is recessive.

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Multiple alleles

Genes that have more than two alleles in the population are said to have multiple alleles e.g. the human 'ABO' blood grouping

EVALUATION

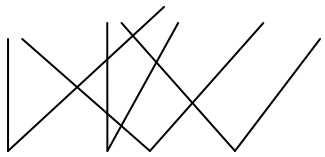
1. How can the genotype of a dominant phenotype be determined?
2. Use blood group 'ABO' to explain co-dominance.

Sex determination in human beings

Each body cell of human beings has 23 pairs (46) of chromosomes, 22 of which are autosomes and a pair is sex chromosome. In male the two sex chromosomes in each body cell are X and Y chromosomes, therefore, each male gamete carries either X or Y chromosome. In the female, all egg cells of the body contain two X chromosomes. Therefore all egg cells contain one X chromosomes each. At fertilization, the combinations of an egg with a sperm carrying either X or Y chromosome occurs by **chance**. The formation of a male or female offspring has equal chances as shown below parents:

XY x XX

Gametes: X Y X X



XX XX XY XY 50: 50

GR = PR = 1: 1

Genotype	Phenotype
(1) 2XX	Girls
(2) 2XY	Boys.

GENERAL EVALUATION

1. Define the two terms involved in the definition of genetics
2. Differentiate between gamete and zygote
3. Define (a) genotype (b) phenotype (c) alleles
4. What is a hybrid?
5. Differentiate between haploid and diploid organisms
6. State Mendel's first and second law of inheritance.
7. Diagramatically illustrate the principle of incomplete dominance.
8. Using 'ABO' blood group, describe the principle of co-dominance.
9. Carry out the genetic crossing up to F2 generation of the following :
   a. Group A and group O parents.
   b. Group B and group O parents.
   c. Group AB and group O parents.

READING ASSIGNMENT

College Biology, chapter 18, page 409 – 428.

WEEKEND ASSIGNMENT

1. The reasons why GregorMondel used pea **PisumSativum**include these except (a) the plant is self pollinating (b) the plant has long life span (c) the plant has many unique properties or characteristics (d) the plant has short life span.

2. The laws of Mendel are based on the principles of (a) co-dominance (b) incomplete dominance (c) complete dominance (d) non dominance
3. The genotype ratio and phenotypic ratio in incomplete dominances. (a)3:1 (b) 1:2:1 (c) 1:3.(d) 2:1
4. The chances of having a male or female child in human is (a) 25% (b) 50% (c) 75% (d) 60%
5. What is genetically common to 4'0 clock plant and Andlausian fowl is (a) co-dominance (b) incomplete dominance (c) complete dominance (d) non dominance.

THEORY

1. State Gregor Mendel's first & second law
2. Use human 'ABO' blood group to explain co-dominance.

WEEK SEVEN
CHROMOSOME: THE BASIS OF HEREDITARY

CONTENT

- Location and structure of chromosome
- Role of chromosome in transmission of hereditary characters.
- Processes of transmission of hereditary characters by chromosomes.
- Probability in genetics
- Application of the principles of hereditary in agriculture and medicine

LOCATION AND STRUCTURE OF CHROMOSOMES

Chromatin granules (thread – like structures) found in the nucleus of eucaryotic cells are the precursors or raw materials of chromosomes.

Chromosomes occur in pairs known as homologous chromosomes. Each chromosome is made up of two threads called chromatids joined at a point called centromere. Each human somatic cell has 46 chromosomes. These are present in 23 pairs of homologous chromosomes. The number of chromosomes in each somatic cell of an organism is called diploid number (2n).

Each chromosome is made up of protein units in a strand of deoxyribonucleic acid, DNA (in double helix). Along its length are genes arranged which are actually DNA segments. The DNA is a very large molecule made up of repeating units called nucleotides. Each nucleotide is made up of deoxyribose (a sugar molecule), phosphate and an organic nitrogenous base which may be **adenine, guanine, thymine or cytosine.** Guanine always pairs with cytosine and adenine with thymine. The two helical chains are referred to as complementary strands of DNA since one is the exact opposite of the other.

Sex chromosomes and autosomes

There are forty-four autosomes which are similar in shape and size in both male and female. The last pair is called sex chromosome which are of genotype XX in female and XY in male. Exception to this is in birds, moths and butterfly where the female has genotype XY and the male XX. Also, in certain grasshoppers, the Y chromosome is absent so that the male has the genotype XO.

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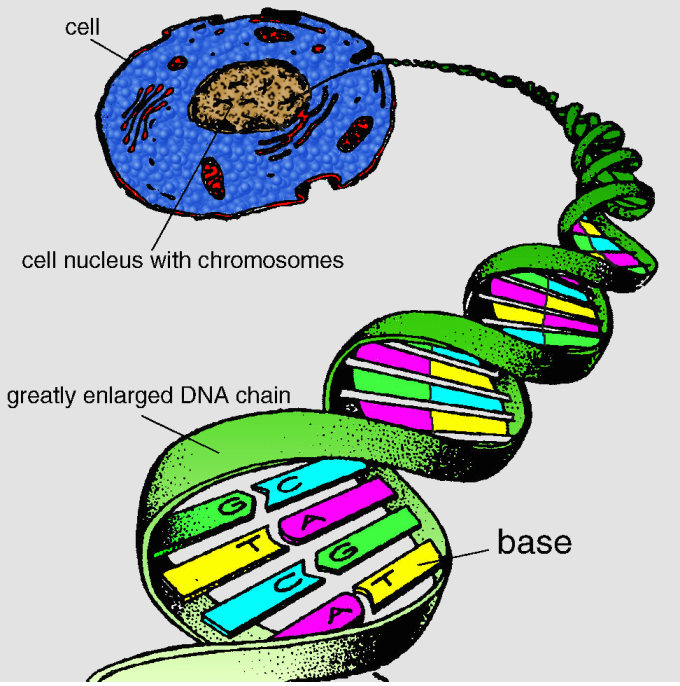
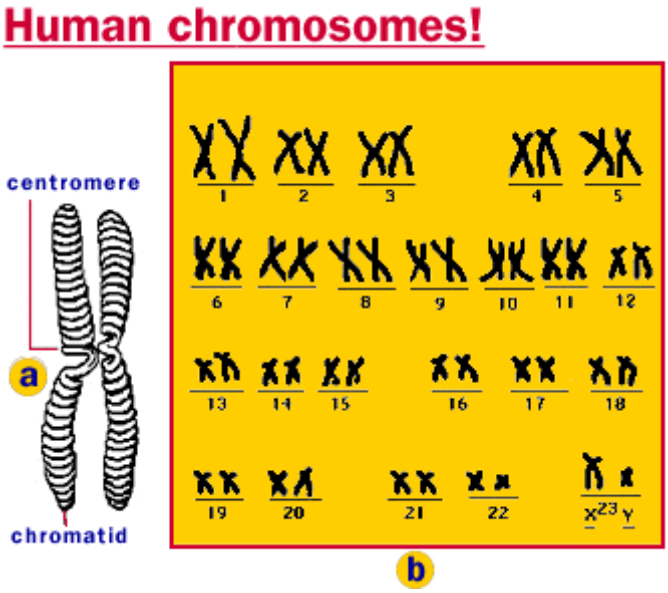
Just before cell division, the protein bundles come together and the DNA strands coil tightly around them, causing the chains to shorten and become visible under the light microscope. This process is called condensation

Each DNA molecule is made up of thousands of genes. The DNA molecules coil around the 23 pairs of chromosomes. In human body cells are about 50,000 genes. Each DNA molecule can make an exact copy of itself in a process called **replication**. This forms the basis for the transmission of hereditary materials from parents to the offspring.





ROLE OF CHROMOSOME IN TRANSMISSION OF HEREDITARY CHARACTERS

Genes are the expression of hereditary characters in organisms and are located on the chromosomes of a body cells. Therefore chromosomes are responsible for the transmission of characters from parents to offspring. Chromosomes are arranged in pairs known as homologous chromosomes (exactly alike in shape and size and carry genes responsible for the transmission of the same characteristics). The genes relating to the same character e. g. tallness and shortness occupy identical loci on the homologous pair. The genes on

homologous pair of chromosomes determine whether the individual will be homozygous or heterozygous for certain characters.

PROCESSES OF TRANSMISSION OF HEREDITARY CHARACTERS BY CHROMOSOMES

i. The chromosomes pass the genes into the gamete during meiosis.
ii. Homologous chromosome separate into two daughter cells during the first stage of meiosis.
iii. The two chromatids of each chromosome separate during the second stage of meiosis. Each gamete therefore has one set of chromosomes hence one copy of genes.
iv. During fertilization, the gametes fuse together to form a zygote. The zygote receives two genes for the same character (one from one chromosome in the egg and the other from one chromosome in the sperm).
v. When the two genes are the same, the offspring is a homozygous but when they are different, the offspring is a heterozygous (hybrid).

EVALUATION

1. Define chromosome and describe its structure.
2. Differentiate between chromosomes and autosomes.

SEX-LINKED TRAITS

Sex–linked traits are characteristics whose genes are carried on the X chromosome of the sex chromosomes instead of autosomes. Such genes are inherited along with such X chromosomes. They are all controlled by a recessive gene. Examples of Sex-linked traits are: colour blindness, haemophilia, baldness, sickle cell anaemia and albinism.

1. **Colour blindness:** A colour blind person cannot distinguish near colours. It is an abnormality of the gene that controls the production of cone cells (light receptors) in the retina of the eye.
2. **Haemophilia:** This is a disorder in which bleeding takes an abnormally long time to stop or fails to stop because blood clotting will not occur. In haemophiliac (the victim) small injuries can result to bleeding to death e.g. Queen Victoria's lineage (gene for haemophilia arose as a mutation in Queen Victoria or one of her parents) in British Royal Family.
3. **Baldness:** The recessive gene controlling this trait causes the hair on the upper part of the head to pull out prematurely. It is more common in male human beings.
4. **Albinism:** This is the condition in which the skin of an animal is non – pigmented because of lack of the pigment called melanin.
5. **Sickle cell anaemia:** The recessive gene controlling this abnormality causes some of the red blood cells to be sickle shaped. The haemoglobin of the affected red blood cells is abnormally shaped thereby making it inefficient in transporting oxygen. In a condition of low oxygen concentration, the haemoglobin breaks down causing the cells to be sickle shaped. This then leads to the blockage of the cavities of the small blood vessels in the body thus hindering free flow of blood. The body part affected receives lower blood, oxygen and nutrients. Therefore, the victim goes into crisis at such periods characterized by pains in the bones and joints.

PROBABILITY IN GENETICS

Probability is usually expressed in units ranging from 0 – 1. Mendel's works were based on probability.

Mathematically,

$$\text{Probability} = \frac{\text{No of times an event occurs}}{\text{Total no of trials}}$$

The two guiding principles of probability in genetics are:

3. The result of one trial of a chanced event does not affect the result of latter trials of the same event.
4. The chance that two independent events will occur together simultaneously is the product of their chances of occurring separately.

APPLICATIONS OF THE PRINCIPLES OF HEREDITARY

In **agriculture**, genetics is relevant and has led to the following:

1. Cross fertilization &self-fertilization procedures
2. Development of early maturing varieties of organisms.
3. Development of disease–resistant varieties of organisms.
4. Production of crops and animals that can adapt to climatic conditions.
5. Improvement of quality and quantity of product

In **medicine**, genetics helps in the following:

1. Determination of paternity of a child.
2. Blood transfusion
3. Diagnosis of diseases
4. Sex determination
5. Marriage counseling to avoid cases of genetic disorder.
6. Knowing and choosing the sex of a baby.
7. Development of test tubes babies.

NOTE: All the applications listed above sum up the relevance of biology to life in what is now termed biotechnology. In biotechnology the DNA is now being manipulated to the benefits of humanity i.e. genetic engineering

EVALUATION

1. Give five examples of sex-linked traits in human beings.
2. State five applications of genetics in medicine.

GENERAL EVALUATION

1. What is a chromosome
2. Differentiate between chromosomes and autosomes
3. Describe the structure of a chromosome.
4. Define condensation and replication in chromosomes.
5. What is the role of chromosome in transmission of hereditary characters?
6. State five application of genetics in medicine and agriculture
7. What is the probability of sickle cell anaemic children resulting from two parents with genotypes i) AA and AS OR Hb^AHb^A and Hb^AHb^S
   ii) AS and AS OR Hb^AHb^S and Hb^AHb^S

READING ASSIGNMENT

College Biology chapter 18, page 410 – 412

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WEEKEND ASSIGNMENT

1. The basic hereditary unit is the ---------- (a) cell (b) nerve (c) gene (d) nucleus
2. In man there are ---------- autosomes and ---------- sex chromosomes (a) 46:2 (b) 44:2 (c) 44:1 (d) 45:1
3. The manipulation of DNA molecules for the benefit of humanity is known as a) Genetic b) Biotechnology c) Hereditary d) Bioremediation
4. A condition in which bleeding take an abnormally long time to stop or fail to stop in a person is known as a) anaemia b) sickle cell c) haemophilia d) albinism
5. What is the probability that a male and a female that are carriers of albino gene will have albino offspring a) ¼ b) ½ c) ¾ d) 1

THEORY

1. What are sex-linked traits? Give five examples
2. Explain how blood group can be used to determine the paternity of a child.