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Theme: Genetics

S4 New Curriculum Biology-Chapter 5– Variation and selection



Variation

The term variation describes the differences in characteristics shown by organism belonging to the same natural population or species.

Causes of variation

- (i) Sexual reproduction: Male and female gametes from parents carrying different characteristics fuse randomly during fertilization to form a zygote. During the random fusion, the resultant offspring might end up with genetic compositions that are different from that of its parent.
- (ii) Genetic mutation: Mutations are sudden changes in the gene. These changes normally alter the original structure of DNA. When passed onto an offspring, the altered genes will give an organism that is different from the parents.
- (iii) Environmental conditions: These are external conditions that may favour or hinder the expression of certain gene or genes in an individual or increase attractiveness certain individuals to opposite sex. For example cosmetics, food temperature or light.

Types of variation

1. **Continuous variation.** Variation is said to be continuous when there is a **gradual change** of character from one individual to another e.g. skin color, length of leaves, and height of individuals. i.e. it is quantitative.
2. **Discontinuous variation.** In discontinuous variation, there is a **clear – cut difference** between the characteristics, for example:
 - (i) Man discontinuous variations include blood groups, tongue- rolling, sex (male or female), finger print pattern, blood groups, etc.

Tongue rolling

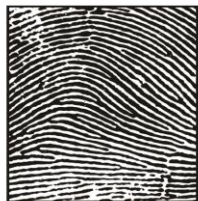


Tongue roller



Non-tongue roller

Basic fingerprint types



Arch



Whorl



Loop



Albino



Female

Male

- (ii) Animals discontinuous variations include sex (male or female), presence or absence of horns in cow, hair colour in cows (Black , white brown)
Discontinuous characteristics in animals



Male and female cattle

Horned and hornless cattle

- (iii) In plants discontinuous variation include venation (parallel or network), length of internodes in peas, flower colours in garden pea (red or white) flower types in paw paws (male or female)



Parallel and network veins



Female and male pawpaw flowers

Genetic mutations

These are sudden changes in the structure and amount of DNA. They can occur in chromosomes or genes. They usually result in genetic disorders

Mutations that occur in chromosomes are called **chromosomal mutations** while those that occur in gene are called **gene mutations**. Substances such as UV rays, X-rays, extreme heat and chemicals that cause mutation are called **mutagens**. Individuals with defects caused by mutation are called **mutants**.

Beneficial Effects of mutation in Man include resistance to diseases such as HIV, bone density, resistance malaria (sickle cell trait).

Harmful effects of mutation in man include sickle cell anaemia, albinism, haemophilia, turner's syndrome, down's syndrome.

Beneficial mutation in crops

Mutations in crops can lead to improved traits such as higher yields, enhanced resistance to pests and diseases, better tolerance to environmental stresses, and improved nutritional content

Evolution

It is a gradual change of species from simple life forms to more complex life forms over a long period of time. This theory was first put forward by an English biologist Charles Darwin from his finding published in his book called **Origin of species**.

Natural selection

Darwin and Wallace proposed natural selection as the mechanism by which new species arise from pre-existing species based on three observations and two deductions which may be summarized as follows:

Observation 1; Individuals within a population have a great reproduction potential, e.g., American oyster produces 10 eggs per season.

Observation 2; The number of individual in a population remain approximately constant.

Deduction 1; Many individuals fail to survive or reproduce. There is a '**struggle for existence**' with the population

Observation 3. Variations exists within all populations.

Deduction 2: In the 'struggle for existence' those individuals showing variation best adapted to their environment have a 'reproductive advantage' and produce more off spring than less adapted organism.

Natural Selection is the process by which those organisms which appear physically, physiologically and behaviourally well adapted to the environment survive and reproduce. They pass on their successful characteristic to the next generation while the less adapted die.

Therefore, selection can be seen to operate through the process of differential mortality and differential reproduction potential. Selection has an adaptive significance in perpetuating those characteristics most likely to ensure survival of the species and depends upon the existence of phenotypic variation with the population.

Importance of natural selection

- organisms that are best adapted to a particular environment are allowed to survive and reproduce
- Population size of a given environment is regulated to supportable limit.
- Undesirable genes are eliminated from a population
- Leads constant improvement of the population to better species

Speciation

Speciation is the process by which one or more species arise from previously existing species.

Artificial selection

It is a process whereby breeders' animals and plants select individuals with favourable characteristics and allow them to interbreed while individuals lacking the desired qualities are prevented from breeding. By rigorous selection over many generations special breeds or varieties may be developed for particular purposes.

Animals that have been subjected to artificial selection include.

- cow for beef and/or milk
- Sheep for wool and/or meat
- horse for racing and holding
- pig for bacon or lard production
- dog for beauty

Among plants crops such as wheat, barley and potatoes, have been bred for higher yield, greater resistance to disease and drought.

Inbreeding: This is the crossing of closely related individuals. Inbreeding leads to a loss of fitness known as inbreeding depression. This is because an individual produced as a result of the crossing of close relatives is more likely to have two copies of harmful or even lethal recessive alleles.

Hybrid: It is the result of a cross between individuals belonging to two different varieties [outbreeding] such individuals show hybrid vigour. This is because a hybrid tends to be heterozygous at many of their loci. Any harmful allele therefore has its effect masked by healthy ones.

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