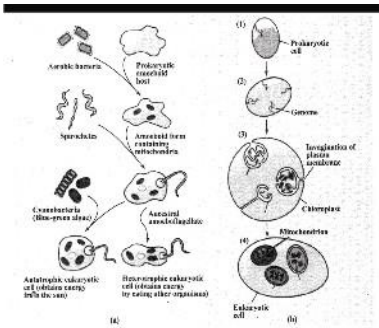

Chapter 24 Evolution

24.0 INTRODUCTION

Questions of origins of earth and life on it have been on the minds of humans since prehistoric times. Many of us are also concerned with questions of origin.

- How old is the planet earth?
- How long has life been on earth?
- How did life arise on earth?
- How did a certain animal species come into existence?

Answers for these questions come from scientific inquiry. In this chapter we will study some aspects of organic evolution.

Definition

Evolution refers to the processes that have transformed life on earth from its earliest forms to the vast diversity that we observe today.

Explanation

- Evolutionary change is based mainly on the interactions between populations of organisms and their environments.
- Whenever we say or hear the word evolution, name of Darwin comes in our mind immediately.
- In fact, he was the first person who argued from evidence that species were not specially created in their present forms rather they had evolved from ancestral species.

He also proposed a mechanism for evolution, which he termed **Natural Selection.**

24.1 CONCEPT OF EVOLUTION VS SPECIAL CREATION

In the earlier 19th century, there were two schools of thoughts.

1) Creationists believed on theory of **Special Creation.**

2) Evolutionists believed on theory of **Natural Selection.**

1) Theory of Special Creation

According to this theory, all living things came into existence in their present forms especially and specifically created by nature. Among the scientists who believed in divine creation was Carolus Linnaeus (1701-1778). Carolus Linnaeus in the eighteenth century classified organisms. He grouped similar species in the same genus and similar genera in one family. But as a natural theologian, he believed that species were permanent creations. Carlous Linnaeus was one of the believers of this theory.

2) **Theory of Natural Selection**

According to this theory, organisms evolved through time, with one type of organism giving rise to another type of organism.

It is ancient one starting from days of Aristotle to Darwin.

However, the present-day concept of evolution is based on history.

Scientist's Name	Life Span	Achievements
Linnaeus	1707-1778	Order in diversity of life, binomial nomenclature
Lamarck	1744-1829	Theory of evolution
Malthus	1766-1834	Essay on 'Principle of Population'.
Cuvier	1769-1832	Science of Palaeontology, earth's history by catastrophism.
Lyell	1797-1875	Principles of Geology
Darwin	1809-1882	1. Voyage of Beagle. 2. Books on origin of species. 3. Essay on origin of species.
Mendel	1822-1884	Papers on inheritance
Wallace	1823-1913	Sent his theory to Darwin

24.2 EVOLUTION FROM PROKARYOTES TO EUKARYOTES

Different speculations about the origin of first life form and evolution of prokaryotes into eukaryotes are mentioned briefly.

1) Vent Hypothesis

Origin of First Life Form

According to one concept, life may have originated in the oceans, in underwater hot springs called hydrothermal vents. These vents could have supplied the energy and raw materials for the origin and survival of early life forms.

Archaebacteria are considered as first life form, which support this vent hypothesis because they can tolerate temperature upto 120ºC and undergone less evolutionary changes than any other living species.

As bacteria are prokaryotes, so prokaryotes are considered as first life form on earth.

2) Evolution of Photosynthetic Organisms

Nutrients produced in primitive environment would have limited early life. Photosynthesis, another source of nutrients, probably freed living organisms from a dwindling supply of nutrients.

- First photosynthetic organisms probably used hydrogen sulfide as a source of hydrogen for reducing carbon dioxide to sugars.
- Later water served this same purpose and oxygen liberated by photosynthetic reaction begun to accumulate in the atmosphere.

3) Evolution of Aerobic Respiration

Accumulation of oxygen in atmosphere changed the primitive environment.

- Ozone developed by oxygen in upper atmosphere began to filter ultraviolet radiations from the sun. It is considered that about 4.2 billion (420 million) years ago, enough protective ozone had built up to make life on land possible.
- Reducing atmosphere slowly changed into oxidizing atmosphere.
- Some living organisms began to utilize oxygen.
- Ironically, the change from a reducing atmosphere to an oxidizing atmosphere also means that life could no longer arise abiotically.

4) Evolution of Prokaryotes into Eukaryotes

- The prokaryotes may have arisen more than 3.5 billion years ago.
- Eukaryotes may have evolved 1.5 billion years ago.

It is considered that prokaryotes converted into eukaryotes. Major change is development of organelles. Two hypotheses are considered in this context.

A) ENDOSYMBIONT HYPOTHESIS

This hypothesis was presented by Lynn Margulis.

According to this hypothesis, eukaryotes and their organelles had been produced by some symbiotic relation with prokaryotes. Origin of some organelles has been described below.

i) Origin of Mitochondria

According to this hypothesis eukaryote cell might have evolved when large anaerobic amoeboid prokaryote ingested small aerobic bacteria and stabilized them instead of digesting them. This idea is known as the endosymbiont hypothesis.

These aerobic bacteria then converted into mitochondria, which are the sites of aerobic respiration and energy conversion in eukaryotic cells.

ii) Origin of Flagella

Flagella (whip-like structure) might have evolved through the ingestion of prokaryotes similar to spiral-shaped bacteria (spirochetes).

iii) Origin of Chloroplast

Ingestion of prokaryotes that resembled present day cyanobacteria could have led to the endosymbiotic development of chloroplast in plants.

B) CELL MEMBRANE INVAGINATION HYPOTHESIS

According to this hypothesis, cell membrane of prokaryotes invaginated (folded inward) to enclose copies of its genetic material.

This invagination resulted in the formation of several double membrane-bounded entities (organelles) in single cell. These entities could then have evolved into the eukaryotic mitochondrion, nucleus, chloroplast etc.

5) Evolution of Multicellular Eukaryotic Organism and Diversity

Formation of eukaryotic cell led to a dramatic increase in the complexity and diversity of life forms on earth.

During evolution, eukaryotic cell became specialized into tissues, which in turn formed organs for many different functions. These multicellular forms then adapted themselves to life in a great variety of environment.

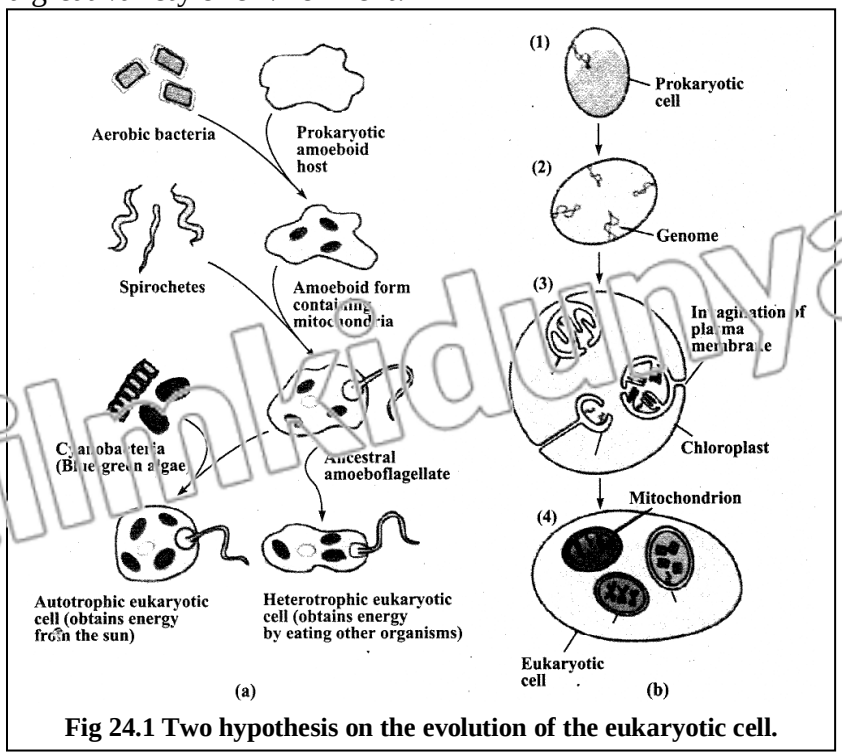

Fig 24.1 Two hypothesis on the evolution of the eukaryotic cell.

QUESTIONS RELATED TO ABOVE ARTICLE

Explain endosymbiont hypothesis for origin of eukaryote cells.

How did eukaryotes evolve from prokaryotes? (LHR 2017, LHR 2021, MTN 2021)

Explain the evolution of eukaryotes by endosymbiotic hypothesis and membrane invagination hypothesis? (GRW2021, SWL 2022)

Describe the details of engulfment of aerobic bacteria and cyanobacteria by a prokaryotic cell to develop a eukaryotic cell? (SGD 2022)

How did evolution proceed from prokaryotes to eukaryotes? (Exercise Question iv)

24.3 INHERITANCE OF ACQUIRED CHARACTERS

Presentation

This concept was presented by Jean Baptist Lamarck (1744-1829). He was in charge of invertebrate collection at the Natural History Museum in Paris. He published his theory of evolution in 1809, the year Darwin was born.

This theory is considered wrong, as there is no inheritance of somatic structures. (acquired characteristics)

Mechanism

He proposed two ideas about evolution.

1) Use & Disuse of Organs

Lamarck argued that those parts of the body, which are used extensively to cope with the environment become larger and stronger, while those that are not used deteriorate.

Example

Examples given by Lamarck were

- Blacksmith developing a bigger bicep in the arm that works the hammer.
- Giraffe stretching its neck to new lengths in pursuit of leaves to eat.

2) Inheritance of Acquired Characters

According to this concept of Lamarck, modifications which an organism acquires during its lifetime can be passed along to its offsprings.

Example

Example is long neck of giraffe as given by Lamarck.

Lamarck reasoned that long neck evolved gradually as the cumulative product of a great many generations of ancestors stretching higher and higher.

QUESTIONS RELATED TO ABOVE ARTICLE

Describe the inheritance of acquired characteristics.

Explain the theory of inheritance of acquired characteristics. (SGD 2019)

What is Lamarckism? Differentiate it from Neo – Darwinism. (MTN 2022)

24.3.1 CHARLES DARWIN

Introduction

Charles Darwin was born in Shrewsbury, in Western England in 1809. He joined the expedition on Beagle to South American coastline.

Observations

During his voyage, he observed and collected thousands of specimens of diverse faunas and floras of South America.

- He noticed that the fauna and flora of the different regions of the continent had a definite South American stamp, very distinct from the life forms of Europe.
- South American fossils were different from modern species but showed many resemblances with living plants and animals of that continent.
- Most important observations were related to Galapagos Islands. Most of the animals of Galapagos Island were not found anywhere else in the world but they showed some resemblances with species living on South American mainland. It was thought that animals and plants from mainland diversified and colonized on these islands.
- Among the birds, Darwin collected about 13 types of finches. Although they showed some resemblances but were different species. Some were unique to individual islands, while other species were distributed on two or more islands that were close together.

Conclusion

After returning to Great Britain in 1836, Darwin perceived origin of new species and adaptations as closely related processes.

- According to Darwin, a new species would arise from an ancestral form by gradual accumulation of adaptations to different environment, separated from original habitat by geographical barriers.
- Over many generations, the two populations could become dissimilar enough to be designated as separate species.

Essay & Theory

- In early 1840s, Darwin had worked on major features of his theory of natural selection as mechanism of evolution.
- In 1844, he wrote a long essay on the origin of species and natural selection.
- Before publication of Darwin's theory, Alfred Wallace, working as naturalist in East Indies, developed a theory of natural selection essentially identical to Darwin's.
- Wallace's paper alongwith extracts from Darwin's unpublished 1844 essay, were presented to the Linnaean Society of London on July 1, 1858. Darwin quickly finished the **"origin of species"** and published it the next year in this book.

ORIGIN OF SPECIES BY NATURAL SELECTION

In his book, Darwin developed two main points about evolution.

1) Descent with Modification

Darwin believed in perceived unity of life with all organism related through descent from some common ancestor. He believed in perceived unity of life.

According to Darwin, history of life is like a tree with multiple branching and rebranching from a common trunk all the way to the tips of living twigs, symbolic of current diversity of organisms. At each fork of the evolutionary tree is an ancestor common to all lines of evolution branching from that fork.

2) Natural Selection and Adaptation

Darwin suggested that different species are adapted to their local environment through natural selection. Darwin's theory of natural selection was based on following points.

a) Struggle for Existence

Production of more individuals than the environment can support leads to a struggle for existence among individuals of a population, with only a fraction of offsprings surviving each generation.

b) Survival of The Fittest

Survival is not random and depends upon hereditary characteristics of individual. Individuals with better heredity material fit for environment are survived and produce more offsprings, while others don't.

c) Evolution of New Species

This unequal ability of individuals to survive and reproduce leads to gradual changes in population with favourable characteristics accumulating over the generations, which ultimately leads to evolution of new species.

QUESTIONS RELATED TO ABOVE ARTICLE

Explain Darwin's Theory of Natural selection. (LHR 2019)
Describe the main point of theory of natural selection. (GRW 2019, BWP 2021)
Write down the contributions of Darwin in evolution. (GRW 2021)

24.3.2 Neo-Darwinism—the Modern Evolutionary Synthesis

The Origin of Species convinced most biologists that species are products of evolution. An important turning point for evolutionary theory was the birth of population genetics.

With progress in population genetics in 1930s, Mendelism and Darwinism were reconciled, and the genetic basis of variation and natural selection were worked out and lead to a comprehensive theory.

This theory was further known as Neo-Darwinism or Modern Synthesis.

It is called a synthesis because it integrated discoveries and ideas from many different fields including paleontology, taxonomy, biogeography and population genetics.

QUESTIONS RELATED TO ABOVE ARTICLE

Write a short note on Neo-Darwinism. (DGK 2019, SWL 2021)

24.4 EVIDENCES OF EVOLUTION

Evolution leaves observable signs. Darwin supported his theory with evidences from geographical distribution and fossil record. Later on, many evidences were presented to support this theory. Some of the evidences are described below.

24.4.1 Evidence from Biogeography

Definition

It is geographical distribution of species.

It was first evidence that suggested idea of evolution by Darwin.

Relation with Evolution

According to Darwin, islands have many species of plants and animals that are endemic but closely related to species of the nearest mainland or neighbouring island.

Example

Armadillos (armored mammals) live only in America. Evolutionary view of biogeography predicts that contemporary armadillos are modified descendants of earlier species that occupied these continents. Fossil records also confirm existence of such ancestors.

24.4.2 Evidence from Fossil Record

Definition

Fossils are either the actual remains or traces of organisms that lived in ancient geological times.

- Organisms may be embedded in sand, resin or ice.
- An impression or cast is made of body parts. Tissues being replaced or petrified by silica or calcium carbonate minerals.

Most fossils are found in sedimentary rocks.

Relation with Evolution

The succession of fossil forms is a strong evidence in favour of evolution. It provides a visual record in a complete series showing the evolution of an organism.

Example

- Oldest known fossil is of prokaryote (bacteria). It indicates prokaryotes as ancestors of all life forms including eukaryotes on earth.
- Chronological appearance of the different classes of vertebrate animals in the fossil record is also best example. It presents fossil fishes the earliest vertebrates, with amphibians next, followed by reptiles, then mammals and birds.
- The evolution of horse provides an example of such a history.

24.18 Evidence from Comparative Anatomy

Definition

- Such organs, which are functionally different but structurally similar are called homologous organs and similarity in characteristics resulting from common ancestry is known as homology. They are considered to be evolved by divergent evolution.
- Such organs, which are functionally alike but structurally different are called analogous organs. They are considered to be evolved by convergent evolution.
- Such organs, which are historical remnants of structures that had important functions in ancestors but are no longer essential are called vestigial organs. These are oldest homologous structures.

Relation with Evolution

Anatomical similarities between species grouped in the same taxonomic category bring another support to the theory of descent with modification.

Comparative anatomy supports that evolution is a remodeling process in which ancestral structures that function in one capacity become modified as they take on new functions.

Example

Example of Homologous Structures

- Same skeletal elements make up forelimbs of humans (arms), cats (forelegs), whales (flippers), bats (wings) and all other mammals although these appendages have very different functions.
- The flower parts (sepals, petals, stamens, carpals) of flowering plants are homologous. They are considered to have evolved from leaves.

Example of Analogous Structures

Wings of bat, birds and insects are examples.

Examples of Vestigial Structures

- Pelvis in whales and leg bones in snakes.
- Vermiform appendix in carnivores.
- Ear muscles in man.

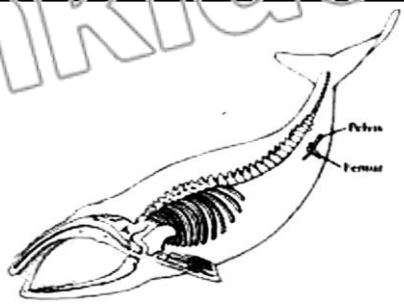

Fig 24.2 The whale retains pelvic and leg bones as useless vestiges.

24.4.4 Evidence from Comparative Embryology

Definition

The study of animal development from fertilized egg to formation of all major organs is called embryology.

Relation with Evolution

Comparative embryology can often establish homology among structures, such as gill pouches, that become so altered in later development that their common origin would not be apparent by comparing their fully developed forms.

Example

All vertebrate embryos go through a stage in which they have gill pouches on the sides of their throats. At embryonic stage of development, similarities between fishes, frogs, snakes, birds, humans and all other vertebrates are much more apparent than differences. As development progresses, the various vertebrates diverge more and more, taking on the distinctive characteristics of their classes.

In fishes, for example, the gill pouches develop into gills; in terrestrial vertebrates these embryonic structures become modified for other functions such as Eustachian tube that connect the middle ear with the throat in humans.

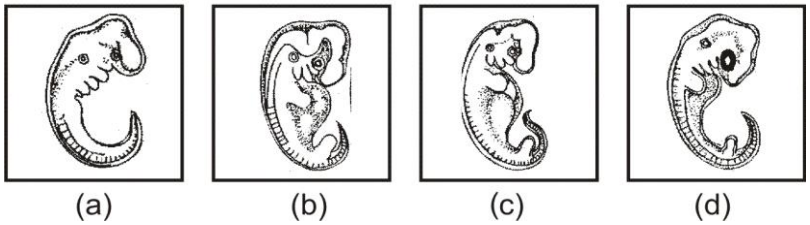

Fig 24.3 Homologies among vertebrates are clearly evident early in development, as the photos reveal. Embryo (a) turtle (b) mouse (c) human (d) chick

24.4.5 Evidence from Molecular Biology

Definition

The study of biochemical structures and functions of organisms at molecular level is called molecular biology.

Relation with Evolution

Evolutionary relationships among species are reflected in their DNA and proteins, in their genes and gene products. If two species have genes and proteins with sequences of monomers that match closely, the sequences must have been copied from a common ancestor.

Molecular biology provides strong evidence in support of evolution as the basis for the unity and diversity of life.

Example

- A common genetic code brings evidence that all life is related.
- Humans and bacteria have some common proteins.
- Cytochrome c, a respiratory protein, is found in all aerobic species.

QUESTIONS RELATED TO ABOVE ARTICLE

Describe comparative anatomy as evidence of evolution. (LHR 2018)

How comparative embryology support the process of evolution? (LHR 2018)

Discuss migration and Genetic drift as factors affecting gene frequency. (BWP 2019)

Explain the evidences of evolution by fossil record and comparative anatomy. (LHR 2021)

Describe comparative anatomy and fossil record as evidences of evolution. (GRW 2018, MTN 2019, LHR 2019, BWP 2019, FSD 2022)

Describe evidences of evolution from any five branches of biology. (Exercise Question iii)

24.5 NATURAL SELECTION AND ARTIFICIAL SELECTION

Adaptation and Variations

Adaptations are the changes acquired by organism by its own actions. These are not heritable. These changes, adaptations or variations are thus non-hereditary. An adaptation in one situation may be useless or even detrimental in different circumstances.

Only heritable variations are important in transferring changes from one to next generation. Natural selection is based on hereditary variation.

Artificial Selection and Natural Selection

- Humans have modified other species over many generations by selecting individuals with the desired traits as breeding stock. The plants and animals, we grow for food, bear little resemblance to their wild ancestors. Domestication of these animals and plants to get desired results is called artificial selection.
- From the changes achieved by artificial selection within a relatively short period of time, Darwin postulated that natural selection operating over vast spans of time could account for the entire diversity of life. Natural selection is regional and timely.

  An example of natural selection is the evolution of antibiotic resistance in bacteria.

24.5.1 Population, Gene Pool, Allele & Genotype Frequency

Population

A population is a localized group of individuals belonging to the same species.

Features

- A species is a group of population that have the potential to interbreed in nature.
- A population may be isolated from others of the same species, exchanging genetic material only rarely e.g. populations of separate islands, unconnected lands or mountain ranges.
- Individuals of different centers in same population interbreed with themselves than others.

Allele

Alternative form of gene having similar locus is called allele.

Gene Pool

The total aggregate of genes in a population at any one time is called the population's gene pool.

Features

- Population's gene pool consists of all alleles, at all gene loci, in all individuals of population.
- For a diploid species, each locus is represented twice in the genome of an individual, who may be either homozygous or heterogyzous.
- If all members of a population are homozygous for the same allele, that allele is said to be fixed in the gene pool.

Genotype Frequencies

More often, there are two or more alleles for a gene, each having relative frequency (proportion in gene pool. It is called genotype frequency or allelic frequency.

Example

Consider a wildflower population with two varieties contrasting in flower colour.

- Allele for pink flower A is dominant over allele for white flower a.
- Suppose there are only two alleles for this locus in population i.e. each member is dominant.
- Our imaginary population has 500 plants. 20 are homozygous recessive for white flower (aa). 320 are homozygous pink (AA) and 160 are heterozygous pink (Aa).

Now we consider the allelic frequencies of this population.

- 500 diploid plants mean 1000 alleles for flower colour in population. This is gene pool. Dominant alleles account 800 and recessive allele 200.
- Frequency of 'A' allele is this gene pool is 80% or 0.8 and 'a' allele is 20% or 0.2.

Related to these allelic frequencies are genotype frequencies. In our model

- Genotype frequency for homozygous pink i.e. AA is 64% or 0.64 (320/500).
- Genotype frequency for heterozygous pink i.e. Aa is 32% or 0.32 (160/500).
- Genotype frequency for homozygous white is 4% or 0.04 (20/500).

24.5.2 Hardy-Weinberg Theorem

The frequencies of genotypes of non-evolving populations are described by Hardy-Weinberg theorem.

Presentation

This theorem was presented by two scientists Hardy and Weinberg who presented it separately in 1908.

Statement

It states that

"The frequencies of alleles and genotypes in a population's gene pole remain constant over the generations unless acted upon by agents other than sexual recombination."

So shuffling of alleles due to meiosis and random fertilization has no effect on the overall genetic structure of a population.

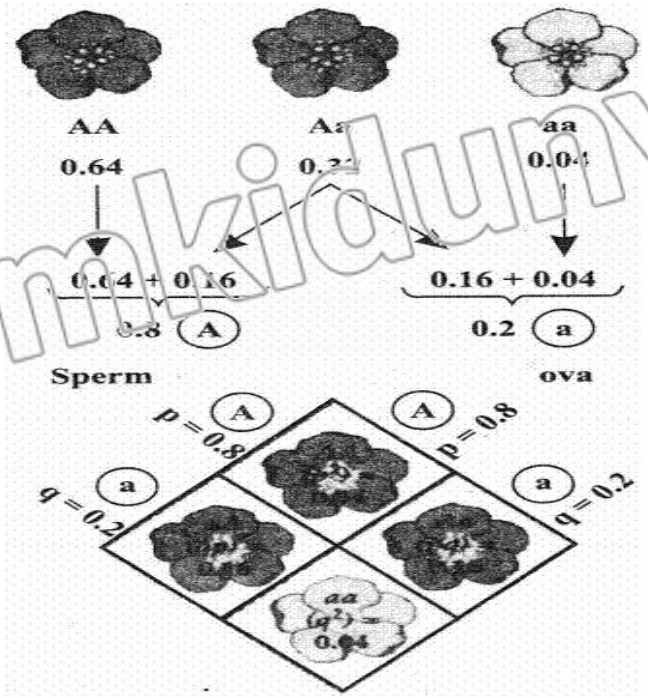

Fig 24.4 The Hardy-Weinberg theorem. The genetic structure of a non-evolving population remains constant over the generations. Sexual recombination alone will not alter the relative frequencies of alleles or genotypes. (*p* = frequency of A; *q* = frequency of a).

Hardy-Weinberg Equation

$p^2 + 2pq + q^2 = 1$

- This equation is in fact binomial expansion i.e. $(p + q)^2 = p^2 + 2pq + q^2$
- This equation is used for calculating the frequencies of alleles and genotypes in populations at equilibrium.

Explanation with Example

In a population where only two alleles occur for a gene, 'p' represents one frequency of one allele and 'q' of another allele.

- Consider an imaginary wild flower population.

$p = 0.8$
$q = 0.2$
Thus $p + q = 1$

The combined frequencies of all possible alleles must account for 100% of the genes for that locus in the population.

If there are only two alleles and we know the frequency of one, the frequency of other can be calculated.

If $p + q = 1$
Then $1 - p = q$
Or $1 - q = p$

- When gametes combine to form a zygote, then their genotype becomes p^2 for gene pair (suppose AA).

In the wild flower population;

$p = 0.8$	$p^2 = 0.64$	(Frequency for homozygous dominant AA)
$q = 0.2$	$q^2 = 0.04$	(Frequency for homozygous recessive aa)
$2pq = 2$	$0.8 \times 0.2 = 0.32$	(Frequency for heterozygous Aa)

Now if we add all these frequencies, it will be equal to 1.

Consider equation;

p^2	+	2pq	+	q^2	=	1
0.64	+	0.32	+	0.04	=	1

24.5.3 Factors Affecting Gene Frequency

Many factors can alter gene frequency and out of these five affect proportion of homozygotes and heterozygotes enough to produce significant deviation from proportion claimed by Hardy Weinberg principle.

1) Mutation

- It is ultimate source of all changes.
- Single mutation alone does not change allele frequency much.

2) Migration

- It is a very potent agent of change.
- Emigration and immigration of members of a population cause disturbance in the gene pole.

3) Genetic Drift

- It is change in frequency of alleles at a local that occur by chance.
- In small populations, such fluctuations may lead to loss of particular alleles.

4) Non-random Mating

- Inbreeding is its most common form.
- It does not alter allele frequency but lessens the proportion of heterozygote individuals.

5) Selection

- Some individuals leave behind more progeny than others, and the rate at which they do so is affected by their inherited characteristics.
- Selection can be natural or artificial.
- In natural selection, environment plays role, thus affecting the proportions of gene in a population.

In artificial selection, the breeders select for the desired characters

QUESTIONS RELATED TO ABOVE ARTICLE

Discuss factors affecting gene frequency.

Describe Hardy-Weinberg Theorem with the help of example. (MTN 2019)

Define Hardy-Weinberg Theorem. Discuss the various factors affecting gene frequency. (SWL 2019)

Describe the factors affecting gene frequency of a population. (LHR 2017, (MTN 2021)

Discuss any four factors affecting gene frequency. (ISD 2021, RWP 2021)

p + q = 1 Argue that this balance shown in theorem may not vary for a non-evolving population? (LHR 2022)

Discuss natural selection and artificial selection. (RWP 2019, SGD 2021, LHR 2022)

Explain factors affecting gene frequency in relation to p + q = 1. (DGK 2022)

Many factors can alter the gene frequency. Discuss various factors responsible for evolutionary change. (GRW 2022, RWP 2022)

State and explain Hardy Weinberg theorem. (Exercise Question ii)

Analyze the Darwin's theory of natural selection as mechanism of evolution. (Exercise Question v)

24.6 ENDANGERED SPECIES

Definition

- An endangered species is in imminent danger of extinction throughout its range (where it lives).
- A threatened species is likely to become endangered in the near future.

Causes of extinction

Various causes involved are,

i) Habitat destruction
ii) Climate change
iii) Pollution
iv) Invasions from foreign species

Out of all these, habitat destruction is most important.

Number of Extinctions

Accurately estimating the number of extinctions is impossible in areas like rain forests, where taxonomists have not even described most species.

Commonly Affected Habitats

Tropical rain forests are the most threatened areas on earth. They have been reduced to 44% of their original extent. In certain areas, like Ecuador, forest coverage has been reduced by 95%.

Other affected habitats are grassland, marshes, deserts and coral reefs.

Conservation of Endangered Species

Preservation of endangered species depends on a multifaceted conservation plan that includes the following components;

i) A global system of national parks to protect large tracts of land and wildlife corridors that allows movement between natural areas.
ii) Protected landscapes and multiple use areas that allow controlled private activity but also retain value as wildlife habitat.
iii) Zoos and botanical gardens to save species whose extinction is imminent.

Endangered Species in Pakistan

Extinct species

Cheetah, Tiger, Asian lion, Indian rhino, Cheer pheasant, Crocodile and Gavial has been declared extinct in Pakistan.

Endangered species

Indus dolphin, Blackbuck, Common leopard, Great Indian bustard, Houbara bustard, White-headed duck and Marbled teal are among the animal near to extinction.

- Deserts, Sub-mountainous tract and Wetlands are habitats in peril.

Endangered species of plants have been recorded to more than 500.

QUESTIONS RELATED TO ABOVE ARTICLE

Discuss about "The Endangered Species". (GRW 2017)
Write a note on endangered species with their methods of conservation. (BWP 2022)
What are endangered species? What measures could be adapted for their preservation? (Exercise Question i)

KEY POINTS

Reducing and oxidizing environments

The old environment of the earth was reducing. It uses hydrogen and produce oxygen. This oxygen accumulated in the environment. Thus this environment becomes oxidizing. They started using oxygen.

Acquired characters

Modification in structure or function acquired by an organism during its life, caused by environmental factors. With respect to higher organisms, there is no evidence that such changes are transmissible genetically-the view associated with Lamarckism but, among protozoans and bacteria, certain induced changes are heritable.

Hydrothermal vent

The bottom of the ocean is without light and oxygen. Here temperature is much higher (120°C). These are called hydrothermal vent. First archaeobacteria were formed in these hydrothermal vents.

Population genetics and natural selection

Population genetics believes that the variations are present within the population. So natural selection takes place at population level. This selection does not take place at specie level. Therefore, population is the unit of evolution.

Sedimentary Rocks

Sedimentary rocks are formed by the accumulation of small particles and subsequent cementing of minarets or organic particles on the floor of oceans or other bodies of water at the Earth's surface.

Neo-Darwinism

This is an altered explanation of Darwin's theory with regards to modern synthesis of natural selection and Mendelian genetics. The main force driving speciation is the gathering of genotypic variations in a gene pool. Sometimes this theory is also referred to as the Modern synthetic theory of natural selection.

EXERCISE

Q 1

Fill in the blanks.

i) Archaebacteria can tolerate high temperature upto _____.

ii) The first eukaryote appeared about _____ years ago.

iii) _____ presented the theory of the origin of species by means of natural selection.

iv) _____ developed a theory of natural selection essentially identical to Darwin's.

v) _____ are considered to be ancestors of all life.

vi) A respiratory protein called _____ is found in all aerobic organisms.

vii) Total aggregate of genes in a population at any time is called its _____.

viii) Hardy Weinberg theorem describes a _____ population.

ix) _____ is a series of ch anges in the genetic composition of a population over time.

x) Level of classification between species and family is called _____.

xi) Hardy Weinberg equation is binomial expansion of _____.

xii) An _____ species is in imminent danger of extinction throughout its range.

xiii) A _____ is a localized group of individuals belonging to the same species.

xiv) The first photosynthetic organisms used _____ as source of hydrogen for reducing carbon dioxide to sugars.

xv) _____ published an essay on 'The Principle of Population'.

Ans i) 120˚C ii) 1.5 billion
iii) Darwin iv) Wallace
v) Prokaryotes
vi) Cytochrome c vii) Gene pool
viii) Stable or non-evolving
ix) Evolution x) Genus
xi) $(p + q)^2$
xii) Endangered xiii)Population
xiv) (H_2S) xv) Malthus

Q 2 **Encircle the correct answer from the multiple choices.**

i) **The gill pouches of mammals and birds embryos are:**
(a) Support for 'ontogeny recapitulate phylogeny'
(b) Homologous structures
(c) Used by the embryos to breath
(d) Evidence for the degeneration of unused body parts

ii) **Darwin's theory, as presented in 'The Origin of Species', is mainly concerned:**
(a) How new species arise
(b) The origin of life
(c) How adaptations evolve
(d) How extinctions occur
(e) The genetics of evolution

iii) **The smallest biological unit that can evolve over time is:**
(a) A particular cell
(b) An individual organism
(c) A population
(d) A species
(e) An ecosystem

iv) **A gene pool consists of:**
(a) All the alleles exposed to natural selection
(b) The total of all alleles present in a population
(c) The entire genome of a reproducing individual
(d) The frequencies of the alleles for a gene locus within a population
(e) All the gametes in a population

v) In a population with two alleles for a particular locus, B and b, the allele frequency of B is 0.7. What would be the frequency of heterozygote if the population is in Hardy-Weinberg equilibrium?

(a) 0.7 (b) 0.42
(c) 0.49 (d) 0.09
(e) 0.21

vi) In a population that is in Hardy-Weinberg equilibrium, 16% of the individuals show the recessive trait. What is the frequency of the dominant alleles in the population?

(a) 0.84 (b) 0.36
(c) 0.60 (d) 0.4
(e) 0.48

vii) Selection acts directly on:

(a) Phenotype
(b) Genotype
(c) The entire genome
(d) Each allele
(e) The entire gene pool

Answer key

i	**a**	**vi**	**c**
ii	**a**	**vii**	**c**
iii	**d**		
iv	**b**		
v	**b**		

Q 3 Short Questions.

i) What are hydrothermal vents?

Ans. These are underwater hot springs, deep in the oceans and are considered to be related with origin of life on earth. These vents could have supplied the energy and raw material for origin and survival of early life forms.

ii) State endosymbiont hypothesis.

Ans. According to endosymbiont hypothesis, different organelles have been produced due to symbiotic association between different prokaryotes residing inside the cells. This idea was proposed by Lynn Margulis.

iii) Define population genetics.

Ans. Study of genes and their interactions at population level is called population genetics. It recognizes the importance of quantitative characters.

iv) How does fossil record provide evidence of evolution?

Ans. Fossils are either the actual remains or traces of organisms that lived in ancient geological times. They show relation of past organisms with present day organisms. It provides a visual record in a complete series showing the evolution of an organism.

v) Explain the term homology with a suitable example.

Ans. Similarity in characteristics resulting from common ancestry is known as homology, and such anatomical structures are called homologous structures. Homologous organs are functionally different but structurally alike.

Example: The forelimbs of human, cats, whales and bats.

vi) What are vestigial organs? Give two examples.

Ans. Vestigial organs are historical remnant of structures that had important functions in ancestors but are no longer essential presently.

Example: The skeletons of whales and some snakes retain vestiges of the pelvis and leg bones of walking ancestors. Vermiform appendix in carnivores.

vii) How are evolutionary relationships reflected in DNA and proteins?

Ans. If two species have genes and proteins with sequences of monomers that match closely, the sequences must have been copied from a common ancestor. For example, a common genetic code brings evidence that all life is related.

viii) State Hardy Weinberg theorem.

Ans. It states that the frequencies of alleles and genotypes in a population's gene pool remain constant over the generations unless acted upon by agents other than sexual recombination.

ix) What is difference between endangered species and threatened species?

Ans.

- An endangered species is in imminent danger of extinction throughout its range (where it lives).
- A threatened species is likely to become endangered in the near future.

x) Name any five species declared extinct in Pakistan.

Ans. Cheetah, Tiger, Asian Lion, Indian Rhino, Cheer Pheasant, Crocodile and Gavial.

Q 5 Extensive Questions.

i) What are endangered species? What measures could be adapted for their preservation?

Ans (see article 24.6)

ii) State and explain Hardy Weinberg theorem.

Ans (see article 24.5.2)

iii) Describe evidences of evolution from any five branches of biology.

Ans (see article 24.4)

iv) How did evolution proceed from prokaryotes to eukaryotes?

Ans (see article 24.2)

v) Analyze the Darwin's theory of natural selection as mechanism of evolution.

Ans (see article 24.3.1)