Written as per the revised syllabus prescribed by the Maharashtra State Board of Secondary and Higher Secondary Education, Pune.

Perfect Biology – II

STD. XII Sci.

Salient Features

- Exhaustive coverage of syllabus in Question Answer Format.
- Covers answers to all Textual Questions.
- Covers answers to all Board Questions till date.
- Includes marking scheme for Board Questions from 2013 to 2017.
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- Includes Board Question Papers of 2016 and 2017.
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Note: All Textual questions are represented by * mark.
NCERT Questions are represented by # mark.

10 Origin and Evolution of Life

Syllabus

10.0	Introduction	10.2	Organic Evolution
10.1	Origin of Life	10.3	Origin and Evolution of Human Being

10.0 Introduction

Q.1. What is Big Bang?

Ans: The single titanic explosion that happened about 15 billion years ago, which resulted in the formation of universe is called Big Bang.

NCERT Corner

- **Big Bang Theory**

Single huge explosion
↓
Expansion of universe, temperature came down
↓
Hydrogen and Helium formed sometime later
↓
Condensation of gases under gravitation, formation of galaxies of the present day universe
↓
Earth was formed about 4.5 billion years ago
↓
No atmosphere on early earth
↓
Water vapour, CH_4, CO_2, NH_3 released from molten mass covered the surface
↓
$H_2O \xrightarrow{\text{UV rays}} H_2 + O_2$ (Lighter H_2 escaped)
↓
$O_2 + NH_3 + CH_4 \longrightarrow H_2O + CO_2$ + other gases
↓
Formation of ozone layer
↓
Water vapour condensed and fell as rain (after cooling)
↓
Oceans formed

Q.2. How did the solar system come into existence?

Ans:
i. The Universe is presumed to have come into existence with a single titanic explosion called the "Big Bang", about 15,000 million (15 billion) years ago.
ii. All the matter and tremendous energy came into existence, with the Big bang.
iii. The fragments of the fire ball expanded and cooled to give rise to many more celestial bodies.
iv. This eventually resulted in the formation of our solar system consisting of the sun and planets.

10.1 Origin of Life

***Q.3. What kind of atmosphere was existing on primitive earth?**

Ans: Primitive earth atmosphere was strongly reducing and contained hydrogen, methane, ammonia and water vapours, free oxygen was absent.

Q.4. What is protobiogenesis? Which are the different theories of origin of life?

Ans: The origin of life on the earth is called protobiogenesis.

There are different theories put forth to explain the origin of life. They are:

i. Theory of special creation.
ii. Cosmozoic theory.
iii. Theory of spontaneous generation or Theory of abiogenesis.
iv. Theory of biogenesis.

Q.5. Explain in brief the 'Theory of special creation'.

Ans:
i. The theory of special creation is the oldest of all the theories.
ii. It was proposed by Spanish monk Father Suarez.
iii. According to this theory, all living beings on the earth were created by God or by a supernatural power.
iv. This theory is purely based on religious belief.
v. It has no scientific evidence. Therefore, it is not accepted by the scientific world.

NCERT Corner

- **Evolution of Life Forms**

Theory of Special Creation

3 connotations

- All living organisms (species or types) seen today were created as such
- Diversity was the same since creation and will be the same in future
- Earth is about 4000 years old

i. These ideas were strongly challenged in the 19th century.
ii. Alfred Wallace, a naturalist who worked in Malay Archipelago had also come to similar conclusions like Charles Darwin, during that time.
iii. In the course of time, new type of organisms became recognisable. The existing life forms however share similarities and have common ancestors. These ancestors were present at different epochs, periods and eras in the history of earth.
iv. The geological history of the earth correlates with its biological history.
v. A common permissible conclusion is that the earth is very old, not thousands of years as was thought earlier but billions of years old.

Q.6. Write a short note on Cosmozoic theory.

Ans:
i. Cosmozoic theory was given by Richter in 1865 and is also known as panspermia theory.
ii. According to this theory, life on earth came from a distant planet in the form of spores or microorganisms.
iii. It was called cosmozoa or panspermia which were preserved inside meteorites (mass of matter from outer space).
iv. The barren earth was struck by meteorites thus releasing the cosmozoa and helping in the development of various creatures.
v. This theory failed to explain the origin of life on the planet, hence it is not accepted.

Q.7. What is abiogenesis? Explain the 'Theory of spontaneous generation' or 'Theory of abiogenesis'.

Ans: **Abiogenesis:** It is the hypothetical process by which living organisms are believed to have developed from non–living matter.

Theory of spontaneous generation:

i. It is also called the 'Theory of autobiogenesis' (auto = self, bios = life, genesis = formation).

ii. According to this theory, life originated from non–living material spontaneously, without any interruption.

iii. This theory was put forth by Greek Philosophers in 600 B.C. and was supported by Aristotle.

iv. The Greek Philosophers believed that air, water, fire and earth are vital forces or the active principles which have the capacity to transform non-living matter into living organisms.

v. Louis Pasteur finally disproved the theory of spontaneous generation and gave the scientific explanation that life originated only from pre-existing life or biogenesis.

Q.8. Write a note on 'Theory of biogenesis'.

Ans: i. The theory of biogenesis was put forth based on classical experiments carried out by three famous scientists.

ii. Francisco Redi, followed by Spallanzani and Louis Pasteur conducted experiments to disprove the theory of abiogenesis.

iii. According to the theory of biogenesis, living organisms are always produced from pre-existing living forms by reproduction and not from non-living or lifeless matter.

iv. This theory could explain continuity of life.

v. However, this theory could not explain the origin of first life on earth.

***Q.9. Describe Oparin – Haldane theory of chemical origin of life.**

Ans: The Russian scientist Alexander Ivanovich Oparin (1924) and British scientist J.B.S. Haldane (1929) proposed the 'Theory of chemical evolution of life'.

According to this theory, life originated from non-living matter, some three billion years ago, in a primitive atmosphere, through a process of chemical evolution.

This theory is also known as 'self assembly theory of origin of life or 'biochemical origin of life' or 'molecular evolution'.

The entire process of chemical evolution can be divided into the following steps:

i. Origin of earth and its primitive atmosphere:

a. The origin of life on earth is closely related to the origin of earth itself.

b. The earth is presumed to have originated about 4.6 billion years ago.

c. When it was broken from the sun, it was a glowing fire and a rotating cloud of hot gases, vapours of various elements and pieces of rocks and metals called Nebulous.

d. The earth cooled as it moved away from the sun. This led to the condensation of gases.

e. The heavy elements like iron, nickel, etc., sank to the centre and formed the solid core of earth.

f. The lightest elements like helium, hydrogen, oxygen, nitrogen, carbon, etc., occupied the atmosphere of the earth.

g. The atmosphere of primitive earth i.e. about 3600 million years ago, was reducing type and without free oxygen, quite different from the geological conditions found today.

ii. Formation of ammonia, water and methane:

a. The prebiotic environment had very less resemblance with the present day environment.

b. The earth was very hot initially and so the atoms could not combine with each other very easily.

c. The primitive earth contained a large amount of hydrogen, nitrogen, carbon and oxygen. Out of which hydrogen was very active.

d. Hydrogen combines with nitrogen to form ammonia (NH_3), with oxygen to form water (H_2O) and with carbon to form methane (CH_4).

e. Due to high temperatures, ammonia and methane remained as gases and water remained as steam.

f. As the temperature of the earth decreased through the years, steam condensed into water which resulted in rain and the earth became cold.

g. Water gradually accumulated and led to the formation of water bodies like rivers, streams, lakes, seas and oceans.

h. Chemical compounds like ammonia and methane dissolved in rain water and accumulated in the sea.

i. The first chemicals formed on the earth were water, ammonia, methane, etc.

iii. Synthesis of simple organic compounds:

a. In the next step of molecular evolution, highly reactive free radicals –CH and $–CH_2$ condensed to form a variety of both saturated and unsaturated hydrocarbons.

b. The simple inorganic molecules of the oceanic water interacted with one another to form simple organic molecules such as sugar, fatty acids, glycerol, amino acids, purines and pyrimidines.

c. The energy for these reactions was provided by the electrical discharges (lightning), ultraviolet rays (solar radiations), volcanic activities and decay of radioactive elements.

$CH_4 + NH_3 + H_2O \rightarrow$ amino acids

$CH_4 + HCN + NH_3 + H_2O \rightarrow$ purines + pyrimidines

$CH_4 + H_2O \longrightarrow$ sugar + glycerol + fatty acids

d. Haldane described the sea containing an abundance of molecules of these organic substances as 'the hot dilute soup' or 'primitive broth'.

iv. Formation of complex organic compounds:

a. The hot dilute soup was sterile and oxygen free.

b. Increasing numbers of simple organic substances came together.

c. They colloided, reacted and aggregated giving rise to new complex molecules such as polysaccharides, fats, proteins, nucleosides and nucleotides.

d. Polymerization of amino acids resulted in the formation of protein molecules.

e. These proteins performed enzymatic reactions and were called protoproteins.

f. Due to their enzymatic nature, these proteins accelerated the rate of other chemical reactions.

g. The formation of protein molecules is considered as a landmark in the origin of life.

v. Formation of nucleic acid:

a. The next step in chemical evolution was the formation of nucleic acid.

b. The aggregation of phosphoric acid, sugar, purines and pyrimidines formed nucleic acids.

c. They were linked in various combinations to form different types of nucleotides.

d. Nucleic acid formed as a result of joining of thousands of nucleotides.

e. It acquired self replication ability, which is a fundamental property of living forms.

vi. Formation of Protobiont or pre-cells:

a. The nucleic acid along with inorganic and organic molecules formed the first form of life and were called **protobionts** or **pre-cells.**

b. The proteins formed colloidal hydrophilic complexes surrounded by water molecules.

c. Oparin and Sidney Fox demonstrated the formation of this aqueous suspensions of polymers.

d. Oparin called these aggregates as Coacervates, while Sidney Fox called them Protenoids or Microspheres.

vii. Formation of First Cell:

a. The nucleic acids in pre-cells had the capacity to multiply but they gradually started directing a series of chemical reactions like protein synthesis.

b. That was the significant step in the transformation of pre-cell into a cell.

c. This chemical evolution gave rise to biological evolution.

viii. Biological evolution:

a. The first cells or primitive cells were marine and heterotrophic in nature and obtained their food from the surrounding areas.

b. Growth and multiplication of these cells caused depletion in the food and increase in CO_2 due to fermentation.

c. These were the favourable circumstances for mutation, which resulted in the development of chromophores.

d. The chromophores had the ability to trap light energy and convert it into chemical energy.

e. This event helped in the transformation of heterotrophs into autotrophs.

f. Due to release of oxygen as a byproduct of photosynthesis, the primitive reducing atmosphere was slowly and gradually converted into an oxidizing atmosphere.

Q.10. Explain formation of aqueous suspension polymers as demonstrated by Oparin and Sidney Fox.

Ans: Coacervate theory of Oparin:

i. In 1938, Oparin performed an experiment in which he explained that the formation of protein molecules was a very crucial event in the course of chemical evolution.

ii. He also tried to explain the transformation of non-living substances into living forms.

iii. He suggested the formation of coacervates.

iv. Oparin suggested that they might have originated from the primitive earth, substances from which the first cell like forms might have come into existence.

v. He called them 'Protobionts' or 'Eubionts'.

Microsphere theory of Sydney Fox:

i. In 1959, Dr. Sidney Fox studied Oparin's coacervate theory and performed the experiments by stimulating prebiotic environmental conditions in the laboratory.

ii. In his experiments, he heated the amino acids which polymerized into protein like droplets called **proteinoids.**

iii. These aggregated into spherical colloidal droplets which were called **microspheres.**

<u>Assembly of organic compounds</u>

Q.11. Give an account of Urey and Miller's experiment.

Ans: i. Stanley Miller and Harold Urey designed an apparatus and created conditions similar to primitive atmosphere.

ii. The apparatus had a spark discharge glass chamber with two tungsten electrodes, flask for boiling water, side tube connected to a vacuum pump, condenser and a U-shaped trap.

iii. The electric discharge was created by using electrodes in a spark chamber containing methane, ammonia, hydrogen and water vapours in the ratio 1: 2 : 2 without air. This was done to create the prebiotic environment.

iv. The flask containing water was heated at a very low temperature to provide water vapour necessary for the reactions. Water vapours stimulated the ocean present on primitive earth.

v. The mixture of water vapour and other gases was circulated continuously exposing it to high electric sparks of 75,000 volts.

vi. They circulated the gases continuously, exposing it to electric discharge for several days and then analysed the chemical composition of the liquid inside the apparatus.

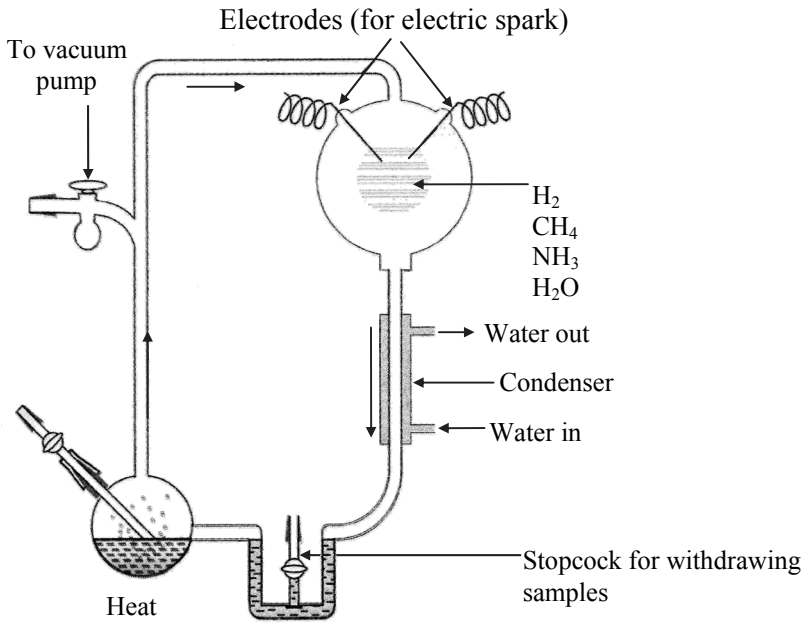
Observation:

They observed formation of a large number of simple organic compounds especially some amino acids such as alanine, glycine and aspartic acid.

Conclusions:

All these complex organic compounds including amino acids, were synthesized non-enzymatically.

This proved that complex organic compounds were probably synthesized in reducing atmosphere without the help of enzymes and thus, supported the Theory of chemical evolution. The experiment provided proof that the essential building blocks like nucleotides and amino acids may have been formed on primordial earth.



Urey and Miller's Experiment

10.2 Organic Evolution

Q.12. Define 'evolution'. Give the principles of Darwin's theory of natural selection. Mention any 'one' objection to it. [Mar 17]

Ans: **Organic evolution** is a slow, gradual, continuous and irreversible change through which the present day complex forms have descended from their simple, pre-existing forms of the past. *[Definition – **1 mark**]*

Charles R. Darwin, a British biologist, postulated the "Theory of origin of species by natural selection".

Principles of Darwinism:

Darwin's theory of organic evolution by natural selection is based on the following principles:

i. **Over production or prodigality of production:**
All organisms have a natural tendency to over produce i.e. produce more young ones than those which can survive upto maturity.
If this tendency is not checked, then even a single species of a plant or animal will occupy the entire space available on the earth.

ii. **Struggle for existence:** Organisms multiply in geometric ratio, but space and food remain constant leading to competition for survival. Increase in the number of species leads to a competition called struggle for existence.

iii. **Variation and Heredity:**
The differences which occur between closely related organisms are called variations.
It is universal law of nature. Variations may be favourable or unfavourable. Useful variations are preserved and passed on to offsprings. This plays an important role in evolution.

iv. **Survival of the fittest or natural selection:**
According to Darwin, in the struggle for existence, the fittest individuals survive and reproduce, while the unfit individuals perish. Since nature selects only those organisms that possess favourable variations (organisms that are fittest to survive), the theory is known as natural selection.

v. **Origin of new species:**
According to Darwin, useful variations appear in every generation and are inherited from one generation to another. Thus, a new species originates by gradual accumulation of favourable variations for many generations.

*[Principles – **5 marks**]*

Objections to Darwin's natural selection theory:

i. Natural selection theory explained "survival of the fittest" but not "arrival of the fittest".
ii. Darwin did not take into account the hereditary principles.
iii. He could not provide a satisfactory explanation for the cause, origin and inheritance of variations.
iv. He could not explain the inheritance of certain useless variations. e.g. vestigial organs.
v. He was unable to differentiate variations as hereditary and environmental variations.

*[Any one objective – **1 mark**]*

***Q.13. Describe Darwin's theory of natural selection. State the objections raised against this theory.**

Ans: *Refer Q.12*

***Q.14.Write a note on "Struggle for existence".**

Ans: Struggle for existence: According to Darwin, individuals multiply in geometric ratio, however space and food remain constant. This leads to competition amongst the individuals for getting requirements of life. This competition is called struggle for existence. The struggle may be intra-specific, inter-specific or environmental.

i. Intra-specific struggle:

It is the competition among the individuals of the same species. Since the need and approach of all competing organisms is precisely same, this type of struggle is very severe. e.g. struggle between cow and cow, horse and horse, deer and deer, etc.

ii. Inter-specific struggle:

It is the struggle between the organisms of different species living together. Individuals of one species compete with other species for food, shelter and breeding place. e.g. Struggle between cow, horse and deer for getting grass.

iii. Environmental struggle:

It is the struggle of all living forms against adverse environmental conditions, i.e. against natural calamities like extreme heat or cold, drought, storms, earthquakes, volcanic eruptions, etc.

***Q.15.Describe the concept of "Survival of the fittest". [Oct 15]**

Ans: Survival of the fittest or Natural selection:

i. Nature selects the organisms with favourable variations.
ii. Organisms with favourable variations are fittest to survive and they get selected in the process of evolution.
iii. These organisms transmit favourable characters to the next generation.
iv. In the succeeding generation also, nature selects organisms with favourable variations. Hence, this theory is known as natural selection.

*[Explanation: four points – **2 marks**]*

Q.16. What are the important postulates of Hugo de Vries' Mutation theory?

Ans: Hugo de Vries proposed the Mutation theory to explain organic evolution based on his studies on the evening primrose (*Oenothera lamarkiana*).

Salient features of Mutation Theory are:

i. New varieties and species are formed by mutations or discontinuous variations that appear suddenly.
ii. Mutations are the raw material for evolution that give rise to new species through organic evolution.
iii. Mutations are heritable and establish new species.
iv. Useful mutations are selected by nature. Unsuitable mutations get eliminated by natural selection.