

SAMPLE MODULE

NEET
Sarthi
KOTA

NEET BIOLOGY



ORIGIN AND EVOLUTION

Theory With Solved Examples.

Practice Section (DPP)

Topicwise, NCERT Based & Analytical Exercise

Previous Year Questions (15 Years)

Online Platform for NEET, JEE & NTSE

NEET Module Details

(Total = 24)

CLASS - XI : 13 MODULES

PHYSICS

Module - 1	
Ch. No.	Chapter Name
1.	Mathematical Tools
2.	Vector
3.	Unit, Dimension and Measurement
4.	Kinematics
5.	Newton's Laws of Motion
Module - 2	
1.	Work Power and Energy
2.	Center of Mass & Collision
3.	Rotational Motion
4.	Gravitation
Module - 3	
1.	Fluid Mechanics
2.	Surface Tension
3.	Elasticity & Viscosity
4.	Simple Harmonic Motion
5.	Wave Motion
Module - 4	
1.	Thermometry & Calorimetry
2.	Thermal Expansion
3.	Kinetic Theory of Gases
4.	Thermodynamics
5.	Heat Transfer

CHEMISTRY

Module - 1	
Ch. No.	Chapter Name
1.	Some Basic Concept of Chemistry
2.	Atomic Structure
3.	Redox Reactions
4.	States of Matter
Module - 2	
1.	Chemical Equilibrium
2.	Ionic Equilibrium
3.	Chemical Thermodynamics And Energetics
Module - 3	
1.	Periodic Table and Periodic Properties
2.	Chemical Bonding
3.	Hydrogen and its compounds
4.	s-Block elements
5.	p-Block (13 to 14 groups)
Module - 4	
1.	IUPAC
2.	Isomerism
3.	GOC-I
4.	Hydrocarbons
5.	Environmental Chemistry

BIOLOGY

Module - 1	
Ch. No.	Chapter Name
1.	The Living World
2.	Biological Classification
3.	Plant Kingdom
4.	Morphology of Flowering Plants
5.	Anatomy of Flowering Plants
Module - 2	
1.	Animal Kingdom
2.	Structural Organisation in Animals
3.	Cell: The unit of life
4.	Cell cycle and cell division
5.	Biomolecules

Module - 3	
Ch. No.	Chapter Name
1.	Transport in Plants & Mineral Nutrition
2.	Photosynthesis in Higher Plants
3.	Cell Respiration in Plant
4.	Plant Growth & Development
5.	Enzymes
Module - 4	
1.	Digestive System
2.	Respiratory System
3.	Body Fluids and Circulation
4.	Excretory System
Module - 5	
1.	Locomotion and Movement
2.	Neural Control and Coordination
3.	Chemical Coordination and Integration

NEET : Biology

Sample Module



STUDENT NAME: _____

SECTION: _____ ROLL NO: _____



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❖ PREFACE ❖

This module covers the theoretical concepts associated with NEET syllabus and contain sufficient multiple choice and previous year questions. We are confident that students would find this module helpful for their preparations.

Research & Development team of NEET Sarthi keeps working to improve the study material. Suggestions and inputs from students and readers are always welcome.

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“If you can dream it, you can do it”

-Dr. A.P.J. Abdul kalam

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NEET Sarthi

Chapter-01

Origin and Evolution

- Introduction
- Origin of Life
- Evidences of Evolution
- Theories of Evolution
- Human Evolution

INTRODUCTION:

Evolutionary Biology:

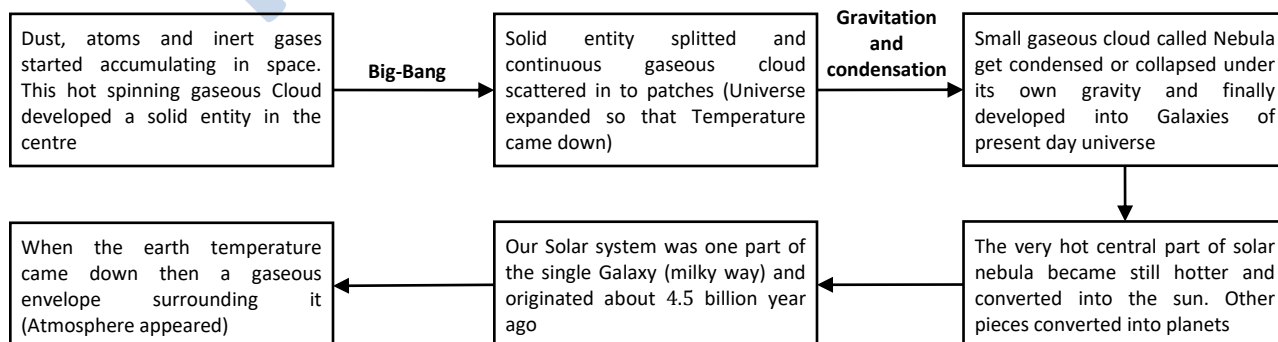
- It is the study of history of life forms (i.e. the changes in flora and fauna that have occurred over millions of years) on earth.
- This is the story of origin of life and evolution of life forms or biodiversity on Planet earth in the context of evolution of earth and against the background of evolution of universe itself.

What is Evolution?

- The word evolution means to unfold or unroll or to reveal hidden potentialities. Evolution simply means an orderly change from one condition to another.
- It can be best explained by Darwin's concept of 'Descent with modification'.
- Evolution is a slow, gradual and continuous process of change occurring in flora and fauna.

What is Universe?

- The universe is a huge cluster of galaxies. Galaxies contain stars and clouds of gas and dust. Considering the size of universe, earth is indeed a speck i.e. The universe is vast.
- When we look at stars on a clear night sky we are, in a way, looking back in time. Stellar distances are measured in light years. What we see today is an object whose emitted light started its journey millions of years back and from trillions of kilometers away and reaching our eyes now. However, when we see objects in our immediate surroundings, we see them instantly and hence in the present time. Therefore, when we see stars we apparently are peeping into the past.
- The Big Bang theory attempts to explain to us the origin of universe **Big Bang theory:** Proposed by **Abbe Lemaitre**.
- According to it, the universe originated about 20 billion years ago due to a thermonuclear explosion of a dense entity. This single huge explosion which is unimaginable in physical terms, is called as **big bang**.



Origin of Earth : About 4.5 billion years ago

- The temperature of early earth was 5000-6000°C and there was no atmosphere.
- The conditions on primitive earth were -
 1. High temperature
 2. Volcanic eruption
 3. Molten mass (Volcanic lava) covered the earth surface and it released CH₄, NH₃, CO₂, water Vapour etc.
$$\text{H}_2\text{O} \xrightarrow[\text{because of no O}_3 \text{ shield}]{\text{U.V. Rays from sun}} \text{H}_2 + \text{O} \uparrow$$

$$\text{CH}_4 + \text{NH}_3 + \text{O} \uparrow \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{Nitrides}$$
 4. All gases like H₂, CH₄, NH₃ make primitive reducing atmosphere.
- By the passing of time, the earth temperature came down (below 100°C) and **hydrosphere** also formed due to condensation of water vapour (Raining).

ORIGIN OF LIFE:

Theories for Origin of Life:

Different scientists proposed their different theories, some of them are as follows :

- (1) Theory of special creation
- (2) Cosmic panspermia theory
- (3) Theory of spontaneous generation (Abiogenesis/Autogenesis)
- (4) Theory of biogenesis
- (5) Oparin - Haldane theory (Modern theory)

(1) Theory of Special Creation:

- Proposed by **Father Suarez**
- This is a mythology-based theory.
- This theory has three connotations (ideas)
 - (i) All living organisms that we see today were created as such.
 - (ii) The diversity was always the same since creation and will be the same in future also.
 - (iii) The earth is about 4000 years old.
- All these ideas were strongly challenged during the nineteenth century based on observations of **Charles Darwin, Wallace** etc. They believed that life forms varied over the periods of time.
- From fossils records and their dating, we can conclude that earth is very old, not thousands of years as was thought earlier but billions of years old.

(2) Cosmic Panspermia Theory:

- Proposed by **Richeter**
- Some scientists believe that life came from outer space.
- Early Greek thinkers thought units of life called **spores** were transferred to different planets including earth.
- '**Panspermia**' is still a favorite idea for some astronomers.

(3) Theory of Spontaneous Generation (Abiogenesis/Autogenesis):

- This theory was supported by ancient **Greek philosophers**.
- According to this theory life came out of decaying and rotting matter like straw, mud etc. spontaneously.

(4) Theory of Biogenesis:

- Proposed by **Harvey & Huxley**
- They stated "**Omnis vivum ex ovo or vivo**", which means "New life can be originated on earth only by pre existing life."
- **Supporter of theory** : Experiments of **Francesco Redi, Lazzaro Spallanzani, and Louis Pasteur** etc supported the theory of biogenesis and disproved the abiogenesis. Experiment of Louis Pasteur is most renowned among all of these.

Experiment of Louis Pasteur: 'Swan neck flask experiment'

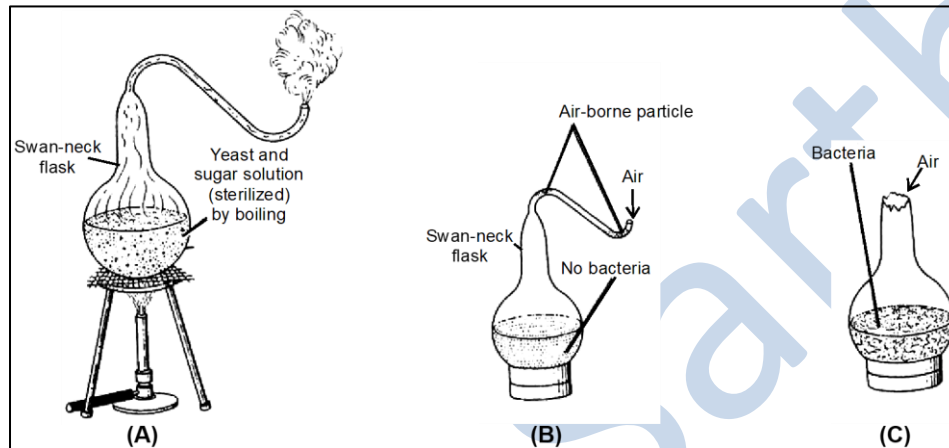


Fig.: Louis Pasteur's swan neck flask experiment

- He prepared sterilized syrup of sugar and killed yeast by boiling them in flasks.
- He took two flasks one of broken neck and another of curved neck (Swan neck/ "S" shaped neck flask)
- He showed that in pre-sterilized swan neck flasks, life did not come from killed yeast because germ laden dust particles in the air were trapped by the curved neck which serves as filter while in another flask open to air (broken neck), new living organisms arose. Thus, he proved that new organism can be produced from pre-existing organisms only.
- Hence spontaneous generation theory was dismissed once and for all. However, this did not answer how the first life form came on earth.

(5) Modern Theory:

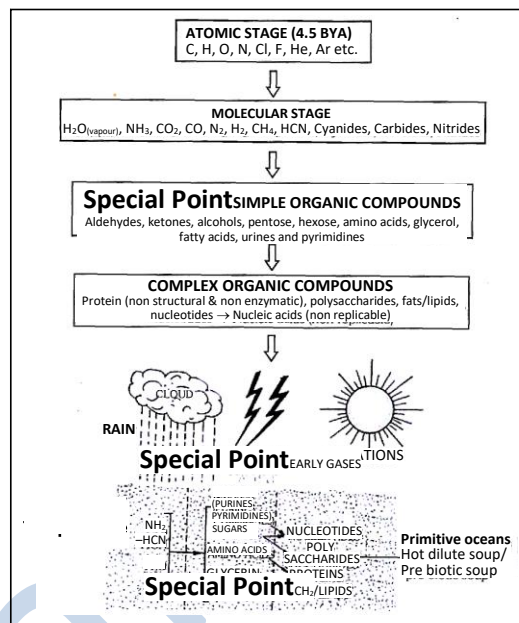
- Also known as **Chemical evolution theory** or **Oparin – Haldane theory**.
- Oparin of Russia and Haldane of England proposed that the first form of life could have come from **pre-existing non-living organic molecules (e.g. RNA, protein, etc.)** and that formation of life was preceded by chemical evolution, i.e., formation of diverse organic molecules from inorganic constituents.
- Oparin's theory was published in his book '**The Origin of Life**'.
- First life originated in sea water, so water is essential for origin of life.
- Most accepted theory and according to it, life originated abiogenetically first but biogenetically ever since.
- According to this theory, life originated in following two phases:

(A) Chemical Evolution (Chemogeny)

(B) Biological Evolution (Biogeny)

(A) CHEMICAL EVOLUTION:

- The primitive conditions on earth were high temperature, volcanic storms, lightening and reducing atmosphere.
- Early earth had free atoms of all those elements which were essential for formation of protoplasm (C, H, O, N etc.)
- Hydrogen was maximum among all of them.
- Due to high temperature, hydrogen reacted with oxygen to form water and no free oxygen was left, which made the atmosphere reducing.
- Hydrogen also reacted with nitrogen and formed ammonia.
- Hence Water and ammonia were probably the first inorganic compounds formed on earth.
- **Methane (CH₄)** was the first organic compound.
- As the earth cooled down, the water vapour fell as rain, to fill all the depressions and form primitive oceans. During this, molecules continued to react with each other and formed various simple and complex organic compounds.
- Now, the water of oceans became a rich mixture of macromolecules/ complex organic compounds. **Haldane** called it **Hot dilute soup/ pre biotic soup**.
- Hence the possibilities of life were established in the water of primitive oceans because these macromolecules (**Proteins, polysaccharides, fats/lipids, nucleic acids**) form the main components of protoplasm.



However, we have no clear idea about how the first self-replicating metabolic capsule of life arose, but many attempts were made to solve the mystery of arise of life on earth. From these macromolecules how first life was originated, will be studied in Biological evolution.

(B) BIOLOGICAL EVOLUTION:

- Origin of protobionts → Non cellular form (Protocell) → First cellular form (prokaryotes) → Eukaryotic cell
- (i) Origin of protobionts:**
 - Macromolecules which were synthesized abiotically in primitive oceans later came together and formed large colloidal drop like structures named as **protobionts**.
 - It is believed that they were the clusters of proteins, polysaccharides, lipids, nucleic acids etc.
 - These protobionts were unable to reproduce but they could grow by absorbing molecules from their surroundings and they were partially isolated from the surroundings.
 - Protobionts were also synthesized artificially by some scientists in laboratory.
 - **Oparin** prepared **coacervates** and **Sydney Fox** synthesized **microspheres** (proteinoid bodies).

(ii) Origin of Non-cellular form (Protocells):

- Nucleic acid developed the ability of self duplication due to a sudden change called **mutation**.
- Nucleic acid and proteins combined to form **nucleoproteins**. Nucleoproteins were the first sign of life.
- Clusters of nucleoproteins surrounded by lipid coat called **protocell**, the **first form of life**.
- These **first non-cellular forms of life** could have originated **3 billion years ago**.
- They would have been giant molecules (**RNA, Protein, Polysaccharides, etc.**). These capsules reproduced their molecules perhaps.



Altman (1980) discovered that some RNA molecules have enzymatic activity, called as **ribozymes**. It means at the time of origin of life, RNA molecule could carry out all the processes of life (replication, protein formation etc.) without the help of either protein or DNA. Hence this concept called as **RNA World**.
High Temperature

(iii) Origin of first cellular form (Prokaryotes):

- As a result of mutation protocells became more complex and efficient to use the materials available in the surrounding medium and evolved into **prokaryotic cells**.
- This **first cellular form** of life did not possibly originate till about 2000 million years ago.
- The first living beings were single celled bacteria like prokaryotes with naked DNA.
- They were probably **chemoheterotrophs** and **anaerobic**.

Chemoheterotrophs → Chemoautotrophs → Photoautotrophs (Non-oxygenic) → Photoautotrophs (oxygenic)

- Some of the chemoheterotrophic bacteria evolved into **chemoautotrophs**. They were anaerobic and synthesized organic food from inorganic material; this mode of nutrition is called as **chemosynthesis**. e.g. Iron bacteria, Nitrifying bacteria etc.
- When bacteriochlorophyll was developed in some chemoautotrophic bacteria, they started to convert light energy into chemical energy, this mode of nutrition is called as **photosynthesis**. They used H_2S as source of hydrogen instead of H_2O hence they were **non oxygenic photosynthetic** bacteria. e.g. Planktonic sulphur bacteria
- Some molecular changes occurred in bacteriochlorophyll, and it transformed into true chlorophyll. Such organisms used H_2O as source of hydrogen and released oxygen in the environment, they were **oxygenic photosynthetic** bacteria. e.g. Cyanobacteria (Blue green algae).

OXYGEN REVOLUTION

Liberation of free oxygen by cyanobacteria was a revolutionary change in the history of earth. It includes some major changes like:

- Atmosphere of earth changed from reducing to oxidizing, hence possibilities of further chemical evolution finished, because chemical evolution always takes place in reducing environment.
- Free O_2 oxidized CH_4 and NH_3 to form gases like CO_2 , N_2 and H_2O .
- Accumulation of free oxygen formed a layer of ozone outside the atmosphere of earth which started to absorb most of the UV rays of sunlight.
- Some prokaryotes adapted themselves for aerobic mode of respiration which provides approx. 20 times more energy than anaerobic respiration.

(iv) Origin of Eukaryotic cell :

Nucleus, mitochondria and other cell organelles developed in the cell and metabolically it became more active. Thus, free living eukaryotic cell like organisms originated about 1.5 billion years ago in the primitive ocean.

EVIDENCES OF EVOLUTION:

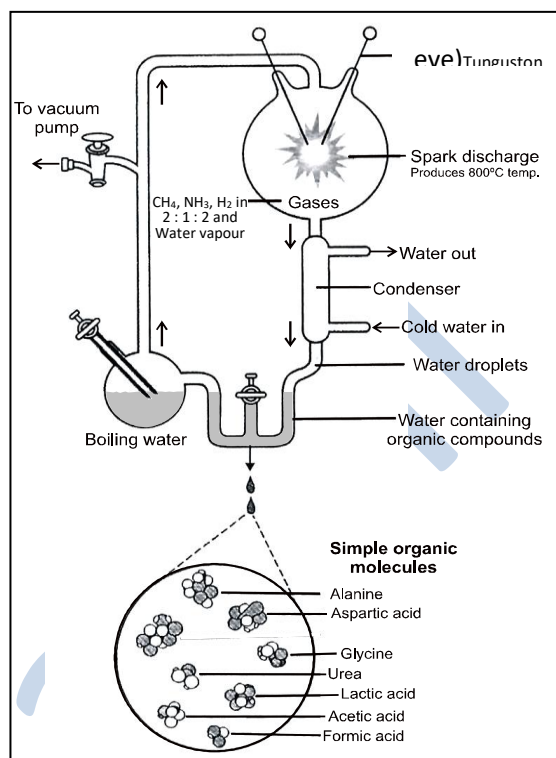
Evidences in favour of chemical evolution:

(1) Harold Urey & Stanley Miller Experiment:

- In 1953, S.L. Miller, an American scientist created similar conditions at laboratory scale, which were thought to be on primitive earth.
- He took CH_4 , NH_3 , H_2 (in ratio 2:1:2) and water vapour at 800°C in a large flask.
- He created **electric discharge** by using two tungsten electrodes as source of energy.
- He observed the formation of simple amino acids like glycine, alanine, and aspartic acid.
- In similar experiments other scientists observed, formation of sugars, nitrogen bases, pigment and fats.

(2) Evidences from meteorites:

- Analysis of meteorite contents also revealed similar compounds indicating that similar processes are occurring elsewhere in space.
- With these limited evidences, the first part of the conjectured story, i.e., chemical evolution was more or less accepted.
- This version of abiogenesis, i.e., the first form of life arose slowly through evolutionary forces from non-living molecules is accepted by majority. However, once formed, how the first cellular forms of life could have evolved into the complex biodiversity of today is the fascinating story that will be discussed in **organic evolution**.



EXTRA KEY POINTS

- Universe originated – about **20 BYA**.
- Solar system and earth were formed – about **4.5 BYA**.
- Life appeared – about **4 BYA**. (500 million after origin of earth)
- First non-cellular form of life – **3 BYA**.
- First cellular form of life – **2 BYA**.
- Evolution up to formation of coacervates – Chemical evolution
- Evolution from coacervate to simple cell – Biological evolution
- Evolution from simple cell to recent – Organic evolution
- Oparin's theory is based on artificial synthesis, so also called as **artificial synthetic theory**.

PRACTICE SECTION-01

- Q.1** Definition of evolutionary biology is:
 (1) Understanding life
 (2) Study of history of life forms on earth and how they progress
 (3) Study of organism's habitat
 (4) Study of origin of universe
- Q.2** What is not true for Big-Bang theory of origin of universe?
 (1) Originated about 20 billion year back (2) Originated after repeated huge explosion
 (3) Originated after single and huge blast (4) Unimaginable in physical terms
- Q.3** Earth's Primitive atmosphere was made up of the mixture of:
 (1) Oxygen, ammonia, methane, water (2) Hydrogen, ammonia, methane, oxygen
 (3) Hydrogen, vapour, methane, ammonia (4) Oxygen, methane, water, nickel
- Q.4** Primitive atmosphere was reducing because:
 (1) Hydrogen atoms were few
 (2) Hydrogen atoms were active and in greater number
 (3) Nitrogen atoms were more
 (4) Oxygen atoms were more
- Q.5** Which of the following was the unique event in the history of universe?
 (1) Biological evolution (2) Origin of earth (3) Origin of life (4) Mutation
- Q.6** Mark the events which happened on the primitive earth.
 (A) Breakdown of water into hydrogen and oxygen by UV rays
 (B) Formation of ozone layer
 (C) Release of water vapour, CH₄, CO₂, NH₃
 (D) Oxygen combined with NH₃ and CH₄ to form water, CO₂ and others.
 (E) Water vapour cooled and fall as rain to form oceans.
 (1) A & B Only (2) A, C & D (3) C, D & E (4) A, B, C, D & E
- Q.7** Oparin and Haldane proposed that the first form of life could have come from Pre-existing ___A___ molecules and that formation of life was preceded by ___B___.
 Choose the right option which fill A and B blank.
 (1) A–non-living organic, B–Organic evolution (2) A–living inorganic, B–Organic evolution
 (3) A–living inorganic, B–Chemical evolution (4) A–non-living organic, B–Chemical evolution
- Q.8** In 1953, S.L. Miller performed an experiment at lab scale. Find out the incorrect statement regarding this experiment.
 (1) He created early earth conditions in a laboratory.
 (2) He used CH₄, H₂, NH₃ and water vapour at 800°C in a closed flask.
 (3) He observed formation of sugars, nitrogen bases, pigment and fats.
 (4) He observed formation of Amino acid in the apparatus.

Answer Key

Que.	1	2	3	4	5	6	7	8
Ans.	2	2	3	2	3	4	4	3

EVIDENCES OF ORGANIC EVOLUTION:

In support of organic evolution some important evidences are:

- | | |
|---|---|
| (A) Palaeontological Evidences | (B) Morphological and Anatomical Evidences |
| (C) Evidences from vestigial organs | (D) Evidences from connecting links |
| (E) Evidences from Atavism (Reversion) | (F) Evidence from physiology and biochemistry |
| (G) Evidences from bio geographical distribution | (H) Evidences from Embryology |
| (I) Evidences from adaptation and natural selection | |

(A) PALAEOLOGICAL EVIDENCES:

Fossil: Impression or remains of hard parts of past organism found in rocks called fossils.

Palaeontology : Study of fossils

Founder of modern palaeontology : George Cuvier

- **Fossils are found in sedimentary rocks and provide one of the most acceptable evidence in support of organic evolution.**
- Rocks form sediments and a cross-section of earth's crust indicates the arrangement of sediments one over the other during the long history of earth. Such types of rocks are called as **sedimentary rocks**.
- Different-aged rock sediments contain fossils of different life-forms who probably died during the formation of the particular sediment.
- Replacement of organic or soft parts of dead organisms by mineral deposits is called **petrification**. Here only the hard parts like bones, teeth, shells, and wood etc. get preserved, which are called **petrified fossils**. These are the most common types of fossils.
- A study of fossils in different sedimentary layers indicates the geological period in which they existed.
- Some of them represent extinct organisms (e.g., Dinosaurs).
- The study shows that life-forms varied over time and certain life forms are restricted to certain geological time spans.
- New forms of life have arisen at different times in the history of earth, i.e. evolution has taken place.
- Generally, fossils found in older rocks are of simpler types and found in newer rocks are of complex type.
- By fossils we can study the evolutionary pedigree of animals like horse, elephants and man etc.
- **The geological history of earth closely correlates with the biological history of earth.**

Age determination of fossils:

- To find out the correct age of fossils, we determine the age of rocks from which fossils are found.
- Rocks contain some radioactive elements that decay and convert into their more stable forms. This radioactive decay takes place at a constant rate for each radioactive element irrespective of the environmental conditions.
- It is already calculated that how long it will take for half the quantity of the element to change into its stable form, and this time is known as its **half-life**. After another half-life has passed, the element will have decayed to a quarter of its original amount and so on.
- Thus, we can calculate the age of rocks by relative proportions of radioactive element and non-radioactive element in a sample of rock. This method is called **radioactive dating**.

There are several methods used to determine the age of fossils-

(1) **Radio carbon method / Carbon dating (Reminant of fossils) :**

Half-life of carbon-14 is 5730 years; it means in 5730 years, half of the C^{14} starts converting into its stable form N^{14} just after the death of the organism.

(2) **Rock dating :**

(i) **Uranium Lead method**

(ii) **Potassium Argon method:** More commonly used to determine age of older fossils (eg. Human fossils)

(iii) **Electron Spin Resonance (ESR) method :** this is the modern and most accurate technique.

Archaeopteryx:

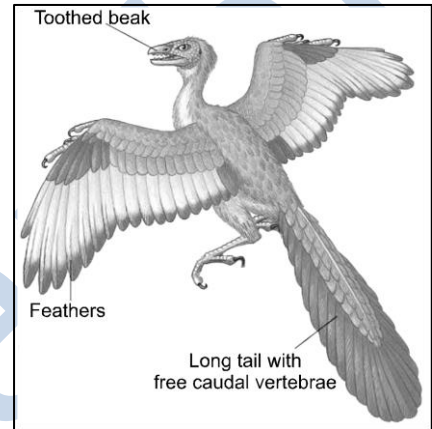
Connecting link (missing) between birds and reptiles. Fossil was discovered by **Andreas wagner** from **Bavaria** in Germany. It was found in the rocks of the **Jurassic period**.

Reptilian Characters :

- (1) Long tail with free caudal vertebrae.
- (2) Bones were not pneumatic.
- (3) Presence of weak sternum.
- (4) Teeth present in Jaws.

Avian Characters :

- (1) Presence of feathers on the body.
- (2) Jaws were modified into beak.
- (3) The fore limbs were modified into wings (Reduced).
- (4) The hind limbs were built in the typical avian plan.



Evolution (Pedigree) of Horse:

- Evolution of horse was described by C. Marsh.
- Many evolutionary changes were observed in horse:
 - (i) Increment in body height, length of neck & legs.
 - (ii) Reduction in number of toes or fingers and development of running habit.
 - (iii) Development of high crown on teeth and formation of cement.
 - (iv) Enlargement in size of brain.

Epochs	Height (in cms)	Appearance	Horse	Bones of limbs	No. of toes
Pleistocene	160	Modern Horse	Equus		1 - toed (2 Splint bones)
Pliocene	120	Pony like	Pliohippus		1 - toed (2 Splint bones)
Miocene	100	Donkey like	Merychippus		3 - toed (No Splint bones)
Oligocene	60	Sheep like	Meshippus		3- toed (1 Splint bones)
Eocene	40	Fox like	Eohippus		4- toed (1 Splint bones)

Geological Time Scale:

- It is the chronological order of the history of organic evolution on earth.
- The time after formation of the earth (4.5 billion years) is divided into 6 **Eras**, some Eras further divided into **Periods** and periods of recent era are divided into smaller time spans called **Epochs**.
- Intense geological disturbances have occurred on earth time to time, in which most of the pre-existing organisms perished out and the few remaining ones evolved into new and varied organisms. These disturbances are called **great revolution** or **cataclysm**.
- The time before palaeozoic era is also called as **Precambrian** era because the first period of palaeozoic is Cambrian.

GEOLOGICAL TIME SCALE			
Era	Period	Epochs	Life forms
COENOZOIC (Age of Birds, Mammals and Angiosperms)	QUATERNARY	Holocene (Age of Man)	Mental age, supremacy of man
		Pleistocene (Ice Age)	Human appeared, social life of human started
	TERTIARY	Pliocene	Apelike ancestors of human appeared
		Miocene	
		Oligocene	– Anthropoid apes evolved from monkeys – Rise of monocots
		Eocene	Eohippus appeared
		Palaeocene	Origin of primates
ROCKY MOUNTAIN REVOLUTION			
MESOZOIC (Age of Reptiles)	CRETACEOUS		– Extinction of Dinosaurs & archaeopteryx – Origin of primitive placental mammals and Modern birds, Angiosperms also appeared
	JURASSIC (Golden age of Dinosaurs)		– Dominance of dinosaurs and origin of first toothed birds and marsupial mammals – Gymnosperms and ferns also dominated
	TRIASSIC		Origin of dinosaurs and oviparous mammals
APPALACHIAN REVOLUTION			
PALAEOZOIC	PERMIAN		– Origin of mammal like reptiles – First Gymnosperm appeared
	CARBONIFEROUS (Golden age of amphibians)		– Amphibians were dominant – Origin of reptiles (seymauria) – First seed plant originated
	DEVONIAN (Golden age of fishes)		– Fishes were dominant – Origin of amphibians
	SILURIAN		– Jawless fishes were dominant – Origin of true fishes
	ORDOVICIAN		– Giant mollusks were dominant – Origin of jawless fishes (1st vertebrates), – Origin of chordata
	CAMBRIAN		Trilobites (Extinct arthropods) were dominant
SECOND GREAT GEOLOGICAL REVOLUTION			
PROTEROZOIC			Origin of protozoa, sponges, coelenterate, annelida & mollusca
FIRST GREAT GEOLOGICAL REVOLUTION			
ARCHAEOZOIC (Era of Invisible life)			– Prokaryotes originated and dominated – Eukaryotes also evolved
AZOIC			No life, Only chemical evolution took place

Table: A brief account of evolution through ages (on the basis of chronological history of fossils)

- (1) **Appearance of first cellular form of life on earth:** Anaerobic Heterotrophic bacteria were the first cellular form of life on earth, that originated about 2000 million years back.
- (2) **Appearance of invertebrates:** By the time of 500 million year ago, Invertebrates formed and active.

BIOLOGY

- Sea weeds and few plants existed probably around 320 MYA.
- (3) **Appearance of first Vertebrates (Jawless fishes):** Evolved around 350 MYA.
- (4) **Lobed fin fishes (Coelacanth):** Fish with stout and strong flashy lobed fins (coelacanth) could move on land and go back to water. This was about 350 MYA.
 - In 1938, a fish caught in South Africa was coelacanth which was thought to be extinct. Now it is called living fossil.

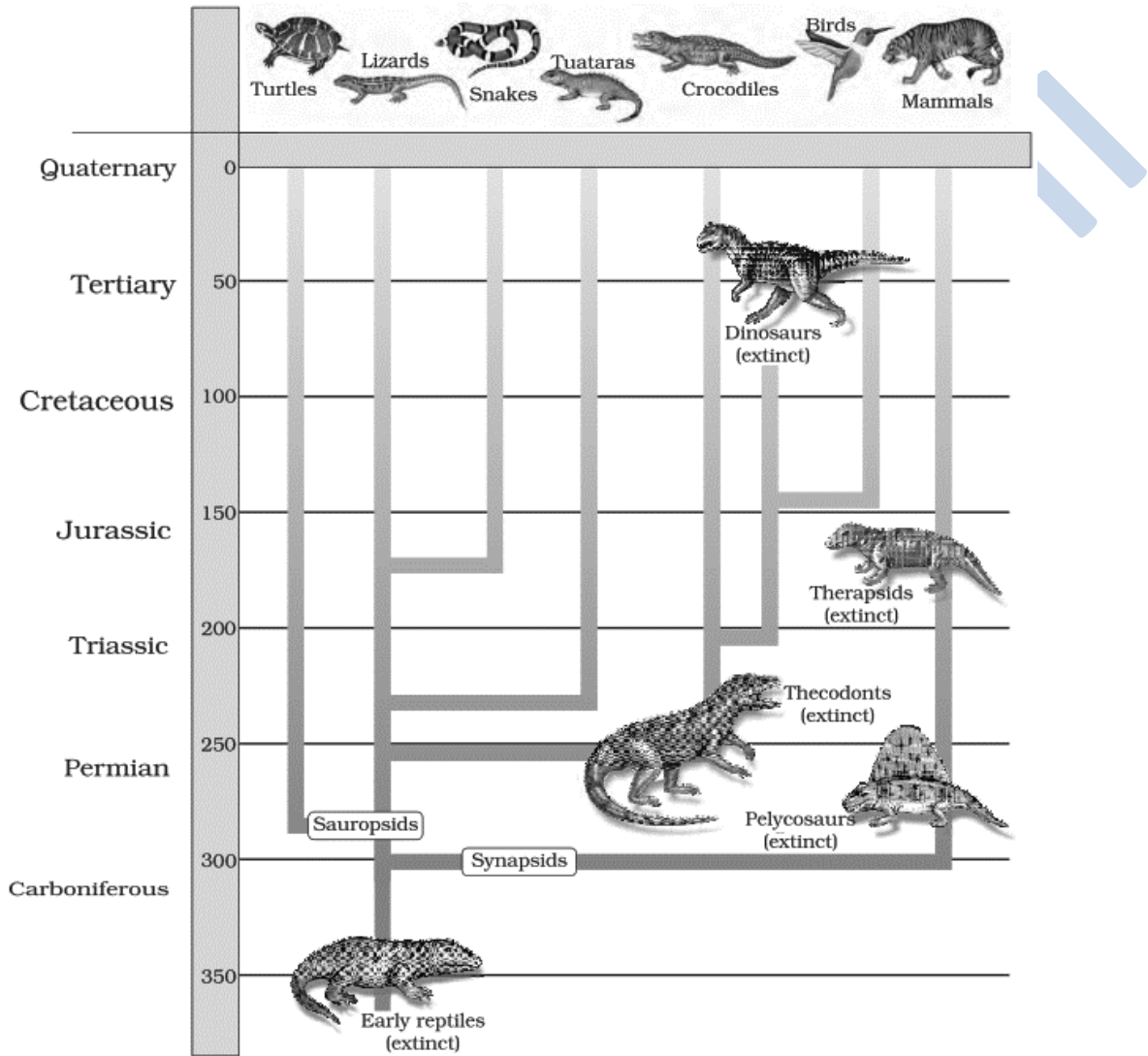


Fig: Representative evolutionary history of vertebrates through geological period

- (5) **First life that migrated from aquatic to terrestrial habitat:** Plants (Moss or Bryophytes)
- (6) **Origin of Amphibia:** Lobbed fin fishes (coelacanth), evolved into first amphibians that lived on both Land and water. There is no specimen of these left with us. However, these were ancestors of modern-day frog and salamanders. Amphibia were first animal but second organism (because first were plants) which migrated from aquatic to terrestrial habitat.
- (7) **Origin of Reptiles:** The amphibians evolved into reptiles and reptiles lay thick shelled eggs (land adaptation) which do not dry up in sun unlike those of amphibian, in next 200 million years or so, reptiles of different shape & size dominated on earth.

Examples:

1. Turtle, Tortoise, Crocodiles, Snakes, Lizards, Tuatara.

2. **Dinosaurs:**

(i) **Ichthyosaurs:** Fish like and aquatic, evolved about 200 MYA when some land reptiles went back into water

(ii) **Tyrannosaurus rex:** Biggest flesh-eating dinosaur with 20 feet height and huge dagger like teeth.

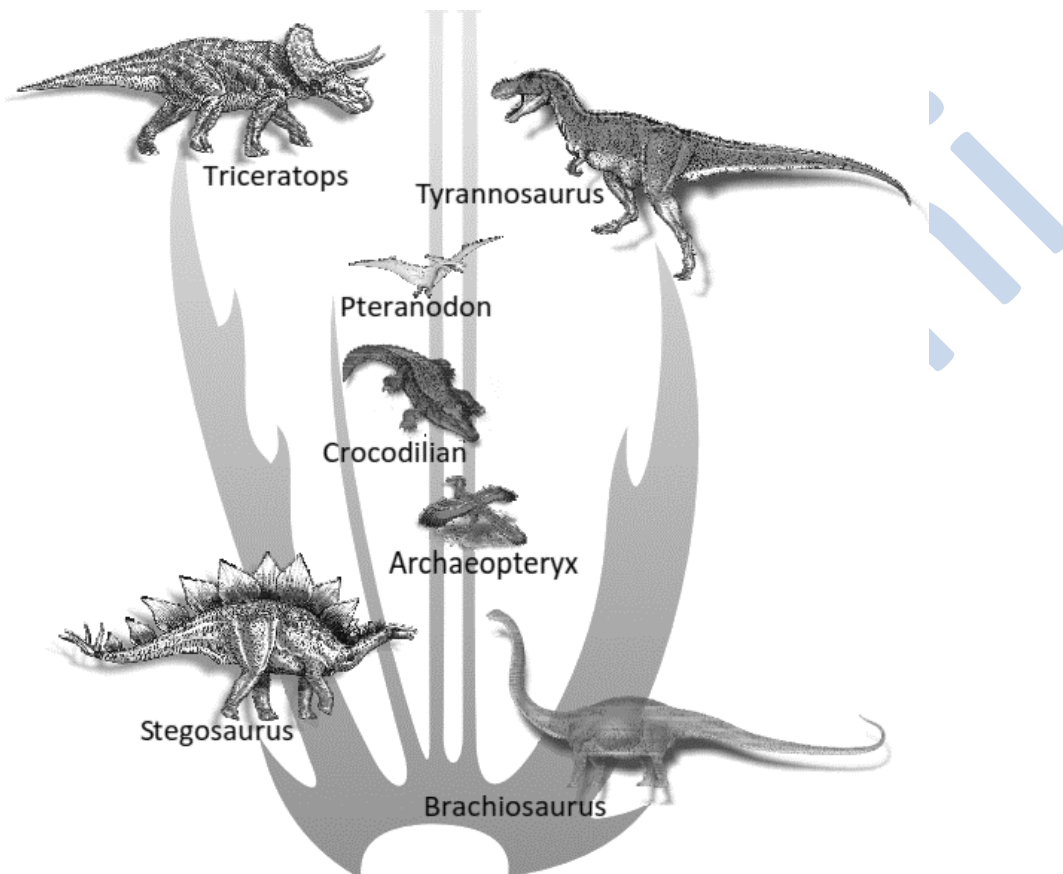


Fig.: A family tree of dinosaurs and their living modern day counterpart organisms like crocodiles and birds

(8) **Extinction of Dinosaurs:** Jurassic period was the golden age of dinosaurs and after that dinosaur suddenly disappeared about 65 MYA (cretaceous period) because of three probable reasons:

(i) Climatic changes killed them (ii) Most of them evolved in birds (iii) Meteorite collision

- The true reason of extinction of dinosaurs is still unknown.
- Small sized reptiles of that era still exist today.
- Giant ferns (pteridophytes) were also present but they all fell to form coal deposits slowly.

(9) **Origin of Birds:** Birds originated from reptiles and evidences come from Archaeopteryx.

(10) **Origin of mammals and their domination upon others:** Mammals also originated from reptiles (therapsid) with separate line of birds.

- The first mammals (primate like) were shrews, their fossils are small sized.
- When reptiles came down, mammals took over this earth.
 - (i) Mammals were viviparous and protected their unborn young inside the mother's body.
 - (ii) Mammals were more intelligent in sensing and avoiding danger at least.

(11) **Mammals with interest of evolutionary history:** Horse, elephant, dog with special stories of evolution.

(12) Most success full story of Human evolution: With language skills and self consciousness.

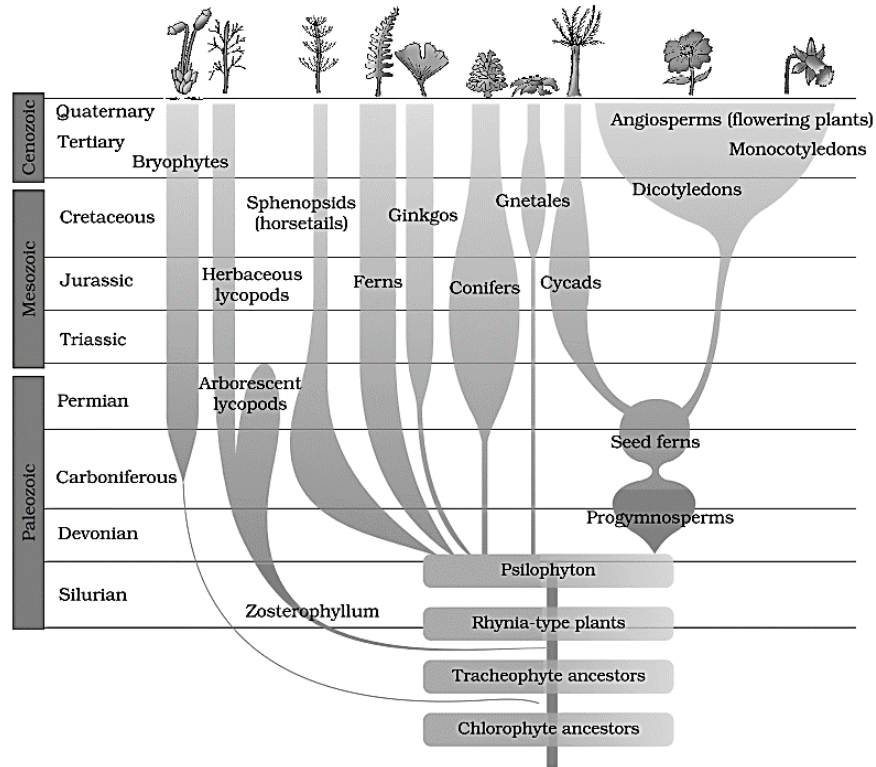


Fig.: A sketch of the evolution of plant forms through geological periods

(B) EVIDENCES FROM COMPARATIVE MORPHOLOGY AND ANATOMY:

- Similarities and differences are found among organisms of today and those that existed years ago. Such similarities can be interpreted to understand whether common ancestors were shared or not.

- These similarities are of two types: **(I) Homology** **(II) Analogy**

(I) Homologous organs (Homology) :

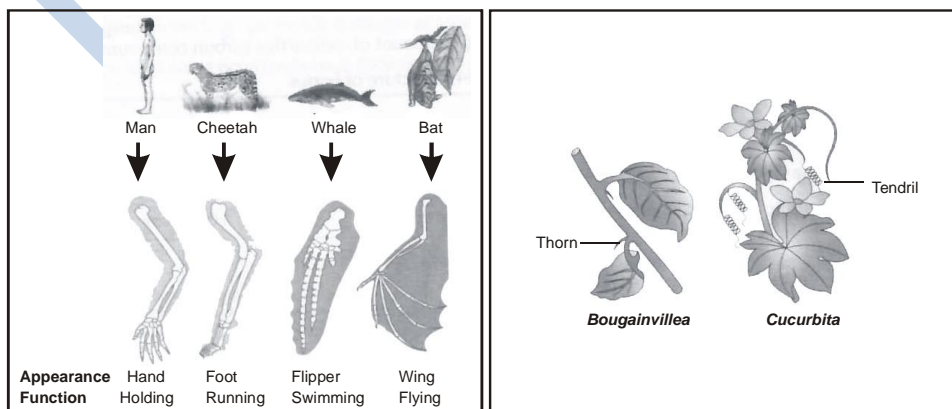
The organs which have common origin, embryonic development and same fundamental structure but perform similar or different functions. this phenomenon is called Homology.

- **Similarity in appearance and function is not necessary.**

Examples of homologous organs:

- (i) **Forelimbs of mammals-** Whales, bats, Cheetah and human (all mammals) share similarities in the pattern of bones of forelimbs though these forelimbs perform different functions. In these animals, forelimbs have similar anatomical structure - all of them have humerus, radius, ulna, carpals, metacarpals and phalanges in their forelimbs.

- (ii) **Thorn of Bougainvillea and tendril of Cucurbita:** both are modification of axillary bud.



- (iii) **Vertebrate hearts or brains (Visceral organs)**
- (iv) **Mouth parts of insects:** mouth parts comprise labrum, mandible, maxilla etc.
Cockroach: (Biting & chewing)
Honey bee: (Chewing & lapping)
Mosquito: (Piercing & Sucking)
- (v) **Testes in male and ovaries in female**
- (vi) **Potato and Ginger:** both are modified shoot
- (vii) **Radish and Carrot:** both are modified roots
- (viii) **Molecular homology:** Homology found at molecular level. For example, the plasma proteins found in the blood of man and apes are similar.

Note:

- ☞ When the same structures develop along different directions due to adaptations to different needs, this is called as **divergent evolution**.
- ☞ Homology indicates **common ancestry** and based on divergent evolution.

(II) Analogous organs (Analogy):

The organs which have different origin and fundamental structures but perform similar functions are called **Analogous organs** and this phenomenon is called as analogy.

Examples of analogous organs:

- (i) **Wings of butterfly and birds:** They are not anatomically similar structures though they perform similar functions i.e. used for flying.
- (ii) **Eye of the octopus and of mammals**
- (iii) **Flippers of Penguins and Dolphins**
- (iv) **Sweet potato** (root modification) and **potato** (stem modification)
- (v) **Sting of bee and scorpion**
- (vi) **Chloragogen cells of earthworm and liver of vertebrates**

EXTRA KEY POINTS

- When different structures evolve for the same function due to the similar habitat, this is called **convergent evolution**.
- Analogy doesn't indicate common ancestry and it is based on convergent evolution where different group of organisms have similar adaptive features due to similar habitat or towards the same function, hence analogous structures are a result of convergent evolution.

(C) EVIDENCES FROM VESTIGIAL ORGANS:

- These organs are present in reduced form and do not perform any function in the body but are functional in related animals.
- They are remnants of organs which were complete and functional in their ancestors.
- *Vestigial organs are example of evolution and can be explained by lamarckism (Theory of inheritance of acquired character) and mutation theory.*
- Human body possess about 180 vestigial organs.

Examples:

- Nictitating membrane
- Muscles of pinna (auricular muscles)
- Vermiform appendix (Caecum)
- Coccyx
- Canine teeth
- Third molars (wisdom teeth)
- Body hair
- Nipples in males
- Segmented muscles of abdomen

(D) EVIDENCES FROM ATAVISM (REVERSION):

- Sometimes in some individuals such characters suddenly appear which were supposed to be present in their ancestors but were lost during the course of evolution, this phenomenon is called atavism or reversion.
- Atavism proves that animals developing atavistic structures have evolved from such ancestors in which these structures were fully developed.

E.g. – Tail in new born baby

- **Extra-long and pointed canine teeth**-represents carnivorous ancestors
- **Functional auricular/pinna muscles**
- **Long and thick body hair**-reflects our relationship with apes

(E) EVIDENCES FROM CONNECTING LINKS:

- Some organisms possess characters of two separate groups called as connecting links, which proves that members of higher groups have evolved from the lower group.

Examples:

- **Virus:** Between Living and Non-living
- **Euglena:** Between Plants and Animals
- **Proterospongia:** Between Protozoa and Porifera
- **Neopilina:** Between Annelida and Mollusca
- **Peripatus:** Between Annelida and Arthropoda
- **Balanoglossus:** Between Non-chordates and Chordates
- **Chimera:** Between Cartilaginous and Bony fishes
- **Protopterus (Lung fish):** Between Fishes and Amphibian
- **Platypus and Echidna:** Between Reptiles and Mammals
- **Missing (Fossil) Connecting links:**
 1. **Archaeopteryx:** Between Reptiles and Aves.
 2. **Seymouria:** Between Amphibia and Reptiles.
 3. **Lycaenops:** Between Reptiles and Mammals.



Living fossil: Only existing representative of a group, means all the member of that group have becomes extinct. They still show primitive characters.

- E.g.
- | | |
|-------------|--|
| - Limulus | - King Crab (An Arthropod) |
| - Latimeria | - Coelacanth (Bony Fish) |
| - Sphenodon | - Tuatara (reptile with pineal eye or third) |

(F) EVIDENCES FROM PHYSIOLOGY AND BIOCHEMISTRY

Different organism shows similarities in physiology and biochemistry like:

- **Protoplasm:** Structure and chemical composition of protoplasm is same from Protozoa to Mammalia.
- **Enzymes:** Enzymes perform same function in all animals.
- **Blood:** Chordates show almost same composition of blood.
- **ATP:** This energy rich molecule is formed for biological oxidation in all animals.
- **Hormones:** Secreted in different vertebrates have similar chemical structure and function.
- **Hereditary material:** Hereditary material is DNA in all organism.
- **Cytochrome C** is a respiratory protein situated in the mitochondria of all organism.

☞ **Physiology and biochemistry thus prove that all animals have shared ancestors in distant or recent past.**

(G) EVIDENCES FROM BIOGEOGRAPHICAL DISTRIBUTION

- “**Biogeography**” is the study of geographical distribution of animal and plant species in different parts of earth.
- Different animal species occurring in an area are called **Fauna** and those of plants are called **Flora**.
- It is believed that millions of years ago all the continents were present in the form of a single land mass called **Pangaea**.
- Later, due to continental drift, this huge single land mass broken in to pieces (**continents**) and separated by seas, which prevent the migration of animal and forced them to remain endemic (restricted area or continent).
- On the basis of variable environmental conditions prevailing on the different continents, over centuries these became independently into different biogeographical regions (**Realms**).
- Different habitats in different realm forced species to adapt in that particular habitat and nature had selected such adapted species. (**Adaptation and natural selection**)

EXTRA KEY POINTS

- In South America, mammals resembling horse, hippopotamus, bear, rabbit, etc. were present. Due to continental drift, when South America joined North America, these animals were overridden by North American fauna.
- In prehistoric time Australia was a part of Asian continent. After the evolution of prototherians from reptiles Australia got separated from mainland of Asia, later on eutherian mammals evolved in Asia which were carnivores in nature and they destroyed prototherians and marsupials from Asia but **pouched mammals (marsupials) of Australia survived because of lack of competition from any other mammals**.
 - Today eutherians are also found in Australia, because some of them evolved there and some were later transported by man.

(1) Adaptive radiation / Divergent evolution:

- The process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitat) is called adaptive radiation.
- Both the homology and adaptive radiation are based on divergent evolution.

Examples:

(i) Adaptive radiation of Darwin’s finches:

- Darwin visited to **Galapagos Island** by ship H.M.S Beagle (sea voyage). Galapagos Island consisted of about **22** different islands that have **many endemic** plant and animal species.
- He observed small black birds later called **Darwin finches**.
- All varieties evolved and radiated by a single ancestral seed-eating ground finch (root finch).
- Darwin conjectured that the ancestral seed eating finch radiated to different geographical area (habitat) and underwent profound **adaptive changes** and specially in **beak pattern** due to different feeding habits - (Insectivorous, vegetarian etc.) on Galapagos island itself.

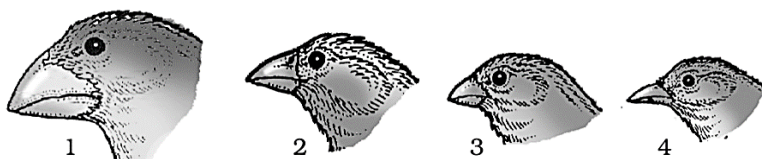


Fig. :- Variety of beaks of finches that Darwin found in Galapagos Island

(ii) Adaptive radiations of marsupials of Australia :

- Furthermore, Australia is the home to the great diversity of marsupials (Pouched mammals) but relatively few placental mammals.
- A number of marsupials, each different from other in morphology, feeding habit and habitats evolved from an ancestral stock but all within the Australian continent.

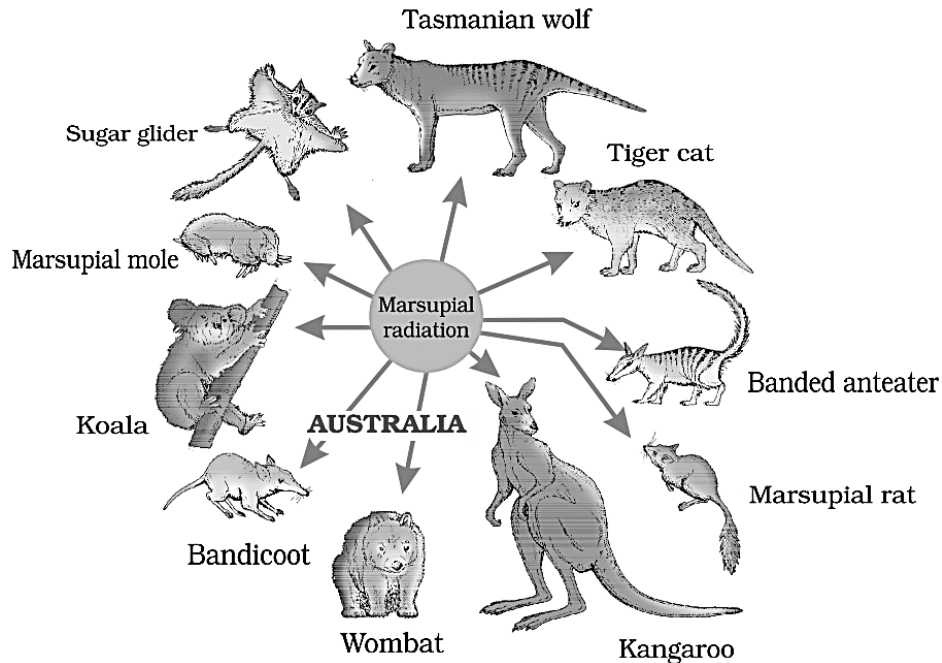


Fig. : Adaptive radiation of marsupials of Australia

(iii) Adaptive radiations of placental mammals: A number of placental mammals have evolved from a common ancestral type in other parts of world also. Placental mammals in Australia also exhibit adaptive radiation.

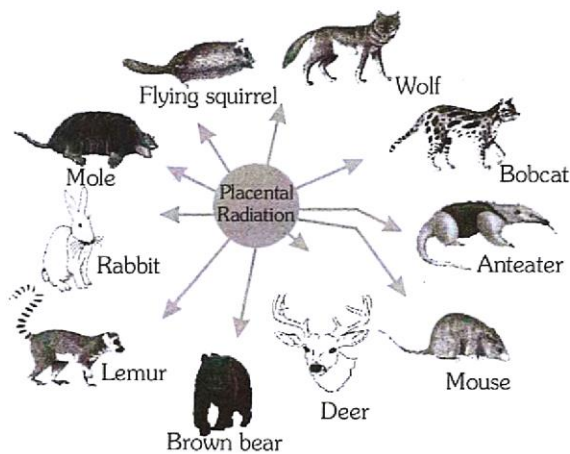




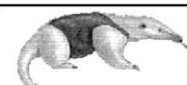

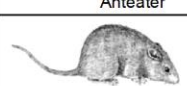

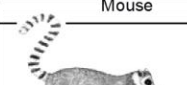
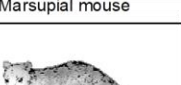

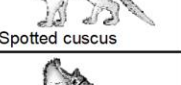
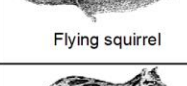
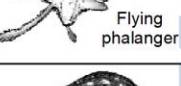
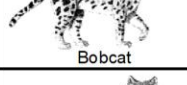
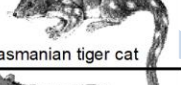
Fig. : Adaptive radiation in placental mammals

(2) Convergent evolution (Adaptive convergence) :

“When more than one adaptive radiation appeared to have occurred in an isolated geographical area (Representing different habitats) one can call this convergent evolution.

Examples:

(i) Similarity in Placental mammals and Marsupials in Australia (placental wolf and Tasmanian wolf).

Placental mammals	Australian marsupials
 Mole	 Marsupial mole
 Anteater	 Numbat (anteater)
 Mouse	 Marsupial mouse
 Lemur	 Spotted cuscus
 Flying squirrel	 Flying phalanger
 Bobcat	 Tasmanian tiger cat
 Wolf	 Tasmanian wolf

(ii) **Shark and Whale** (Various aquatic vertebrate that are not closely related but adapted to survive in aquatic habitat).

Special Note:

Parallel evolution : When adaptive convergence is found in closely related species, it is called as parallel evolution. Parallel evolution occurs when two independent but similar species evolve in the same direction and thus independently acquire similar characteristics. Example: Running habit in horse and deer.

(H) EVIDENCES FROM EMBRYOLOGY

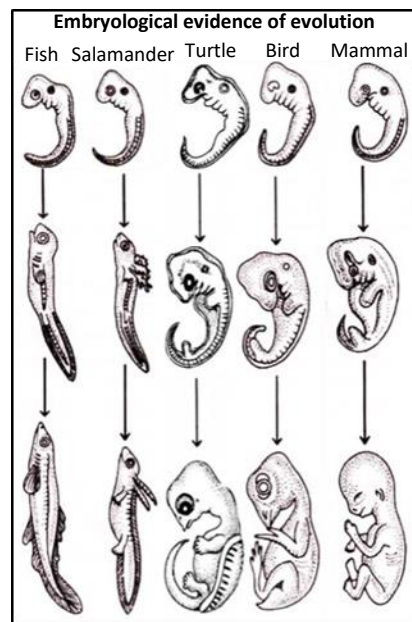
(1) Baer's Law:

- An organism shows its ancestor stages in its embryonic development.
- In embryo stage general characters appear first and specialized characters appears later. (Father of embryology).

(2) 'Recapitulation theory':

- Firstly, proposed by Muller and later explain by Ernst Haeckel.
- According to it '**ontogeny recapitulate phylogeny**' it means any organism shows its ancestral adult stages during its embryonic development.
- It shows that all organism evolved from a common ancestor.

(3) 'Biogenetic law': Ernst Haeckel explained it in detail and give the name Biogenetic law.



Examples :

- In fishes, the young individual, developing from gastrula, is almost-like the adult, but the tadpole larvae of amphibians bear more resemblance to the young once of fishes than to their own adults. This indicates **Origin of amphibians from fishes**.
- All vertebrates have Identical embryo in first stage and reptiles, birds and mammals show similarity upto late stage embryo. This proves that **All Vertebrates** have evolved from common fish like ancestors and also that reptiles, birds and mammals have shared ancestors in recent past.
- When the heart first develops in the embryos of amphibians, reptiles, birds and mammals, it is 2-chambered same as in the embryos and adults of fishes. In later stages of embryonic development in amphibians, reptiles, birds and mammals the heart become, 3-chambered. This condition is retained in adults of amphibians and most reptiles. In birds and mammals, the heart becomes 4-chambered in the last embryonic stages to continue as such in the Adults.
- Von Baer disapproved Haeckel's law and noted that embryo never pass only through the adult ancestral stages.



- **Evolutionary trend:** The continuous change of a character within an evolving lineage is termed as evolutionary trend.
- **Palaeontological** and **biogeographical** evidences are considered as best evidences in support of organic evolution.

PRACTICE SECTION-02

- Q.1** Fossilization can occur when:
 (1) Animals are buried and preserved by natural process
 (2) Animals are destroyed by scavengers
 (3) Animals are eaten by predators
 (4) Animals are destroyed by environmental conditions
- Q.2** Amphibians supposed to be evolved from the most primitive fish with stout and strong fins and could move on land and water, this was:
 (1) Jawless fish (2) Coelacanth (3) Chimera (4) Ichthyosaurs
- Q.3** Which of the following is not an example of convergent evolution?
 (1) Lemur and spotted cuscus (2) Bobcat and tasmanian tiger cat
 (3) Koala and wombat (4) Anteater and numbat
- Q.4** Which of the following is an example of homologous organ and indicates common origin?
 (1) Eyes of octopus and mammals (2) Potato and sweet potato
 (3) Heart of crocodile, pigeon and human (4) Wings of butterfly and crow
- Q.5** Which study shows similarities and differences among organisms of today and those that existed year?
 (1) Paleontological study (2) Embryological study
 (3) Geological study (4) Comparative anatomy and morphology
- Q.6** Which of the following option is correctly matched?
 (1) Age of reptile – Jurassic epochs (2) Golden age of fishes – Carboniferous era
 (3) Golden age of Amphibians – Palaeozoic era (4) Age of Birds & Mammals – Coenozoic era

- Q.7** Find out the incorrect statement :
- I. The first mammals were like shrews
 - II. Unlike amphibians, reptiles lay thick-shelled eggs
 - III. First organisms that invaded land were amphibians
 - IV. Bryophytes originate from rhynia-type plants
 - V. Mammals evolved from therapsids
- (1) II, III, IV, V (2) II, III, V (3) I, III, V (4) III, IV
- Q.8** Find out the correct sequence of evolution of different plant forms :
- (1) Tracheophyte ancestors → Chlorophyte ancestors → Psilophyton → Seed ferns
 - (2) Rhynia type plants → Psilophyton → Seed ferns → Progymnosperms
 - (3) Chlorophyte ancestors → Tracheophyte ancestors → Psilophyton → Rhynia type plants
 - (4) Psilophyton → Progymnosperm → Seed ferns → Angiosperms

ANSWER KEY								
Que.	1	2	3	4	5	6	7	8
Ans.	1	2	3	4	4	4	4	4

THEORIES OF ORGANIC EVOLUTION:

Following theories are given by different scientist regarding organic evolution:

- (A) Theory of Lamarck (Lamarckism)**
 - Criticism of Lamarckism: Germplasm theory (Weismann)
- (B) Theory of Darwin (Darwinism)**
- (C) Mutation theory (Hugo de Vries)**
- (D) Neo-Darwinism/ Modern synthetic theory of organic evolution**

(A) LAMARCKISM / Theory of inheritance of acquired characters:

- First logical theory of evolution was proposed by a French naturalist: **Jean Baptiste de Lamarck (1744-1829)**
- Book: **Philosophie Zoologique (1809)**

Basic concepts of Lamarckism:

- (i) Internal vital forces:** Due to the presence of some internal vital forces all organisms have the tendency to increase in size of their organs or entire body.
- (ii) Effect of environment and new needs:** Environment influences all type of organisms. Changing environment gives rise to new needs. New needs or desires produce new structures (doctrine of desire/appetency) and change habits of the organism.
- (iii) Use and disuse of organs:** If an organ is constantly used over generations, it would be better developed whereas disuse of organ results in its degeneration (vestigial organs).
- (iv) Inheritance of acquired characters:** During the life time of an organism, new characters develop due to internal vital forces, effect of environment, new needs or use and disuse of organs.
All these acquired characters are inherited from one generation to another. By continuous inheritance through several generations, the variations are accumulated up to such extent that they can give rise to new species.

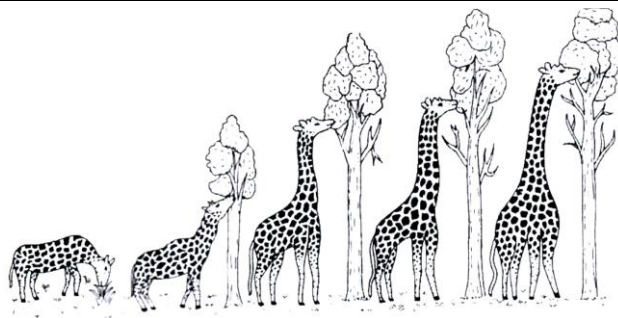


Fig :- Elongation of neck in giraffe according to Lamarck

Examples :

1. Long neck and forelimbs of giraffe:

Lamarck gave the example of Giraffes who in an attempt to forage leaves on tall trees had to adapt by elongation of their necks. As they passed on this acquired character of elongated neck to succeeding generations, Giraffes, slowly over the years came to acquire long necks.

2. Aquatic birds stretched their toes and developed web.

3. Snakes lost their legs.

- Lamarck had said that evolution of life forms had occurred but driven by use and disuse of organs. Nobody believes this conjecture any more.

Criticism of Lamarckism:

(1) Weismann's Theory of Continuity of Germplasm:

- Weismann cut off the tails of rats for as many as 22 generations and allowed them to breed, but tailless or reduced tailed rats were never born.
- On the basis of this experiment Weismann proposed the theory of continuity of germplasm.

According to this theory:

- Two types of protoplasts are present in an organism, **germplasm** and **somatoplasm**.
- There is a continuity of germplasm and the variations influencing the germ cells are only inherited but the somatoplasm is not transmitted to the next generation, hence it does not carry variations to next generation.

(2) Boring of ear pinna and nose in Indian women is never inherited to the next generations.

(3) Chinese women used to wear iron shoes in order to have small feet, but they still have normal feet.

(B) DARWINISM/ Theory of Natural Selection:

- Charles Robert Darwin was born on 12th Feb. 1809 in England.
- Darwin travelled by **H.M.S. Beagle** ship, which left on 27 Dec. 1831 and returned on 02 Oct. 1836 through S. America, S. Africa, Australia & Galapagos Islands.
- Darwin was influenced by two books-
 - (i) "Principles of population" of T.R. Malthus
 - (ii) "Principles of geology" of Charles Lyell
- **Alfred Russell Wallace**, a naturalist who worked in **Malay Archipelago** had also come to similar conclusions around the same time and he sent his conclusions to Darwin in form of a chart.
- This theory was later on explained by Darwin in his book 'On the **origin of species** by means of Natural selection' (1859).

KEY CONCEPTS OF DARWINISM:

- Two key concepts of Darwinian Theory of evolution are :
(A) Branching Descent **(B) Natural Selection**
- Natural selection is based on certain observations which are factual.
 - (i) **Over productions:**
 - All organisms have the capability to produce enormous number of offspring or organisms (multiply in geometric ratio).
 - Hence, theoretically population size will grow exponentially if everybody reproduced maximally (this fact can be seen in a growing bacterial population)
 - but the fact is that population sizes in reality remains almost same except seasonal fluctuations.
 - (ii) **Struggle for existence:**
 - Natural resources are limited and all progeny members of a population do not survive, means that there had been competition for resources (Food, Shelter, Water, Minerals etc.). Only some survived and grew at the cost of others that could not flourish. This is called **struggle for existence**.
 - It is of three types:
 - (a) Intra specific struggle:** It is competition among the individuals of same species for same needs like food, shelter and breeding. (Most acute type of struggle)
 - (b) Inter specific struggle:** It is the struggle among the individuals of different species for food and shelter. (According to Darwin interspecific struggle is a potent force in organic evolution).
 - (c) Environmental struggle:** This struggle is between the organisms and their environment. All organisms struggle with cold, heat, wind, rain, drought, flood etc.
 - (iii) **Variations and heredity:**
 - Members of a population vary in characteristics (in fact no two individuals are alike) even though they look superficially similar i.e. population has built in variation in characteristics.
 - Those characteristics which enable some to survive better in natural conditions (climate, food, physical factors, etc.) are called **adaptive or useful variations** while others are called as **non - adaptive or harmful variations**.
 - The novelty and brilliant insight of Darwin was he asserted that variations, which are heritable and which make resource utilisation better for few (adapted to habitat better) will enable only those to reproduce and leave more progeny.
 - (iv) **Natural selection/ Survival of the fittest:**
 - Individuals with more adaptive variations are “better fit” than the individuals with less adaptive variations. Hence, those who are better fit in an environment would be selected by nature for survival. Darwin called it **natural selection** and implied it as a mechanism of evolution.
 - **Fitness:** Nature always selects for fitness and fitness is based on characteristics (Adaptive variations) which are inherited.
 - **Fitness is the end result of the ability to adapt and get selected by nature.**
 - According to Darwin, fitness refers ultimately and only to **reproductive fitness**.
 - **Sexual selection:** It is observed that all adult individuals of a population don't have equal chances of mating, some males with better phenotype are preferred by females. This is called **Sexual selection**.
 - Therefore, those adult members which are reproductively better fit and have better phenotype would produce more progeny while others would produce less progeny (Differential reproduction).
 - As a result of heritable variations and natural selection there would be a change in population characteristic generation after generation and hence new forms appear to arise. (New species)

Criticism of Darwinism :

1. The main drawback of this theory is that Darwin didn't have the knowledge of genetics and he had no satisfactory explanation for the cause, origin and **inheritance** of variations.
2. Darwin was unable to differentiate the somatic and germinal variations.
3. This theory only explained survival of the fittest but was unable to explain **arrival** of the **fittest**.
4. Darwin was unable to explain why in a population only a few individuals develop useful variations and others have harmful variations.
5. Criticism of Darwinism was also based on **sexual selection**. Why only females have the right of selection for mating?
6. Darwin couldn't explain the existence of vestigial organs.

[C] MUTATION THEORY :

- This theory was proposed by **Hugo de Vries** based on his work on **evening primrose (Oenothera lamarckiana)**.
- Large differences arising suddenly in a population are called mutations. Actually, mutations are sudden changes of genetic material (DNA) and hence all are inheritable.
- In addition to recombination, mutation is another phenomenon that leads to variation in DNA.
- According to Hugo de Vries it is mutation which causes evolution and not the minor variations (heritable) that Darwin talked about.
- Mutations are **large, random** and **directionless** while Darwinian variations are **small** and **directional**.
- Evolution for Darwin was gradual while De Vries believed mutation caused speciation and hence called it **saltation** (single step large mutation).

Criticism :

- (i) Natural mutations are not very common as Hugo De Vries thought.
 - (ii) Mutations are normally **recessive & harmful**, while the characters taking part in evolution are usually dominant.
- Therefore, only mutation is not responsible for evolution. Although it has an important role in evolution.

☞ **Mutation is a discontinuous source of variations and provides raw material for evolution.**

[D] Neodarwinism / MODERN SYNTHETIC THEORY:

- This theory is the result of the work of a number of scientists namely **Dobzhansky, Fisher, Haldane, Sewall wright, Mayr, Stebbins** etc.
- Stebbins discussed this theory in his book "**Process of Organic Evolution**" and Dobzhansky explained it in his book "**Genetics and the origin of species**".
- According to this theory, many factors are responsible for evolution, like:
 - (a) Gene and chromosomal mutation
 - (b) Gene recombination
 - (c) Hybridization
 - (d) Gene Migration & Gene flow
 - (e) Genetic drift
 - (f) Natural Selection
 - (g) Reproductive isolation

- (a) **Gene and Chromosomal mutation:** They are **discontinuous or ultimate source of variations** which develop due to permanent changes in genotype.
- (b) **Gene recombination:** They are new combination of genes or alleles which are usually caused **by crossing over**.
- (c) **Hybridization:** It is crossing of organisms which are genetically different in one or more traits.
- (d) **Gene migration & Gene flow:** When migration of a section of population to another place and population occurs, gene frequencies change in the original as well as in the new population. New genes/alleles are added to the new population and these are lost from the old population.
- There would be a gene flow if this gene migration, happens multiple times.
- (e) **Genetic drift:** If the change in gene frequency occurs by chance, it is called genetic drift.
- (f) **Natural Selection:** Natural selection is a process in which heritable variations enabling better survival are enabled to reproduce and leave greater number of progenies.

A critical analysis makes us believe that variation results in changed frequency of genes and alleles in future generation. Coupled to enhance reproductive success, natural selection makes it look like different population and lead to new species formation.

- (g) **Reproductive Isolation:** Isolation is a segregation of populations by some barriers which prevent interbreeding. The reproductive isolation between the populations due to certain barriers leads to the formation of new species.

GENETIC DRIFT (Sewall Wright effect):

- It is the elimination or addition of the genes of certain characters when some animals in population migrate or dies or immigrate. It changes the gene or alleles frequency of remaining population.
- **Gene pool:** It is the sum total of all the genes found in a population. Loss or addition of genes/Allels in gene pool is called genetic drift.
- Overall, Random change of gene / allelic frequencies in a population merely **by chance** is called genetic drift.
- It operates in **small population**.
- It is due to habitat fragmentation, isolation, natural calamities or any epidemics.

Two forms of genetic drift:

(a) Founder effect:

When a section of population gets isolated or migrated or drifted from original population, then this section becomes genetically different from the original population due to change in allelic frequency because gene pool of this section may contain some alleles in a very low frequency or may lack a few alleles. Sometimes the change in allelic frequency is so different in the new sample of population that they become a different species. The original drifted population becomes **founders** for the new species and the effect is called founder effect.

- (b) **Bottleneck effect:** Death of several members of a population due to natural calamities (Earthquake, Storm, Flood) also leads to genetic drift. The original size of population is then restored by mating among the survivor. The new population may lack the genes of certain traits. This loss of a section of population by death may lead to formation of new species known as **Bottleneck effect**.

HARDY-WEINBERG PRINCIPLE:

- In a given population one can find out the frequency of occurrence of alleles of a gene or a locus. This frequency is supposed to remain fixed and even remain the same through generations.
- This principle says that allele frequencies in a **randomly mating** population are stable and is constant from generation to generation. The **gene pool** (total genes and their alleles in a population) remains a constant. This is called **genetic equilibrium**.
- Hardy-Weinberg law is applicable only in large population under the following conditions-
 - (i) There should be no mutation
 - (ii) No gene migration or gene flow
 - (iii) No genetic drift
 - (iv) No natural selection
 - (v) Must be random mating (not selective)
- Sum total of all the allelic frequencies is 1.

$$p + q = 1$$

Where $\begin{cases} p - \text{Frequency of dominant allele (A)} \\ q - \text{Frequency of recessive allele (a)} \end{cases}$

- The binomial expansion of this equation is:

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

Where $\begin{cases} p^2 - \text{Frequency of individuals with genotype AA} \\ q^2 - \text{Frequency of individuals with genotype aa} \\ 2pq - \text{Frequency of individuals with genotype Aa} \end{cases}$

- When frequency measured, differs from expected values, then the difference (direction) indicates the extent of evolutionary change. Disturbance in genetic equilibrium, or Hardy - Weinberg equilibrium, i.e., change of frequency of alleles in a population would then be interpreted as resulting in evolution.
- Five factors are known to affect Hardy-Weinberg (Genetic) equilibrium. These are :
 1. Gene migration or gene flow
 2. Genetic drift
 3. Mutation
 4. Natural selection
 5. Genetic recombination

EXTRA KEY POINTS

- **Population genetics:** Application of Mendelian genetics to Darwinian natural selection.
- **Hardy-Weinberg law:** Hardy Weinberg equilibrium that define the genetic structure of a non-evolving population.
- **Genetic Equilibrium:** If all other factors remain constant then the frequency of a particular gene and allele will remain constant in a population through generation to generation and such kind of genetic stability is called Genetic equilibrium.
- Hardy-Weinberg law gives a tool to determine whether evolution is occurring or not.

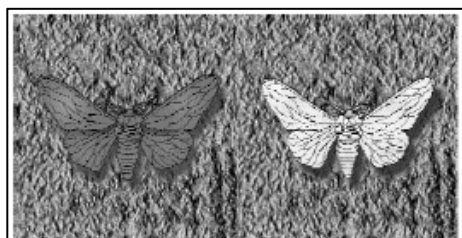
(I) EVIDENCES FROM ADAPTATION AND NATURAL SELECTION

NATURAL SELECTION

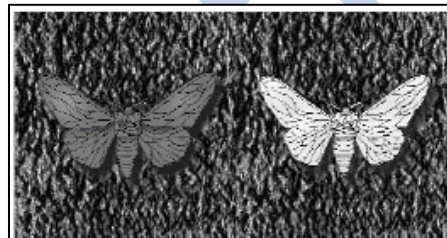
Examples of Natural Selection:

(1) **Industrial Melanism:** This phenomenon was studied by **Bernard Kettlewell** in England.

- In a collection of moths (*Biston betularia*) made in 1850s, i.e., before industrialisation set in, it was observed that there were more white-winged moths on trees than dark-winged or melanised moths.
- However, in the collection carried out from the same area, but after industrialization, i.e., in 1920, there were more dark-winged moths in the same area, i.e., the proportion was reversed.
- The explanation put forth for this observation was that “predators will spot a moth against a contrasting background”.



(a) In unpolluted area



(b) In polluted area

Figure showing white-winged moth and dark-winged moth (melanised) on a tree trunk

- Before industrialization set in, thick growth of almost white-coloured lichen covered the trees-in that background the white winged moth survived but the dark-coloured moth were picked out by predators.
 - **Lichens can be used as industrial pollution indicators.** They will not grow in areas that are polluted.
 - During post industrialization period, the tree trunks became dark due to industrial smoke and soot. Under this condition the white-winged moth did not survive due to predators while dark-winged or melanised moth survived.
 - Hence, moths that were able to camouflage themselves, i.e., hide in the background, survived.
 - This understanding is supported by the fact that in areas where industrialization did not occur e.g. in rural areas, the count of melanic moths was low.
 - This showed that in a mixed population, those that can better-adapt, survive and increase in population size. Remember that **no variant is completely wiped out.**
- (2) **Drug resistance:** The drugs which eliminate pathogens become ineffective in the course of time because those individuals of pathogenic species which can tolerate them survive and flourish to produce tolerant/resistant population.
- Excess use of herbicides, pesticides, etc., has only resulted in selection of resistant varieties in a much lesser time scale. This is also true for microbes against which we employ antibiotics or drugs against eukaryotic organisms / cell. Hence, resistant organisms/cells are appearing in a very less time scale of months or years and not centuries. These are examples of **evolution by anthropogenic action.**
 - This also tells us that evolution is not a directed process in the sense of determinism. Actually, evolution is a **stochastic process** based on chance events in nature and chance mutation in the organisms.

(3) Sickle cell anaemia and Malarial resistance:

- Individuals, homozygous for sickle cell anaemia die at an early stage due to anaemia and the individuals in which heterozygous condition is present for this character, the RBC become sickle shaped.
- In this type of RBC, malarial parasite can't have a normal growth and individuals become resistant towards malaria.
- The individuals with heterozygous condition have better chances of survival, hence are selected by nature.
- Thus, the process of natural selection maintains the abnormal form of hemoglobin along with the normal form in a region where malaria is common. This type of selection is also called **Balancing selection**. It means the preservation of genetic variability is maintained by the selection of heterozygote

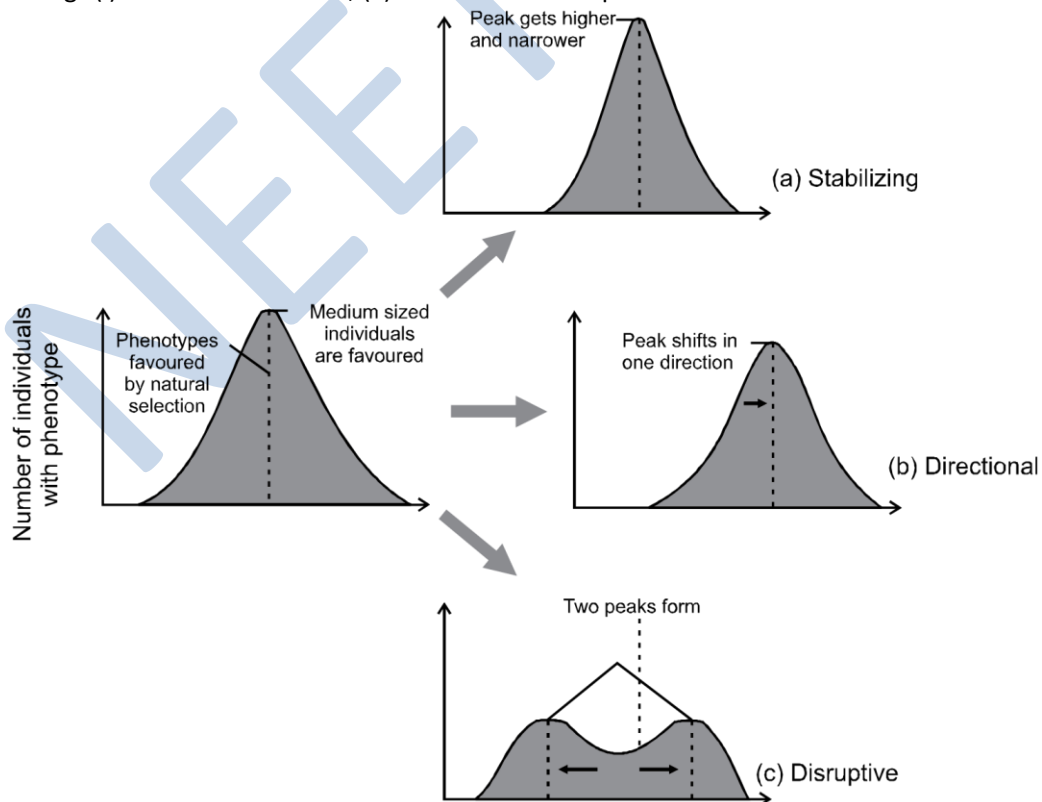
TYPES OF NATURAL SELECTION:

(1) Stabilizing selection:

- Peak gets higher and narrower because more individuals acquire mean character value.
 - Always operates in constant environment.
 - It favours the average or normal phenotype and eliminates the extreme variants.
 - After this natural selection mean value never change.
- e.g. **Mortality in human babies:** The optimum birth weight favoured by stabilizing selection is 3.3 Kg. New born infants with body weight less than 2.5 Kg and more than 4.5 Kg have the highest mortality rate.

(2) Directional / Progressive selection:

- Peak shifts in one direction, because more individuals acquire value other than the mean character value.
 - Always operates in changing environment.
 - It favours one extreme value and eliminates another extreme value and average value.
 - After this natural selection mean value always changes.
- e.g. (i) Industrial melanism; (ii) DDT resistance in pests



(3) Disruptive selection:

- In this natural selection, members of both extreme are selected simultaneously and average value get rejected.
- After this natural selection two peaks are formed because more individuals acquire peripheral character value at both ends of the distribution curve.
e.g. **Squirrel in Africa:** There are three types of squirrel in population, large sized squirrel can protect themselves by fighting against predators, small sized escapes by entering into burrows but average sized can neither fight nor escape (High death rate).

ARTIFICIAL SELECTION:

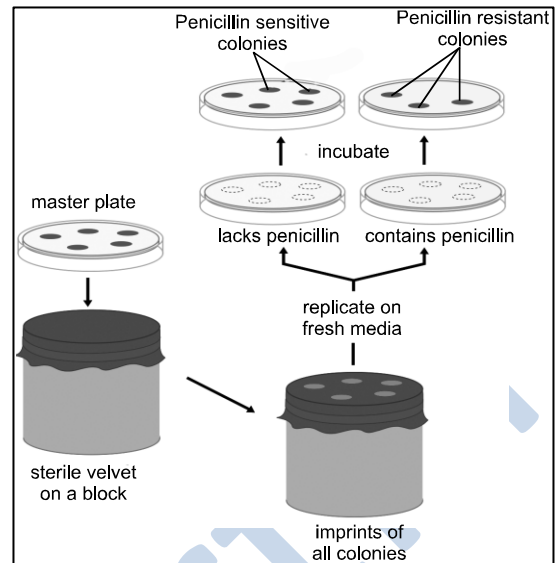
- Man has been taking the advantage of genetic variations for improving the qualities of **domesticated plants and animals**. He selects the individuals with desired characters and separates them from those which do not have such characters. The selected individuals are interbred. This process is termed as **Artificial Selection**. Thus, this process is man made. If it is repeated for many generations it produces a new breed with desired characters.
- By artificial selection animal breeders are able to produce improved varieties of domestic animals like **dogs, horse, pigeons, poultry, cows, goats, sheep and pigs** from their wild ancestors. Similarly, the plant breeders have obtained improved varieties of useful plants like **wheat, rice, sugarcane, cotton, pulses, vegetables, fruits etc.**
- Artificial Selection is similar to natural selection except that the role of nature is taken over by man and the characters selected are of human use.
- It is argued that if within the **hundreds of years** man would create **new** breed, could not nature have done the same over millions of years.

GENETIC BASIS OF ADAPTATIONS / NATURAL SELECTION:

- The essence of Darwinian Theory about evolution is natural selection.
- The rate of appearance of new forms is linked to the life cycle or the life span.
- Microbes that divide fast have the ability to multiply and become millions of individuals within hours.
- A colony of bacteria (say A) growing on a given medium has built in variation in terms of ability to utilise a feed component. A change in the medium composition would bring out only that part of the population (say B) that can survive under the new conditions. Here we say that fitness of B is better than that of A under the new conditions.
- In due course of time this variant population outgrows the others and appears as new species. This would happen within days.
- For the same thing to happen in a fish or fowl would take million of years as life spans of these animals are in years.
- Fitness or adaptive ability is based on characteristics which are inherited. It has a genetic basis. Hence, **there must be a genetic basis for getting selected and to evolve.**
- Microbial experiments show that pre-existing advantageous mutations when selected will result in observation of new phenotypes. Over few generations, this would result in Speciation.

Lederberg's replica plate experiment:

- Performed by Joshua Lederberg & Esther Lederberg.
- They cultured the bacterial cells on agar plate and obtained many bacterial colonies. This multi colony agar plate is known as **master plate**.
- They prepared a **replica** of this master plate by gently pressing it on a velvet covered wooden block.
- Now they tried to prepare a replica on the agar plate which contains antibiotic penicillin. It was seen that some bacteria failed to grow on penicillin agar plate while some bacteria were able to grow and developed new colony.
- It was concluded that the bacteria which survived were penicillin resistant because they had penicillin resistant mutant gene which enabled them to survive in changed environment.
- It means mutations are pre adaptive and natural selection fixes them in a population over the generations.



Reproductive Isolation:

- It is the prevention of inter breeding between the populations of two different or closely related species.
- It maintains the characters of the species but can lead to the origin of new species.
- This mechanism of reproductive isolation was explained by **Stebbins** in his book '**Process of Organic Evolution**'.

Two main subtypes:

- 1. Premating isolation:** Prevents mating between individuals of two different species.
 - (i) Ecological isolation:** Isolation due to different habitats of two species. For example, one may be living in fresh water and other in the sea.
 - (ii) Temporal isolation:** Due to difference in breeding seasons or flowering times of two species.
 - (iii) Behavioral isolation:** Due to difference in sexual or coitus behaviour of two species.
 - (iv) Mechanical isolation:** Due to incompatible external genital organs.
- 2. Post Mating Isolation:** Prevents formation of hybrid zygote and development of viable fertile adult.
 - (i) Gametic isolation:** the sperms and ova of different species can't fuse due to difference in their surface chemicals.
 - (ii) Hybrid inviability:** Hybrid zygote fails to develop. In plants, embryos arising from interspecific cross are not viable.
 - (iii) Hybrid sterility:** Hybrid adults are sterile and do not produce gametes.
e.g. Mules and hinny
 - (iv) Hybrid breakdown:** Sometimes inter specific mating produces a hybrid, which give rise to next hybrid by back cross but they have reduced vigour or fertility or both.
e.g. Tigon (African lioness + Asian tiger) and Liger (Male lion + Female tiger) hybrids are fertile but these species do not interbreed naturally.

EXTRA KEY POINTS

Is evolution a process or the result of a process?

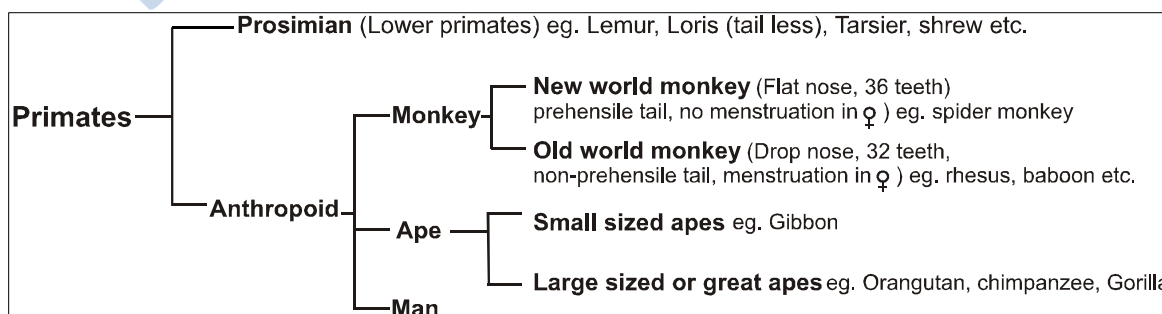
The world we see, inanimate and animate, is only the success stories of evolution. When we describe the story of this world we describe evolution as a process. On the other hand, when we describe the story of life on earth, we treat evolution as a consequence of a process called natural selection. We are still not every clear whether to regard evolution and natural selection as processes or end result of unknown processes.

- Unit of natural selection in an **individual**.
- Unit of evolution is **Population**.
- Genetic drift may accentuate the variations leading to appearance of new species and hence evolution.
- Homology is accounted for the idea of branching descent.
- According to De vries, evolution is a **jerky and discontinuous** process.
- The original idea of survival of fittest was proposed by **Herbert Spencer**.
- **Camouflage**: An organism shows resemblance with the surroundings (environment). e.g. praying mantis.

HUMAN EVOLUTION:

<u>Classification of Man</u>		
Phylum	-	<i>Chordata</i>
Subphylum	-	<i>Vertebrata</i>
Class	-	<i>Mammalia</i>
Subclass	-	<i>Eutheria</i>
Order	-	<i>Primates</i>
Suborder	-	<i>Anthropoidea</i>
Super family	-	<i>Hominoidae</i>
Family	-	<i>Hominidae</i>
Genus	-	<i>Homo</i>
Species	-	<i>sapiens</i>

- Human is a member of order Primata of class Mammalia.
- First real primate ancestors were tree shrews, originated in palaeocene epoch.
- Carolus linnaeus called human as Homo sapiens [wiseman].
- Huxley explained origin of man in his book 'The man's place in nature'.
- Darwin explained ancestry of man in his book 'The descent of man.'
- Primates originated 80-100 million years ago in palaeocene epoch of coenozoic era.
- Primates originated from elephant shrews but they were not real primates and gave birth to first real primates which are tree shrews.



	Apes	Human
1.	Semi erect posture and quadrupedal locomotion	Complete erect posture with bipedal locomotion
2.	Thick growth of hair on whole body	Body hair vestigial
3.	Less cranial capacity (450 cc) & less intelligent	More cranial capacity (1300-1600 cc) & more intelligent
4.	Forelimbs longer than hind limbs	Forelimbs shorter than hind limbs
5.	'U' shaped jaw & chin absent	Semicircular jaw & chin present
6.	Thumb is parallel to palm	Thumb is opposable

EVIDENCES FOR COMMON ORIGIN OF HUMAN & APES:

(1) Chromosomal similarities:

- Banding pattern of chromosome no. 3 & 6 of human and chimpanzee is 100% similar.
- Number of chromosomes are approx. same in human (46) and apes (48).
- DNA content and DNA matching are same in both.

This similarity is more than 99% with chimpanzee, 94% with Gibbon, 88% with Rhesus monkey.

(2) The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull.

(3) Composition of Hb is same in both. Only one amino acid is different in human and gorilla.

(4) Blood group of AB series is present in both and plasma protein is also same.

(5) Menstruation cycle is present in females of both.

(6) Tail is absent in both and have grasping hands.

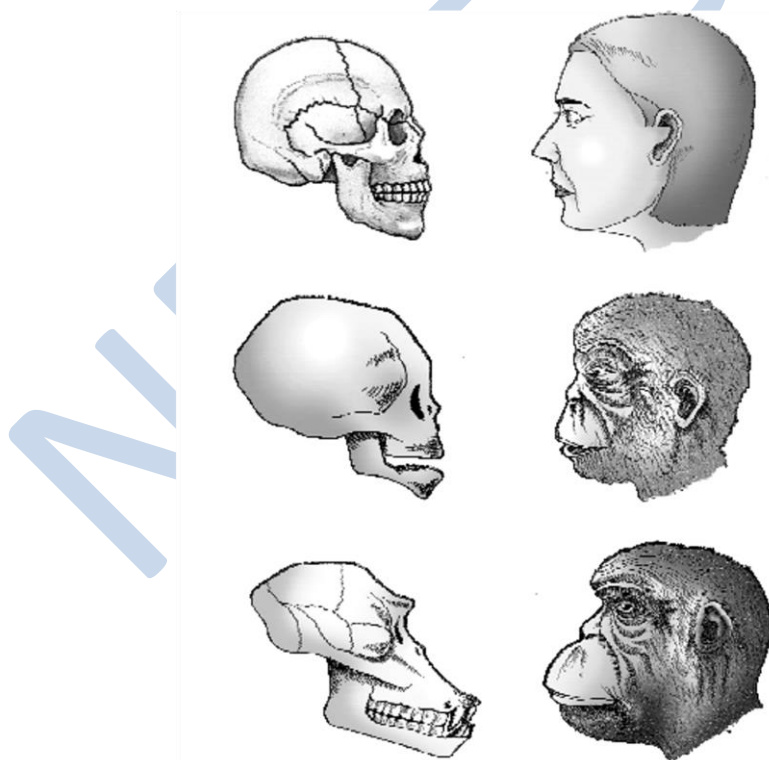


Fig.: A comparison of the skulls of adult modern human being, baby chimpanzee and adult chimpanzee.

The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull

Human Evolution:**(I) APE FOSSILS:**

About 15 mya, primates called **Dryopithecus** and **Ramapithecus** were existing. They were hairy and walked like gorillas and chimpanzees.

(1) Dryopithecus (Proconsul):

- It is considered as **common ancestor of man and apes**.
- Dryopithecus is considered as direct ancestors of modern-day apes.
- They had **semi erect posture**, thick hair, U shaped jaws, larger and sharper teeth and were vegetarian.
- They walked on four legs and their forelimbs were longer than hind limbs.
- They were forest dwellers and spent most of the time on the trees.

(2) Ramapithecus (Shivapithecus):

- They are considered as ancestors of human, similar in characteristics to Dryopithecus, but spent most of the time on the land.
- **Ramapithecus was more man-like while Dryopithecus was more ape-like.**

(II) APE MAN FOSSILS - AUSTRALOPITHECUS

- **Prof. Raymond Dart** discovered a fossil of skull of 5-6 years old baby from the Pliocene rocks of **Tuang** region (S. Africa) and named it **Tuang baby**. Later he renamed it as **A. africanus (African ape-man)**.
- 2 mya, **Australopithecines** probably lived in **East African grasslands**.
- Evidence shows they hunted with stone weapons but essentially **ate fruit**.
- It is also considered as connecting link between apes and man.

(i) Ape like characters:

- Less cranial capacity (**600 c.c.**)
- Thick growth of hair
- U-shaped jaw (prognathous face)
- Larger and sharper teeth

(ii) Man like characters :

- Complete erect posture and Bipedal locomotion (**first man who stood erect**)
- Forelimbs shorter than hind limbs
- Vertebral column with distinct lumber curve

EXTRA KEY POINTS

- Few fossils of man-like bones have been discovered in Ethiopia and Tanzania.
- These revealed hominid features leading to the belief that about 3-4 mya, man-like primates walked in eastern Africa.
- They were probably not taller than 4 feet but walked up right.

BIOLOGY

(III) PREHISTORIC MAN:

A number of other species of Homo appeared and became extinct from time to time on the evolutionary sense before the origin of Homo sapiens. These extinct species are called as prehistoric species of man.

(1) Homo habilis:

- First human like being
- First man who made tools of stones for hunting animals, hence called as **first tool maker man** or **Handy man**.
- They probably did not eat meat.
- The brain capacities were between **650-800cc**.
- Its fossils were discovered by Dr. Leakey from **2 million years old** rocks in Africa.
- They lived in caves.

(2) Homo erectus:

- They existed about 1.5 million years ago.
- They had large brain with a cranial capacity around **900cc**.
- They were cave dwellers and probably **ate meat**.
- Many subspecies are discovered of Homo erectus as given below.

(a) Java man (Homo erectus / Pithecanthropus erectus) :

- Its fossils discovered in **Java** in 1891.
- **First man who used fire** for hunting, protection and cooking.
- They used tools of bones and stones.
- Their cranial capacity was 800-1000 cc (**avg. 900cc**)
- They were omnivorous and cannibalism have also found.

(b) Peking man (Homo erectus pekinensis / Sinanthropus erectus) :

- W.C. Pei discovered the fossils from China.
- They used fire for cooking meat and protection.
- They used sharp **chisel shaped** tools of stones / bones for cutting and killing animals.
- Their cranial capacity was 850-1300 cc (**avg. 1050cc**)
- They were omnivorous and cannibalism have also found.

(c) Heidelberg man:

- Its fossil was recovered in form of lower jaw from Heidelberg in Germany.
- It is believed that this man was evolved as a branch from main line of evolution and got extinct after some time.

(3) Homo sapiens:

- Many subspecies are discovered of Homo sapiens as given below.
- Semi circular jaw and **orthognathous face**.

(a) Neanderthal man (Homo sapiens neanderthalensis):

- They lived near east and central Asia between 1,00,000 - 40,000 years back, fossil was discovered by Fuhrirott in **Neanderthal valley of Germany**.
- They had a brain size of **1400cc** (same as modern man).
- They used hides (skin of animals) to protect their body.
- They **buried their dead** and probably believed in **immortality of soul**.
- They lived in huts and omnivorous by nature.
- Development of speech and language centre started.

(b) Cromagnon man (Homo sapiens fossilis) :

- Origin and evolution 50,000 to 10,000 years ago.
- Fossils discovered by Mac Gregor from **Cromagnon rocks of France**.
- They had a cranial capacity of **1650 c.c. (maximum)**.
- They lived in caves.
- They had larger forehead and well-developed chin.
- Speech and language centre were well developed in them.
- They wore clothes of animal skin.
- This man was hunter and used domesticated dogs in hunting, hence **domestication was started** by this man.
- They also **Painted beautiful paintings on cave walls**. Pre-historic cave art developed about **18,000 years ago**.

(c) Modern man (Homo sapiens sapiens) :

- During ice age between 75,000-10,000 years ago modern Homo sapiens arose.
- It arose in Africa and moved across continents and developed into distinct races (Caucasoid, Negroid, Mongoloid and Australoid).
- This is the **man of today** having a brain capacity of 1300 - 1600 c.c. (**avg. 1450cc**).
- This man has well developed chin, well developed speech centre, smaller forehead and reduced body hair.
- It is omnivorous by nature.
- **Agriculture** was also started by this man. Agriculture came around **10,000 years back** and human settlements started.
- Among the stories of evolution of individual species, the story of evolution of modern man is most interesting and appears to parallel evolution of human brain and language.



- Chimpanzee is closest ape to human.
- Gibbon is the only ape that found in India (forests of Assam).
- **Homo erectus** is the **direct ancestor of Homo sapiens**.
 - **Cro-Magnon man** is the **direct ancestor of modern man (Homo sapiens sapiens)**.

EXTRA KEY POINTS

- Evolution term was introduced by **Herbert Spencer**.
- **Louis Pasteur** also proposed the '**Germ theory of diseases**' and he is famous for his **pasteurization technique**.
- From proto cells or eobionts few cores of nucleoproteins get separated in oceans and became inactive but when they enter in another eobionts they became active so virus like structures were formed. This is an example of **retrogressive evolution**.
- **Birbal Sahni**: Famous for Indian palaeontology
- **Two branches of palaeontology**:
 1. **Palaeobotany**: Study of plant fossils
 2. **Palaeozoology**: Study of Animal fossils
 - India is situated in Oriental realm.
 - Palaeartic and Oriental realms are separated by high Himalayan Mountains.
 - The aquatic mammals like Dolphins, Whales, Seals and Porpoises don't have gills slits, because their adaptation to aquatic life is **secondary**.

SPECIATION : Formation of one or more new species from an existing species is called speciation.

Two types: (1) Divergent speciation (2) Transformation speciation

(1) Divergent speciation: When one or more new species are formed from an ancestor species.

(a) Allopatric speciation: When a species split into two or more geographically isolated populations and these populations finally form a new species. It is called allopatric speciation e.g. Darwin finches.

(b) Sympatric speciation: In this type of speciation a sub population becomes reproductively isolated from its parental population. It is the formation of species without geographical isolation. e.g. mainly present in plants due to polyploidy.

(2) Transformation speciation: When an ancestor species changes into a new species.

(a) Phyletic speciation: Ancestor species changes into new species by gradual changes in thousands of years. e.g. Eohippus → Mesohippus → Merychippus → Pliohippus → Equus

(b) Quantum speciation: In this process suddenly, major changes appear in ancestor species and ancestor species immediately changed into new species. No connective links are present in this type of speciation. It is caused by major mutation.

MIMICRY :

- The term mimicry was given by **Bates**.
 - It is a kind of adaptation.
 - Mimicry is the resemblance of one organism to other organisms for the purpose of concealment, protection or for some other advantage like attack.
 - The organism which exhibits mimicry is called a **mimic** and the organism or natural object which is mimicked is called as **model**.
- 1. Batesian mimicry:** When a tasteful organism resembles a distasteful or poisonous organism.
e.g. (i) Scarlet king snake (mimic) and Coral snake (model).
(ii) Viceroy butterfly (mimic) and Monarch butterfly (model).
 - 2. Mullerian mimicry:** When two or more inedible or unpalatable species resemble each other, than this type of mimicry is called mullerian mimicry. Mullerian mimicry is done by two species for increasing warning effect to predators.
e.g. Ctenuchid moth resembles a wasp, where both of them are unpalatable.

Types of Evolution:

- (i) Micro evolution:** Occurrence of small-scale changes in gene frequencies in a population, over a few generations. It occurs at or below the species level. e.g. Formation of subspecies or races.
- (ii) Macro evolution:** Macro evolution operates above the species level and results in the formation of new genera, families and orders, e.g. Australian marsupials.
- (iii) Mega evolution:** The origin and evolution of new classes, phyla etc. e.g., Origin of amphibia from fishes, origin of reptiles from amphibia, origin of birds and mammals from reptiles.
 - Elephants and lions are mainly found in Africa and India.
 - Giraffe, Zebra and hippopotamus are found only in Africa.
 - Main land of human evolution is Africa.

PRACTICE SECTION-03

- Q.1** Name of the scientist who gave Mutation Theory:
(1) Wallace (2) Malthus (3) Darwin (4) De Vries
- Q.2** According to Lamarck, Snakes do not have legs because :
(1) Legs created hurdle during entry in tunnels, so gradually degenerated and finally lost
(2) Legs are lost due to excess use
(3) The ancestors of reptiles did not have legs
(4) There are no legs in lizards
- Q.3** Genetic drift operates in :
(1) Small isolated population (2) Large isolated population
(3) Fast reproductive population (4) Slow reproductive population
- Q.4** Hardy - Weinberg law is applicable in :
(1) Small population (2) Evolving population
(3) Randomly mating population (4) Selectively mating population
- Q.5** "Excess use of herbicides and pesticides has only resulted in selection of resistant varieties in a much lesser time scale". This is example of evolution by :
(1) Anthropogenic action (2) Artificial selection
(3) Environmental action (4) Both (1) and (3)
- Q.6** Branching descent and ___A___ are the two key concepts of ___B___ theory of evolution.
Find out the correct option for A and B.
(1) A–Speciation, B–Darwinian (2) A–Inheritance of acquired traits, B–Lamarckian
(3) A–Natural selection, B–Lamarckian (4) A–Natural selection, B–Darwinian
- Q.7** Read the following features and find out the correct identification:
I. First human like being
II. Probably did not eat meat
III. Brain capacity between 650-800 cc.
(1) Homo erectus (2) Dryopithecus (3) Homo habilis (4) Neanderthal man
- Q.8** The evolution of life forms is a :
(1) Rapid phenomenon (2) Gradual phenomenon
(3) Intense phenomenon (4) Both (2) and (3)

ANSWER KEY

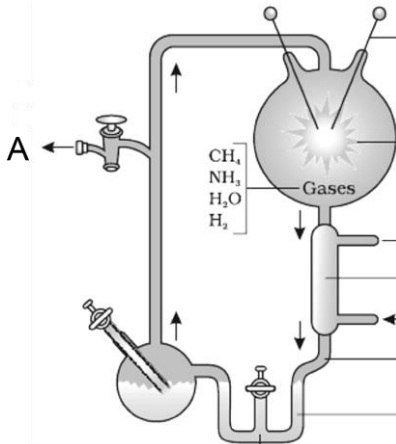
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EXERCISE-I

Topic-wise Questions

ORIGIN OF LIFE

Q.1 There is a diagrammatic representation of miller's experiment, what was the use of structure-A in this experiment:



- (1) Supply of water vapour
- (2) For making apparatus oxygen free
- (3) For removal of water after condensation
- (4) For maintaining normal air pressure within the apparatus

Q.2 Which of the following story is related with the context of evolution of earth?

- (1) Origin of life
- (2) Evolution of life forms
- (3) Biodiversity on earth
- (4) All of these

Q.3 When was life appeared on earth?

- (1) Almost 20 billion years back
- (2) 500 million years after the formation of earth
- (3) Almost 4 billion years back
- (4) Both (2) and (3) options are correct

Q.4 Time gap in between formation of universe & origin of life is :

- (1) 16000 Million years
- (2) 500 Million years
- (3) 3000 Million years
- (4) 4000 Million years

Q.5 Read the following statements:

- (i) Atmosphere was absent on primitive earth
- (ii) Universe expanded hence temperature came down
- (iii) Nebulae get condensed under gravitation and formed galaxies of the present-day universe.
- (iv) H_2 and He formed later.

Select the correct option:

- (1) (i), (iii) and (iv) statements are true while (ii) is false
- (2) (i), (ii) statements are true while (iii), (iv) are false
- (3) (i), (ii), (iii) statements are true while (iv) is false
- (4) (i), (ii), (iii), (iv) all statements are true

Q.6 Miller performed his experiment in:

- (1) 1753 (2) 1901 (3) 1765 (4) 1953

Q.7 According to the theory of special creation, which connotation is correct?

- (1) Earth is about 4000 years old.
- (2) All living organisms that we see today were not created as such
- (3) Diversity was always same since creation but will not be same in future.
- (4) All are correct

Q.8 Process of evolution is:

- (1) Continuous
- (2) Continuous in the past but discontinuous presently
- (3) Discontinuous
- (4) Discontinuous in the past but continuous presently

Q.9 Which compounds were formed in the direction of the origin of life?

- (1) Urea, nucleic-acid
- (2) Urea, amino-acid
- (3) Proteins, nucleic-acid
- (4) Protein, Urea

- Q.10** Which of the following is not found in a coacervate droplet or a proteinoid microsphere?
- (1) Droplets of giant molecules
 - (2) Partial isolation
 - (3) Lipid coat
 - (4) Ability to reproduce
- Q.11** What is most important for origin of life?
- (1) Carbon
 - (2) Oxygen
 - (3) Water
 - (4) Nitrogen
- Q.12** Pasteur succeeded in disproving the theory of spontaneous generation because :
- (1) The laboratory was clean
 - (2) He pulled out the neck of flask into a tube
 - (3) He was lucky
 - (4) Yeast used in flask were dead
- Q.13** According to modern theory, the basis of origin of life is :
- (1) Abiogenesis
 - (2) God's desire
 - (3) Sunlight on mud
 - (4) Special creation
- Q.14** Oxygen in atmosphere has been formed by :
- (1) Evaporation of water
 - (2) Photosynthesis of blue green algae
 - (3) Metabolism of microorganisms
 - (4) Decaying organisms
- Q.15** "For a long time it was also believed that life came out of decaying and rotting matter like straw, mud etc." this theory was dismissed by experiment of which scientist ?
- (1) Oparin and Haldane
 - (2) Louis pasteur
 - (3) Miller and ury
 - (4) Charles Darwin
- Q.16** Who called larger colloidal particles of primitive sea as coacervates?
- (1) Fox
 - (2) Oparin
 - (3) Empedocles
 - (4) Haldane
- Q.17** Who called water of primitive sea as pre biotic soup?
- (1) Haldane
 - (2) Oparin
 - (3) Fox
 - (4) Huxley
- Q.18** Water vapour, CH₄, CO₂ and NH₃ like gases of early earth came from :
- (1) Lightening
 - (2) Formed during chemical evolution
 - (3) Ocean
 - (4) River containing Bacteria
- Q.19** Believers of spontaneous generation theory believed that :
- (1) Life originated from living organisms
 - (2) Life originated from non-living matter spontaneously
 - (3) Life originated from similar organisms
 - (4) Life originated from air
- Q.20** Oparin and haldane theory is based on :
- (1) Biogenesis
 - (2) Spontaneous generation
 - (3) God's will
 - (4) Artificial synthesis
- Q.21** During the course of origin of life what was the sequence of substances which appeared on earth?
- (1) Water, oxygen, nucleic acids, enzymes
 - (2) Amino acids, ammonia, phosphates, nucleic acids
 - (3) Glucose, amino acids, nucleic acids, proteins
 - (4) Ammonia, Amino acids, proteins, nucleic acids
- Q.22** It is believed that the first organisms which inhabited earth's surface were :
- (1) Autotrophs
 - (2) Mixotrophs
 - (3) Heterotrophs
 - (4) Chemoautotrophs
- Q.23** Which one of the following experiments suggests that simplest living organisms could not have originated spontaneously from non-living matter?
- (1) Larvae could appear in decaying organic matter
 - (2) Meat was not spoiled when heated and kept sealed in a vessel
 - (3) Microbes did not appear in stored meat
 - (4) Microbes appeared from unsterilized organic matter

BIOLOGY

- Q.24** A compound having very important role in prebiotic evolution was :
- (1) SO₂ (2) CH₄
(3) SO₃ (4) NO
- Q.25** Under certain conditions scientists have obtained some aggregates of giant molecules. These are known as :
- (1) Microbes (2) Protists
(3) Protobionts (4) Pre biotic soup
- Q.26** According to early Greek thinkers, unit of life were transferred to different planets including earth. This view of origin of life is studied under:
- (1) Theory of biogenesis
(2) Theory of abiogenesis
(3) Theory of special creation
(4) Theory of panspermia
- Q.27** Life cannot originate from inorganic materials at present because :
- (1) High degree of environmental pollution
(2) A very high amount of oxygen in the atmosphere
(3) Very high atmospheric temperature
(4) Absence of raw materials
- Q.28** Who did an experiment to prove that "The organic compounds were the basis of life" ?
- (1) Darwin
(2) Stanley Miller and Harold C. Urey
(3) Huxley and Harvey
(4) Fox
- Q.29** Due to discovery of which of the following in 1980, the evolution was termed as RNA world:
- (1) m-RNA, t-RNA, r-RNA synthesise proteins
(2) In some virus RNA is genetic material
(3) RNA has enzymatic property
(4) RNA is not found in all cells
- Q.30** As per the thought of early greek thinkers, unit of life is called :
- (1) Cell (2) DNA
(3) Gene (4) Spores
- Q.31** First life form on earth was :
- (1) Cyanobacteria
(2) Autotrophs
(3) Chemoheterotrophs
(4) Photoautotrophs
- Q.32** There is no life on moon due to the absence of:
- (1) O₂ (2) Water
(3) Light (4) Temperature
- Q.33** During chemical evolution, key biological compounds were synthesised:
- (1) In the fresh water
(2) Along the ocean shore
(3) In the ocean
(4) Nile river
- Q.34** Miller and Urey performed an experiment to prove the origin of life. They took gases NH₃ and H₂ along with :
- (1) N₂ and H₂O (2) H₂O and CH₄
(3) CH₄ and N₂ (4) CO₂ and NH₃
- Q.35** Abiogenesis is the :
- (1) Origin of life from non-living material
(2) Origin of life from living organism
(3) Origin of viruses and microbes
(4) None
- Q.36** Theory of Spontaneous generation or abiogenesis was postulated by :
- (1) Greek scientist (2) American scientists
(3) Dutch scientist (4) British scientist
- Q.37** Which of the following was not found in free form during origin of life ?
- (1) Ammonia (2) Methane
(3) Oxygen (4) Hydrogen
- Q.38** Who gave experimental proof that hydrogen, methane, water and ammonia gave rise to amino acids ?
- (1) Stanley Miller (2) Charles Darwin
(3) Lamarck (4) Oparin
- Q.39** Oparin of A and Haldane of B proposed that the first form of life could have come from pre-existing C molecules and that form of life was preceded by chemical evolution. Suitable fill ups for above blanks A, B, C will be:
- (1) A- Russia, B-England, C- Non-living organic
(2) A- Russia, B- England, C-Non-living inorganic
(3) A- England, B-Russia, C- Non-living organic
(4) A- England, B-Russia, C- Non-Living organic

Q.40 Suitable and proper definition of chemical evolution is :

- (1) Formation of diverse organic molecules from inorganic constituents
- (2) Chemical changes on primitive earth that gave rise to the first form of life
- (3) First step in development of life on this planet through chemical reactions in the oceans
- (4) All are defining chemical evolution

Q.41 Here are given four options regarding first origin of life and universe as well. You have to select incorrect one :

- (1) Conditions on early earth were high temp., volcanic storms, reducing atmosphere containing CH_4 , NH_3 , H_2
- (2) Chemical evolution of life proposed by miller and Harold ury
- (3) S.L. Miller an American scientist was the great supporter of oparin
- (4) Because of absence of O_3 layer, UV rays from sun directly reached on earth

Q.42 Theory of special creation was greatly challenged during :

- (1) 19th Century
- (2) 18th Century
- (3) 17th Century
- (4) 20th Century

Q.43 When we look at stars on a clear night sky, we apparently are peeping into the past, because :

- (1) We can know about our past by seeing these stars
- (2) When we see objects in our immediate surrounding we see them in present time
- (3) Light emitted by these stars took thousands or millions of years to reach upto our eyes
- (4) We can see them in real time but it happens occasionally

Q.44 Mark the **incorrect** statement about the evolution of life forms on the behalf of fossil records:

- (1) Life forms varied over the period of time
- (2) Some life forms restricted to certain geological periods
- (3) Diversity was same since creation and will be same in future also
- (4) New life forms have arisen at different times in the history of earth

Q.45 Which of the following can be considered as an evidence for first part of the conjectured story of oparin and haldane:

- (1) S.L. Miller's experiment
- (2) Louis pasteur's experiment
- (3) Analysis of meteorite content
- (4) Both (1) and (3)

Q.46 Which of the following statement is not correct regarding the conjectured story of oparin and haldane about origin of life ?

- (1) Life could have come from non-living organic molecules
- (2) Formation of life was preceded by chemical evolution
- (3) The first organism were probably chemoheterotrophic bacterias
- (4) Chemical evolution took place at 800°C and source of energy was electric discharge

Q.47 Which one of the following statements is correct?

- (1) The Big bang theory attempts to explain to us the origin of life
- (2) Analogy is based on divergent evolution whereas homology refers to a situation exactly opposite.
- (3) The geological history of earth closely correlates with the biological history of earth.
- (4) All are correct

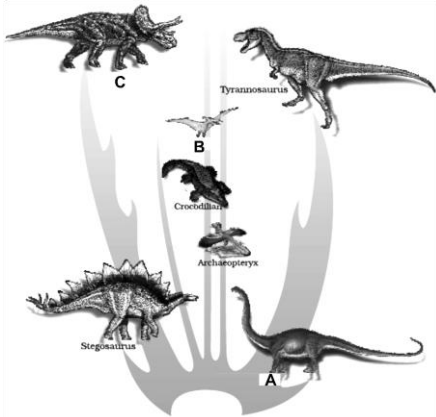
EVIDENCES OF EVOLUTION

Q.48 Which of the following evolutionary change is not observed when we study horse pedigree?

- (1) Increase of height
- (2) Reduction in number of digits
- (3) Loss of body weight
- (4) Increase of brain size

BIOLOGY

Q.49 Given below is the family tree of Reptiles and their living modern day counterpart organisms like Crocodiles, Birds. In this tree some counterparts are indicated as **A, B, C** and you have to select the option which is true for them



- (1) A -Ichthyosaurs, B-Birds, C-Mammals
- (2) A-Brachiosaurs, B-Pteranodon, C-Triceratops
- (3) A-Therapsid, B-Anapsid, C-Pteranodon
- (4) A-Anapsid, B-Therapsid, C-Pteranodon

Q.50 Darwin's finches differ with each other on the basis of:

- (1) Feather (2) Beak
- (3) Colour of eye (4) Body colour

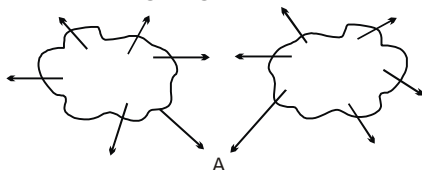
Q.51 Homologous organs are similar in origin and anatomy but perform different function generally. It is due to:

- (1) Adaptation of different needs in different geographical area
- (2) Adaptation to similar need in similar geographical area
- (3) Mutation
- (4) Protection and defence

Q.52 Which is not vestigial organ in man?

- (1) Pinna (2) Pinna muscles
- (3) Wisdom tooth (4) Body hairs

Q.53 Which pattern of evolution is indicated by "A" in the following diagram?



- (1) Adaptive radiation
- (2) Convergent evolution
- (3) Divergent evolution
- (4) Natural selection

Q.54 Which of the following set in man includes vestigial organs?

- (1) Coccyx, vermiform appendix and ear muscles
- (2) Body hair, atlas vertebra and ear muscles
- (3) Coccyx, wisdom tooth and patella
- (4) Body hair, cochlea, vermiform appendix and tongue.

Q.55 In some animals of different groups different structure developed along same direction due to Adaptation to same needs this is called as :

- (1) Divergent evolution
- (2) Convergent evolution
- (3) Parallel evolution
- (4) None of these

Q.56 Find the incorrect statement regarding fossils:

- (1) Fossils are hard parts of life forms found in water bodies
- (2) Fossils are rarely found in sedimentary rocks
- (3) By fossils we can not study the evolutionary pedigree of elephants
- (4) All are incorrect

Q.57 According to Haeckel's biogenetic law:

- (1) Development of individual organism shows embryonic characters of ancestors.
- (2) Ontogeny repeats phylogeny
- (3) Germplasm is immortal
- (4) Every organism is produced by its parents

Q.58 I. Use and disuse of organs.

II. inheritance of acquired characters.

III. Branching descent.

IV. Natural selection

V. Mutation

VI. Reproductive isolation.

The key concepts of Darwinism from the given options are:

- (1) I and II (2) III and IV
- (3) V and VI (4) IV and VI

Q.59 Presence of coelacanth fish was observed in:

- (1) South America (2) South Africa
- (3) North America (4) North Africa

Q.60 Which of the following set has homologous organs ?

- (1) Hands of man, monkey and kangaroo and trunk of elephant
- (2) Wings of insects, birds and bats
- (3) Hind limbs of grasshopper, horse and bat
- (4) Mouthparts of cockroach, mosquito and honey bee

Q.61 The biggest land reptile was :

- (1) Pelycosaurs
- (2) Calotes
- (3) Tyrannosaurus
- (4) Triceratops

Q.62 Who was the first to explain recapitulation theory in detail ?

- (1) Weismann
- (2) Haeckel
- (3) Darwin
- (4) Malthus

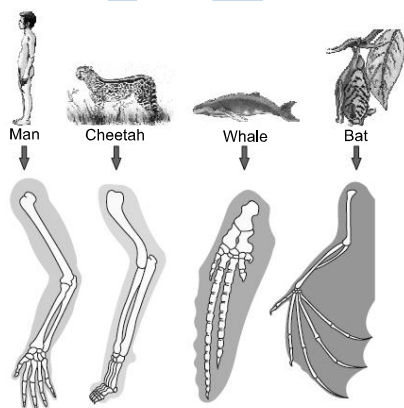
Q.63 Connecting link between annelida and mollusca:

- (1) Balanoglossus
- (2) Lung fish
- (3) Neopilina
- (4) Peripatus

Q.64 Evolution of life shows that life forms had a trend of moving from :

- (1) Land to water
- (2) Dry land to wet land
- (3) Fresh water to sea water
- (4) Water to land

Q.65 Mark the correct option regarding the animals shown in the adjacent figure :



- (1) It indicates their common ancestry
- (2) It indicates divergent evolution
- (3) It shows homologous organs
- (4) All of the above

Q.66 Which of the following sets do not have homologous organs ?

- (1) Wings of mosquito and butterfly
- (2) Wings of butterfly and bat
- (3) carrot and radish
- (4) Heart in all vertebrates

Q.67 Wings of locust, and bat are example of :

- (1) Vestigial organs
- (2) Analogous organs
- (3) Homologous organs
- (4) Atavism

Q.68 Homology is exhibited by :

- (1) Wings of butterfly, birds and bat
- (2) Paddle of whale, forearm of horse and forelimbs of man
- (3) Flippers of penguin and dolphin
- (4) Sting of scorpion and Apis

Q.69 Evolution of first birds and mammals occurred in :

- (1) Eocene and oligocene periods
- (2) Silurian and devonian periods
- (3) Carboniferous and Permian periods
- (4) Cretaceous and triassic periods

Q.70 The mesozoic era of earth is called the :

- (1) Age of amphibians
- (2) Age of armoured fishes
- (3) Age of mammals
- (4) Age of reptiles

Q.71 Fossils are generally found in :

- (1) Sedimentary rocks
- (2) Igneous rocks
- (3) Metamorphic rocks
- (4) Any type of rock

Q.72 An era "age of birds and mammals" is :

- (1) Mesozoic
- (2) Palaeozoic
- (3) Cenozoic
- (4) Cretaceous

Q.73 Origin of life took place in which of the following era :

- (1) Mesozoic
- (2) Palaeozoic
- (3) Archaeozoic
- (4) Proterozoic

Q.74 Homologous organs are :

- (1) Dissimilar origin and dissimilar structures
- (2) Dissimilar origin but similar functions
- (3) Similar origin with similar or dissimilar functions
- (4) Similar origin but always dissimilar functions

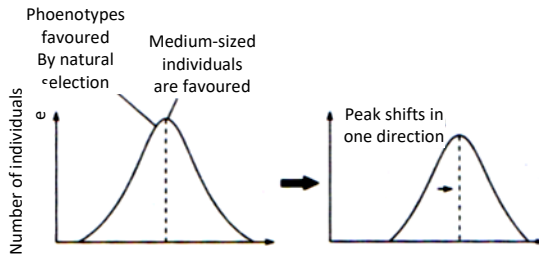
BIOLOGY

- Q.75** When more than one adaptive radiation appears in an isolated geographical area, than it is called:
 (1) Natural selection
 (2) Convergent evolution
 (3) Divergent evolution
 (4) Retrogressive evolution
- Q.76** Human hand, wing of bat and flipper of whale represent:
 (1) Analogous organs
 (2) Vestigial organs
 (3) Homologous organs
 (4) Analogy
- Q.77** Dinosaurs disappeared during which period:
 (1) Jurassic (2) Triassic
 (3) Cretaceous (4) Permian
- Q.78** A missing link between reptiles and birds is :
 (1) Archaeopteryx (2) Platypus
 (3) Java Ape man (4) Pteranodon
- Q.79** Which of the following is not amongst the evolutionary line of mammals ?
 (1) Therapsids (2) Pelycosaurs
 (3) Synapsids (4) Sauropsids
- Q.80** Evolution of heart from one to two, three and four chambered proves :
 (1) Biogenetic law of Haeckel
 (2) Lamarckism
 (3) Hardy weinberg's law
 (4) Neo Darwinism
- Q.81** Which is not a vestigial organ in man?
 (1) Third molar (2) Nails
 (3) Pinna muscle (4) Coccyx
- Q.82** When reptiles came down which animals took over the earth ?
 (1) Birds (2) Dinosaurs
 (3) Mammals (4) Amphibians
- Q.83** Which of the following study is helpful to understand that all mammals share similarities in the pattern of bones of forelimbs?
 (1) Physiology and biochemistry
 (2) Taxonomy
 (3) Comparative anatomy and morphology
 (4) Biogeographical distribution
- Q.84** Development in similar adaptation in organisms with different genotype indicate:
 (1) Microevolution
 (2) Macroevolution
 (3) Convergent evolution
 (4) Divergent evolution
- Q.85** Birbal Sahni was a:
 (1) Zoologist
 (2) Founder of Central Drug Research Institute (CDRI)
 (3) Ornithologist
 (4) Palaeobotanist
- Q.86** In evidences for evolution, similarities in proteins and genes performing a given function among diverse organisms give clues to :
 (1) Common anatomy
 (2) Common morphology
 (3) Common ancestry
 (4) Speciation
- Q.87** Potato and sweet potato:
 (1) Have edible parts which are homologous organs
 (2) Have edible parts which are analogous organs
 (3) Are two species of the same genus
 (4) Have been introduced in India from the same place
- Q.88** The ancestor of modern birds (archaeopteryx) first appeared during the :
 (1) Cretaceous period (2) Jurassic period
 (3) Triassic period (4) Carboniferous period
- Q.89** Which option is correct about Fossils ?
 (1) Preserved hard parts of past organisms
 (2) Remnants of extinct animals and plants
 (3) Prints of past and ancient organism
 (4) All of the above
- Q.90** The age of fossils is determined by :
 (1) Analysis of bones
 (2) Radioactive c^{14} dating
 (3) Electron microscopy
 (4) Weighing the fossils

- Q.91** Which one of the following describes correctly the Analogous structures ?
- (1) Organs with anatomical dissimilarities, but performing same function
 - (2) Organs with anatomical similarities, but performing different functions
 - (3) Organs that have no function now, but had an important function in ancestors
 - (4) Organs appearing only in embryonic stage and disappearing later in the adult
- Q.92** Which connecting link is missing ?
- (1) Peripatus
 - (2) Platypus
 - (3) Neopilina
 - (4) Archaeopteryx
- Q.93** Convergent evolution of two species is associated with :
- (1) Analogous organs
 - (2) Recent common ancestor
 - (3) Homologous organs
 - (4) Different habitat
- Q.94** Organs which have the same anatomical structure but are different in function, are called :
- (1) Vestigial organs
 - (2) Homologous organs
 - (3) Analogous organs
 - (4) Homoplastic organs
- Q.95** What is true for Numbat (Anteater)?
- (1) Pouched mammal
 - (2) Prototheria
 - (3) Egg laying mammal
 - (4) Placental mammal
- Q.96** Which one of the following is not a vestigial structure in Homo sapiens?
- (1) Third molar
 - (2) Epiglottis
 - (3) Plica semilunaris
 - (4) Appendix
- Q.97** Earliest fossil form in the phylogeny of horse is:
- (1) Meshippus
 - (2) Equus
 - (3) Eohippus
 - (4) Merychippus
- Q.98** Flippers of dolphin and seal are modified :
- (1) Fins
 - (2) Hindlimb
 - (3) Forelimb
 - (4) Gills
- Q.99** Darwin's finches are an example of :
- (1) Divergent evolution
 - (2) Adaptive radiation
 - (3) Both (1) and (2)
 - (4) Convergent evolution
- Q.100** According to the theory of special creation, earth originated about 4000 years back. This age of earth is calculated/estimated by :
- (1) Rock dating
 - (2) Carbon dating
 - (3) $K^{40}Ar^{40}$ method
 - (4) None
- Q.101** Which of the following evidences have physical proof and are considered as "documents of evolution"?
- (1) Homologous organs
 - (2) Fossils
 - (3) Analogous organs
 - (4) Biogeographical distribution
- Q.102** Which of the following primitive reptile probably had some aquatic adaptations?
- (1) Pteranodon
 - (2) Stegosaurs
 - (3) Ichthyosaurs
 - (4) Tyrannosaurs
- Q.103** Which fossil still shows primitive character?
- (1) Archeopteryx
 - (2) Tuatara
 - (3) Coelacanth
 - (4) Both (2) & (3)
- Q.104** Mark the incorrect options?
- (1) Pteranodon – Fossil bird, like stegosaurus
 - (2) Brachiosaurus – Herbivorous dinosaur with long neck
 - (3) Tyrannosaurus – Carnivorous dinosaur with dagger like teeth
 - (4) Triceratops – Rhino like dinosaur with three horns
- Q.105** In Evidences of evolution, which of the following give clues to common ancestry?
- (1) Homology
 - (2) Divergent evolution
 - (3) Biochemical similarities among diverse organisms
 - (4) All are correct

THEORIES OF EVOLUTION

Q.106 The figure shown below representing the :



- (1) Stabilisation (2) Directional change
(3) Disruption (4) Genetic drift

Q.107 Ship used by Darwin :

- (1) HSM Beagle
(2) His Majesty service
(3) HMS Beagle
(4) Her Major ship

Q.108 Theory of evolution is mainly concerned with :

- (1) Spontaneous generation
(2) Theory of special creation
(3) Gradual change in livings
(4) Conditions of environment

Q.109 "Change with descent" is the basis of which theory :

- (1) Recapitulation theory
(2) Oparin's theory
(3) Theory of organic evolution
(4) Cell theory

Q.110 "It is argued that, if within hundreds of years, man could create new breeds of animals and crops, nature could not have done the same over millions of years" this statement refers to :

- (1) Environmental selection
(2) Natural selection
(3) Sexual selection
(4) Artificial selection

Q.111 *Biston betularia* has two forms-the light and the dark melanic form. The dark melanic form is expected to be more common in :

- (1) Non-polluted environment.
(2) Polluted environment.
(3) Deforested land.
(4) Colder environment.

Q.112 Darwin's Theory of Natural Selection was based on :

- (1) Inheritance of acquired characters
(2) Mutation
(3) Enormous rate of reproduction in organisms, struggle for existence and survival of the fittest
(4) Changes due to the use and disuse of organs

Q.113 Unit of evolution is :

- (1) Species (2) Individual
(3) Population (4) Phylum

Q.114 Evolution is :

- (1) Determinism (2) Chance event
(3) Both (4) None

Q.115 Natural selection is based on certain factual observations, these are :

- (1) Limited natural resources
(2) Stable size of population (except seasonal fluctuation)
(3) Variation in characteristics in members of a population
(4) All are correct

Q.116 One of the revolutionary concepts in biology was Charles Darwin's 'Origin of Species'.

It deals with :

- (1) Gene mutation
(2) Use and disuse of organs
(3) Germplasm Theory
(4) Natural selection leading to the survival of the fittest

Q.117 Which of the following is responsible for evolution according to Neo-Darwinism ?

- (1) Mutation (2) Natural selection
(3) Genetic drift (4) All of the above

Q.118 A Scientist kept 69 generations of *Drosophila* in darkness even after that the flies had normal eyes, this disproves the theory of :

- (1) De Vries (2) Darwin
(3) Weisman (4) Lamarck

Q.119 The ultimate source of organic variation is :

- (1) Mutation (2) Sexual reproduction
(3) Natural selection (4) Hormonal action

Q.120 Which is the most important factor for evolution of new species ?

- (1) Geographic isolation
- (2) Consistence use of organs.
- (3) Human desire
- (4) Polyploidy

Q.121 Gene pool is :

- (1) Genotype of an individual of a population
- (2) Some total of all genes of a population
- (3) Pool of artificially synthesised genes
- (4) Genes of a genus

Q.122 Which of the following is used as an atmospheric pollution indicator?

- (1) Lepidoptera
- (2) Lichens
- (3) Lycopersicon
- (4) Lycopodium

Q.123 Which of the following evidences does not favour the Lamarckian concept?

- (1) Absence of limbs in snakes
- (2) Presence of webbed toes in aquatic birds
- (3) Melanization in peppered moth in industrial area
- (4) Lack of pigment in cave dwelling animals

Q.124 Who wrote the book 'Genetics and origin of species' which deals with synthetic theory of evolution :

- (1) Dobzhansky
- (2) Haldane
- (3) Mayr
- (4) De Vries

Q.125 Match the columns and choose the correct option :

	Column-I (scientist)	Column-II (belongs to)	Column-III (description given)
(1)	Oparin	England	Life came from non-living inorganic molecules
(2)	Lamarck	France	Passing of acquired characters to succeeding generations
(3)	S.L. miller	America	Experimental explanation of spontaneous generation
(4)	Thomas malthus	England	Large differences arising suddenly in a population

Q.126 Animal husbandry and plant breeding programmes are the examples of :

- (1) Reverse evolution
- (2) Artificial selection
- (3) Mutation
- (4) Natural selection

Q.127 Match the following columns and find correct combination :

Column-I	Column-II
a. Darwin	p. Mutation theory
b. De Vries	q. Protobionts
c. Pasteur	r. Origin of species
d. Fox	s. Special Creation
	t. Swan-Necked Flask Experiment

- (1) a-r, b-p, c-t, d-q
- (2) a-p, b-q, c-r, d-s
- (3) a-t, b-r, c-q, d-p
- (4) a-r, b-t, c-p, d-q

Q.128 Frequency of an allele in an isolated population may change due to :

- (1) Genetic drift
- (2) Gene flow
- (3) Mutation
- (4) Hybridisation

Q.129 Some bacteria are able to grow in Penicillin containing medium due to :

- (1) Natural selection due to drug resistance
- (2) Genetic recombination
- (3) Reproductive isolation
- (4) Genetic drift

Q.130 Variations through mutations are:

- (1) Random and directionless
- (2) Random and directional
- (3) Random and small
- (4) Random, small and directional

Q.131 Which of the following is important for speciation ?

- (1) Seasonal isolation
- (2) Reproductive isolation
- (3) Behavioural isolation
- (4) Tropical isolation

Q.132 Based on observations made during a sea voyage, Charles Darwin concluded that existing living forms share similarities :-

- (1) among themselves only
- (2) with life forms that existed millions of years ago
- (3) Both (1) & (2)
- (4) does not share similarities

Q.133 De Vries gave his mutation theory on organic evolution while working on :

- (1) Oenothera lamarckiana
- (2) Drosophila melanogaster
- (3) Pisum sativum
- (4) Althea rosea

BIOLOGY

Q.134 Which of the following is not true for a species?

- (1) Members of a species can interbreed
- (2) Few variations may occur among members of a species
- (3) The gene flow does not occur between the populations of a species
- (4) Each species is reproductively isolated from every other species

Q.135 Given below are few informations regarding **Alfred Wallace**, mark the **correct** option :

- (i) Was a naturalist
 - (ii) Worked in Malay Archipelago
 - (iii) Had come to completely dissimilar conclusion around the same time of Darwin
 - (iv) He sent his observations and conclusions to Darwin through a letter
- (1) ii and iv (2) i and iii
(3) i, ii and iv (4) Only iii

Q.136 The idea not related to the Darwinian evolutionary theory is :

- (1) Survival of the best
- (2) Struggle for existence
- (3) Inheritance of acquired characters
- (4) Origin of species by natural selection

Q.137 Read the below statements and choose the correct option.

Statement-1: The work of Malthus on population influenced Darwin.

Statement-2: After Darwin, Lamarck had said that evolution of life forms had occurred but driven by use and disuse of organs.

- (1) Both statements are correct
- (2) Both statements are incorrect
- (3) Statement-1 is correct but statement-2 is incorrect
- (4) Statement-1 is incorrect but statement-2 is correct

Q.138 The concept of Inheritance of acquired characters comes from :

- (1) Lamarckism (2) Darwinism
- (3) Neo-Lamarckism (4) Neo-Darwinism

Q.139 The essence of theory of Darwin was :

- (1) Natural selection
- (2) Inheritance of acquired characters
- (3) Omnis cellula e cellula
- (4) Higher productivity

Q.140 The chance of elimination of genes from a small population is an example of :

- (1) Natural selection (2) Speciation
- (3) Adaptation (4) Genetic drift

Q.141 If a mutation is selected by nature then it is :

- (1) neutral (2) harmful
- (3) pre-adaptive (4) post-adaptive

Q.142 The classical example of adaptive radiation is :

- (1) Darwin finches
- (2) Marsupials of Australia
- (3) Placentals in Australia
- (4) All of these

Q.143 Those characteristics which enable an organism to survive better in natural condition, are known as :

- (1) Saltation (2) Mutation
- (3) Adaptive variations (4) Variations

Q.144 Which of the following is not a concept of Lamarck ?

- (1) Direct effect of environment or environmental pressure causes variation
- (2) Rate & survival of organism is different due to variation
- (3) Inheritance of acquired character
- (4) If an organ is used constantly it will continuously increase its size.

Q.145 Raw material for evolution is :

- (1) Genetic drift (2) Natural selection
- (3) Adaptation (4) Mutation

Q.146 What will happen in better adapted and fittest population ?

- (1) Gene pool decreases
- (2) Gene pool increases
- (3) Intraspecific struggle will not be found
- (4) will not evolve

Q.147 According to the Neo-Darwinian theory which of the following is responsible for the origin of new species?

- (1) Mutations only
- (2) Useful variations and natural selection
- (3) Mutations together with natural selection
- (4) Hybridization only

Q.148 Which of the following was not given by Darwin's theory of evolution?

- (1) Struggle for existence
- (2) Over production
- (3) Natural selection
- (4) Genetic drift

Q.149 According to Hugo De Vries, large mutation that causes speciation in single step called :

- (1) Dominant mutation
- (2) Lethal mutation
- (3) Saltation
- (4) Recessive mutation

Q.150 Excess use of herbicides, pesticides, antibiotics etc. has resulted in selection of resistant varieties in a much lesser time scale, these are examples of evolution by :

- (1) Mutation
- (2) Artificial selection
- (3) Natural selection due to anthropogenic action
- (4) Genetic drift

Q.151 Change of allelic frequencies or disturbance of genetic equilibrium in a population would then be interpreted as resulting in evolution, it may happen due to all the following factors except one ?

- (1) Gene migration
- (2) Gene recombination
- (3) Random mating
- (4) Natural selection

HUMAN EVOLUTION

Q.152 Match the columns A and B.

Column-A		Column-B	
(A)	Ice Age	(i)	Between 1,00,000-40,000 year ago
(B)	Starting of agriculture	(ii)	75,000-10,000 year ago
(C)	Neanderthal man	(iii)	18000 year ago
(D)	Pre-historic cave art	(iv)	10000 year ago

- (1) (C) – i, (A) – ii, (D) – iii, (B) – iv
- (2) (A) – i, (B) – ii, (C) – iii, (D) – iv
- (3) (C) – i, (A) – ii, (B) – iii, (D) – iv
- (4) (C) – i, (D) – ii, (A) – iii, (B) – iv

Q.153 Agriculture & Human settlement started about :

- (1) 10000 years back
- (2) 20000 years back
- (3) 30000 years back
- (4) 40000 years back

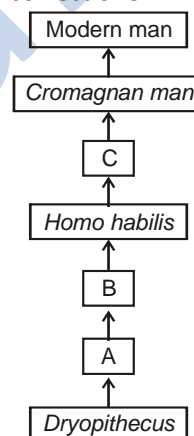
Q.154 Which primate is closest to man regarding organic evolution?

- (1) Old world monkeys (Rhesus)
- (2) New world monkeys
- (3) Apes
- (4) Lemur

Q.155 Which character applies to Homo sapiens?

- (1) Opposable toe
- (2) Large canine
- (3) Cranial capacity 1450 cc
- (4) Prognathous face

Q.156 Below given is the diagrammatic representation of sequence of ancestor of human being evolution identify A, B and C in the given option and choose correct one :



	A	B	C
(1)	<i>Australopithecus</i>	<i>Ramapithecus</i>	<i>Homo erectus</i>
(2)	<i>Ramapithecus</i>	<i>Homo erectus</i>	<i>Australopithecus</i>
(3)	<i>Ramapithecus</i>	<i>Australopithecus</i>	<i>Homo erectus</i>
(4)	<i>Australopithecus</i>	<i>Homo erectus</i>	<i>Ramapithecus</i>

Q.157 Which of the following statement is correct?

- (1) The skull of adult chimpanzee is like modern adult human
- (2) The skull of baby chimpanzee is like modern adult human
- (3) Skull of baby chimpanzee is exactly similar to adult chimpanzee
- (4) Skull of baby chimpanzee and adult chimpanzee has no resemblance to skull of human

BIOLOGY

Q.158 Homo erectus differed from Cro-magnon man in having :

- (1) Prognathous face (2) Tool making
(3) Sloping jaws (4) Arts and paintings

Q.159 Which of the following statement is correct ?

- (1) Dryopithecus was ancestor of man and ape
(2) Dryopithecus was ancestor of man and not of ape
(3) Ramapithecus was more man like
(4) More than one correct

Q.160 Who lived in near east and central Asia between 1,00,000 - 40,000 years back ?

- (1) Homo erectus (2) Homo habilis
(3) Neanderthal man (4) Australopithecines

Q.161 Most recent man found as fossil was :

- (1) Java man (2) Peking man
(3) Cro-magnon man (4) Hiedelberg man

Q.162 What was the cranial capacity of java man :

- (1) 400 cc (2) 650 cc
(3) 900 cc (4) 1450 cc

Q.163 Evolution of man was possible because our apelike ancestors :

- (1) Showed bipedal movement on open land
(2) Used fire
(3) Felt difficulty in feeding
(4) Developed community hunting

Q.164 Fire for protection and cooking was first used by :

- (1) Neanderthal man
(2) Cro-magnon man
(3) Java man
(4) Peking man

Q.165 Civilisation was started by:

- (1) Cro-magnon man (2) Peking man
(3) Java man (4) Neanderthal man

Q.166 C. Fulhrott made an important discovery in evolution and he discovered human fossil from Neanderthal velly, Germany. It was

- (1) Neanderthal man (2) Cro-magnon man
(3) Homo erectus (4) Homo habilis

Q.167 Greatest advantage of bipedal movement :

- (1) Fore arms becoming free for carrying out order of brain
(2) Greater speed
(3) Support the body properly
(4) Loss of weight

Q.168 Which fossil man had cranial capacity almost equal to modern man ?

- (1) Australopithecus (2) Java ape man
(3) Neanderthal man (4) Peking man

Q.169 Largest cranial capacity was found in :

- (1) Peking man (2) Neanderthal man
(3) Java man (4) Cro-magnon man

Q.170 Which of the following is the most primitive ancestor of man ?

- (1) Homo habilis
(2) Ramapithecus
(3) Australopithecus
(4) Homo neanderthalensis

Q.171 Homo habilis refers to :

- (1) Wandering species
(2) Ancient man
(3) Modern man
(4) Skillful or Tool maker man

Q.172 Which of the following statement is true ?

- (1) Australopithecus is not in direct line towards human evolution
(2) Neanderthal man is direct ancestor of modern man
(3) Homo erectus is direct ancestor of Homo sapiens
(4) Fossils of Cro-magnon man first found in Ethiopia

Q.173 Character which is closely related to human evolution :

- (1) Disappearance of tail
(2) Reduction in size of jaws
(3) Binocular vision
(4) Flat nails

Q.174 Which one of the following is the closest living relative of man, on the basis of chromosome banding pattern ?

- (1) Chimpanzee (2) Gorilla
- (3) Orangutan (4) Gibbon

Q.175 Which of the following is correct order of the evolutionary history of man ?

- (1) Peking man, Homo sapiens, Neanderthal man, Cro-magnon man
- (2) Peking man, Neanderthal man, Homo sapiens, Cro-magnon man
- (3) Peking man, Neanderthal man, Heidelberg man, Cro-magnon man
- (4) Peking man, Neanderthal man, Homo sapiens, Heidelberg man

Q.176 According to human fossils which are discovered up to present time, origin and evolution of man was started from which country :

- (1) France (2) Java
- (3) Africa (4) China

Q.177 The banding pattern of chromosomes of 3 and 6 of human beings and chimpanzee shows that both animals had:

- (1) Common origin
- (2) Human have evolved from apes
- (3) Apes have evolved from human
- (4) They have no evolutionary relationship

Q.178 The scientific name of Homo erectus erectus has been given to :

- (1) Cro-magnon man
- (2) Neanderthal man
- (3) Java man
- (4) Peking man

Q.179 Direct ancestor to modern man was :

- (1) Neanderthal man
- (2) Homo habilis
- (3) Cro-magnon man
- (4) Australopithecus

Q.180 Ancestor of man who first stood erect was :

- (1) Australopithecus
- (2) Cro-magnon man
- (3) Java man
- (4) Peking man

Q.181 Mark the incorrect statement regarding human evolution:

- (1) Man like primates walked in eastern Africa about 3-4 MYA and they were not probably taller than 4 feet
- (2) Dryopithecus and Ramapithecus were hairy and walked like gorilla and chimpanzee
- (3) Prehistoric cave arts developed about 18000 years ago
- (4) Homo habilis probably ate meat

EXERCISE-II

Analytical Questions

Q.1 Gene migration / gene flow, genetic drifts, mutation, genetic recombination and natural selection like five factors affect **Hardy - Weinberg** principle.

Here the **actual** meaning of affect is :

- (1) Principle will not be applicable
- (2) Principle will be applicable
- (3) Frequency of an allele remain constant generation to generation
- (4) Will not influence evolution

Q.2 What is true about finches ?

- (a) Present in galapagos island.
 - (b) Have changes in beak pattern / shape, as of food available.
 - (c) Arose from common ancestor.
 - (d) Best example of adaptive radiation.
- (1) a, c, d (2) b, c, d
(3) a, b, c (4) a, b, c, d

Q.3 Organic compound obtained by **Miller** after his own experiment, were :

- (1) Protein (2) Polysaccharides
- (3) Some amino acids (4) Coacervates

Q.4 Read the following table regarding **homologous** and **analogous** organ and select the incorrect match :

		Example	Function	Evolution
1.	Homologous organ	Limbs of man and cheetah	Various skilled work and running respectively	Convergent evolution
2.	Analogous organ	Potato and sweet potato	Storage of starch as stored food	Convergent evolution
3.	Analogous organ	Eye of octopus and man	Organ of sight	Convergent evolution
4.	Homologous organ	Wings of bat and flippers of seal	Flying and swimming respectively	Divergent evolution

Q.5 At present scientist know that certain life form is restricted to certain geological time period. Clear evidences for this conclusion come from:

- (1) Fossils
- (2) Embryology
- (3) Anatomy and Homology
- (4) Biochemistry

Q.6 **Common ancestry** of bio evolution is **evident** from :

- (1) Comparative **anatomy** and **morphology**
- (2) **Homology**
- (3) **Adaptive radiation**
- (4) All of the above

Q.7 Read the below observations carefully and identify the related scientist:

- I. In a population, change in allelic frequency would result in evolution.
- II. Mutation can cause disturbance in genetic equilibrium.
- III. Allele frequency in a population is stable and is constant from generation to generation.

Options are :

- (1) Hugo de vries
- (2) John gregor mendel
- (3) Hardy-weinberg
- (4) Charles darwin

Q.8 Which of the following organ in man is vestigial:

- (1) Pinna muscles
- (2) Wisdom tooth
- (3) Fossa ovalis
- (4) More than one options are correct

Q.9 Homology is exhibited by :

- (1) Vertebrate's heart
- (2) Vertebrate's brain
- (3) Wings of bats and wings of birds
- (4) All of the above

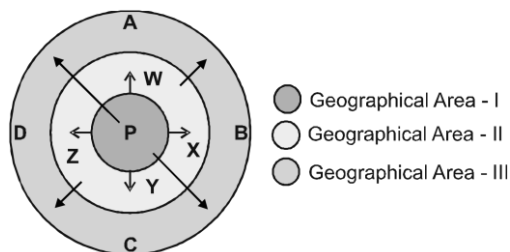
Q.10 Select the incorrect match out of four :

- (1) Homology - Wings of birds and flipper of dolphin
- (2) Adaptive radiation - Darwin's finches
- (3) Fittest - Individual with inferior phenotype
- (4) Analogy - Eyes of mammals and octopus

Q.11 Fishes were dominant during _____ period.

- (1) Carboniferous (2) Devonian
- (3) Ordovician (4) Cambrian

Q.12 See the following given sketch carefully :



P - Ancestral species
W to **Z** and **A** to **D** are different forms of **P**

Select the **correct** option given below :

- (1) It represents adaptive radiation.
 - (2) It is adaptive radiation exhibited by Marsupials of Australia and Darwin's Finches.
 - (3) In nature such types of evolution do not occurs.
 - (4) Both (1) and (2)
- Q.13** Archaeopteryx, a transitional fossil between birds and reptiles was discovered from the rocks of following period:
- (1) Jurassic
 - (2) Archaeozoic era
 - (3) Cretaceous
 - (4) Triassic
- Q.14** Who completely dismissed the theory of spontaneous generation ?
- (1) Louis pasteur
 - (2) Van Helmont
 - (3) Lazzaro spallanzani
 - (4) Fransisco Reddy
- Q.15** Which of the following statement incorrectly describe the hardy-weinberg principle ?
- (1) Allele frequency of an individual is stable
 - (2) Total genes and their alleles in a population remains constant
 - (3) Sum total of all the allelic frequency is 1.
 - (4) Allele frequencies in a population are constant from generation to generation.
- Q.16** Which of the following factors help in evolution but is not consider the basic factor for evolution :
- (1) Isolation
 - (2) Adaptation
 - (3) Variation
 - (4) Mutation
- Q.17** First life probably originated in :-
- (1) Water
 - (2) Air
 - (3) At 800°C temp.
 - (4) In Vapour state

- Q.18** Marsupial mole, Koala, Bandicoot & Wombat in Australia are examples of :
- (1) Parallel evolution
 - (2) Convergent evolution
 - (3) Adaptive radiation
 - (4) Co-evolution
- Q.19** Some organisms avoid their detection from enemies by resembling other organisms, this is called :
- (1) Natural selection
 - (2) Mimicry
 - (3) Homology
 - (4) Speciation
- Q.20** Louis pasteur by careful experimentation demonstrated that life does not come :
- (1) From pre-existing life
 - (2) From killed yeast
 - (3) Through biogenesis
 - (4) All of the above
- Q.21** It is argued that if within the **hundreds of years** man could creat **new** breed, could not nature have done the same over millions of years. Justify the above statements :
- (1) It explains the evolution and origin of new species
 - (2) Shows importance of human in evolution.
 - (3) Shows human involvement made evolution faster.
 - (4) All of these
- Q.22** Factors helps in the formation of new species are :
- (1) Competition and variation
 - (2) Reproductive isolation and competition
 - (3) Competition and mutation
 - (4) Reproductive isolation and mutation
- Q.23** The reason of reversal proportion in population of two different coloured moth [Dark and White] in England after industrialisation was :
- (1) Adaptation and natural selection
 - (2) Mutation
 - (3) Geographical distribution
 - (4) Stabilization
- Q.24** Flying squirrel & flying phalanger represent the phenomenon of :
- (1) Divergent evolution
 - (2) Convergent evolution
 - (3) Adaptive radiation
 - (4) Divergent radiation

BIOLOGY

- Q.25** According to Hugo de vries speciation due to mutation is also known as 'Saltation' which means :
- (1) Single step variation
 - (2) Variations at regular intervals
 - (3) Single step large mutation
 - (4) Huge change due to Natural selection
- Q.26** Which reptile went back into water to evolve into fish like reptile ?
- (1) Ichthyosaurs (2) Calotes
 - (3) Hemidactylus (4) Alligator
- Q.27** Select the true statements :
- (1) Ramapithecus and Dryopithecus were existing about 50 million years ago
 - (2) Ramapithecus was man like while Dryopithecus was more ape like
 - (3) Ramapithecus was more ape like while Dryopithecus was more man-like
 - (4) 1 & 2 both
- Q.28** Brain capacity of Homo habilis was :
- (1) 650-800 cc (2) 800-900 cc
 - (3) 600-1000 cc (4) 900-1100 cc
- Q.29** Fossils of Homo erectus was discovered in :
- (1) Java (2) Bangladesh
 - (3) Ethiopia (4) Tanzania
- Q.30** Neanderthal man lived near :
- (1) East & West Africa
 - (2) South Africa
 - (3) North Africa
 - (4) East & Central Asia
- Q.31** Prehistoric cave art developed about :
- (1) 10000 years ago (2) 15000 years ago
 - (3) 18000 years ago (4) 20000 years ago
- Q.32** The story of evolution of modern man in respect to brain & language appears as :
- (1) Convergent evolution
 - (2) Divergent evolution
 - (3) Parallel evolution
 - (4) All
- Q.33** Branching descent is accounted for :
- (1) Homology (2) Analogy
 - (3) Vestigial organs (4) Atavism
- Q.34** Highest brain capacity among the following human ancestor is found in :
- (1) Australopithecus (2) Homo habilis
 - (3) Homo erectus (4) Neanderthal
- Q.35** Who proposed the first form of life from pre-existing non-living organic molecules ?
- (1) Oparin & Haldane
 - (2) Stanley Miller & Harold Urey
 - (3) Lamarck & Darwin
 - (4) Hugo de Vries & Dobzhansky
- Q.36** The ___A___ is considered as a unique event in the history of ___B___.
- Choose the correct option to fill A and B.
- (1) A–Origin of dinosaurs; B–Universe
 - (2) A–Origin of humans; B–Earth
 - (3) A–Origin of life; B–Universe
 - (4) A–Origin of life; B–Earth
- Q.37** All various species of finches radiated from a common ancestral finch. What is true for ancestral finch ?
- (1) Seed eating (2) Fruit eating
 - (3) Cave dweller (4) Omnivorous
- Q.38** Different species of Darwin's finches of galapagos island exhibits :
- (1) Sympatric speciation
 - (2) Allopatric speciation
 - (3) Convergent evolution
 - (4) Analogy in beaks
- Q.39** Select the incorrect statements :
- (1) Natural selection is a heritable variation & by reproduction leave greater number of progenies
 - (2) During stabilisation of natural selection more individuals acquire value other than mean character value
 - (3) By the time of 500 million years ago invertebrates were formed and were active
 - (4) Reptiles lay thick shelled eggs which do not dry up in sun unlike those of Amphibians

Q.40 Match the columns and select correct option.

- | | |
|----------------------|--|
| (a) Australopithecus | (i) First human like |
| (b) Homo habilis | (ii) Used hides to protect the body |
| (c) Homo erectus | (iii) Arose in Africa |
| (d) Neanderthal man | (iv) Probably ate meat |
| (e) Homo sapiens | (v) Hunted with stone weapons and ate fruits |
- (1) a-v, b-ii, c-iv, d-i, e-iii
(2) a-i, b-ii, c-iv, d-iii, e-v
(3) a-v, b-i, c-iv, d-ii, e-iii
(4) a-v, b-ii, c-iii, d-i, e-iv

Q.41 Different species of Darwin's finches of galapagos island exhibits :

- (1) Analogy in beaks (2) Homology in beaks
(3) Vestigial wings (4) Both (1) and (2)

Q.42 The theory of spontaneous generation stated that

- (1) Life arose from living forms only
(2) Life can arise from both living and non-living
(3) Life can arise from non-living things only
(4) Life arises spontaneously, neither from living nor from the non-living

Q.43 Palaeontological evidences for evolution refer to the :

- (1) Development of embryo
(2) Homologous organs
(3) Fossils
(4) Analogous organs

Q.44 The bones of forelimbs of whale, bat, cheetah and man are similar in structure, because :

- (1) One organism has given rise to another
(2) They share a common ancestor
(3) They perform the same function
(4) They have biochemical similarities

Q.45 Analogous organs arise due to :

- (1) Divergent evolution
(2) Artificial selection
(3) Genetic drift
(4) Convergent evolution

Q.46 $(p+q)^2 = p^2 + 2pq + q^2 = 1$ represents an equation used in :

- (1) Population genetics
(2) Mendelian genetics
(3) Biometrics
(4) Molecular genetics

Q.47 According to J. Lederburg and E. Lederburg appearance of antibiotic resistant bacteria is an example of :

- (1) Adaptive radiation
(2) Transduction
(3) Pre-existing variation in the population
(4) Divergent evolution

Q.48 Viviparity is considered to be more evolved because :

- (1) The young ones are left on their own
(2) The young ones are protected by a thick shell
(3) The young ones are protected inside the mother's body and are looked after they are born leading to more chances of survival
(4) The embryo takes a long time to develop

Q.49 For the MN-blood group system, the frequencies of M and N alleles are 0.7 and 0.3, respectively. The expected frequency of MN-blood group bearing organisms is likely to be :

- (1) 42% (2) 49% (3) 9% (4) 58%

Q.50 Which type of selection is industrial melanism observed in moth, *Biston betularia*:

- (1) Stabilising (2) Directional
(3) Disruptive (4) Artificial

Q.51 The most accepted line of descent in human evolution is :

- (1) Australopithecus → Ramapithecus → Homo sapiens → homo habilis
(2) Homo erectus → Homo habilis → Homo sapiens
(3) Ramapithecus → Homo habilis → Homo erectus → Homo sapiens
(4) Australopithecus → Ramapithecus → Homo erectus → Homo habilis → Homo sapiens

BIOLOGY

Q.52 Match the scientists listed under column 'A' with ideas listed column 'B'.

Column-A	Column-B
i. Darwin	M. Abiogenesis
ii. Oparin	N. Use and disuse of organs
iii. Lamarck	O. Continental drift theory
iv. Wagner	P. Evolution by natural selection

Options are :

- (1) i-M; ii-P; iii-N; iv-O (2) i-P; ii-M; iii-N; iv-O
(3) i-N; ii-P; iii-O; iv-M (4) i-P; ii-O, iii-N, iv-M

Q.53 Rate of appearance of new forms of a species is directly linked to the :

- (1) Life span / time interval of life cycle
(2) Protection and feeding
(3) Environmental conditions
(4) Body size

Q.54 What is true for fitness ?

- (1) Inheritable (2) Non-heritable
(3) Temporary (4) Somatic

Q.55 In 1953 S.L. Miller created primitive earth conditions in the laboratory and gave experimental evidence for origin of first form of life from preexisting non-living organic molecules. The primitive earth conditions created include :

- (1) Low temperature, volcanic storms, atmosphere rich in oxygen
(2) Low temperature, volcanic storms, reducing atmosphere
(3) High temperature, volcanic storms, nonreducing atmosphere
(4) High temperature, volcanic storms, reducing atmosphere containing CH₄, NH₃, H₂ etc.

Q.56 The naturalist who came about with the same ideas that of the Darwin :

- (1) Alfred Nobel (2) Alfred Wallace
(3) Lamarck (4) H. Khorana

Q.57 Bob cat and Tiger cat exhibit :

- (1) Divergent evolution
(2) Adaptive radiation
(3) Convergent / parallel evolution
(4) More than one options are correct

Q.58 If different animals adapted to reside in a common habitat then it exhibits:

- (1) Natural selection
(2) Common ancestry
(3) Adaptive convergence
(4) Homology

Q.59 According to Darwin, the term fitness refers to :

- (1) Social fitness
(2) Mental fitness
(3) Physical fitness
(4) Reproductive fitness

Q.60 Dead remains of organisms found in the earth crust are the :

- (1) Palaeontological evidences
(2) Morphological evidences
(3) Anatomical evidences
(4) Physiological evidences

Q.61 Who gave the theory of Genetic equilibrium?

- (1) Lamarck (2) Hugo deVries
(3) Hardy - Weinberg (4) Darwin

Q.62 According to Lamarck Giraffe's neck and forelimbs get elongated during the course of evolution, due to:

- (1) Inheritance of acquired characters
(2) Natural selection and use of organs
(3) Geographical isolation
(4) Convergent evolution

Q.63 First mammals (primate like) were :

- (1) Human (2) Apes
(3) Monkeys (4) Shrews

Q.64 The first human being like prehistoric man was :

- (1) Homo sapiens (2) Homo erectus
(3) Homo habilis (4) Neanderthal man

Q.65 In which type of natural selection two peaks are formed ?

- (1) Stabilizing selection
(2) Directional selection
(3) Disruptive selection
(4) Both (1) and (3)

- Q.66** Before industrialization set in England :
- (1) Only white winged moths were present on trees
 - (2) White winged moths were less in number on trees
 - (3) Dark winged moths were less in number on trees
 - (4) White winged moths were absent
- Q.67** Proper burial of dead bodies for the first time started by which pre historic man ?
- (1) Java man
 - (2) Homo habilis
 - (3) Neanderthal man
 - (4) Australopithecines
- Q.68** Homo sapiens arose in and moved across continents and developed into distinct races:
- (1) America
 - (2) Australia
 - (3) China
 - (4) Africa
- Q.69** The most accepted view for origin of life is :
- (1) Chemical evolution
 - (2) Spontaneous generation
 - (3) Religious literature
 - (4) Panspermia
- Q.70** The study of fossils in different aged rocks shows all of the following except:
- (1) They probably died during the formation of that particular sediment
 - (2) Some of them appear similar to modern organisms
 - (3) Life forms varied over time and certain forms were restricted to certain geological time spans
 - (4) They do not represent extinct organisms
- Q.71** Which vertebrates evolved into the first amphibians?
- (1) Jawless fishes
 - (2) Lobefin fishes (Coelacanth)
 - (3) Salamanders
 - (4) *Ichthyosaurus*
- Q.72** Paddles of whale, wings of bat, forelimbs of cheetah and human show:
- a. Similarities in the pattern of bones
 - b. Homology
 - c. Analogous organs
 - d. Convergent evolution
 - e. Divergent evolution
 - f. Different structures evolving for same functions
- (1) a, b and c
 - (2) c, d and f
 - (3) a and d
 - (4) a, b and e
- Q.73** If a particular animal has shelled eggs, hair and mammary gland and has cloaca, it may be a connecting link between:
- (1) Reptiles and birds
 - (2) Birds and mammals
 - (3) Reptiles and mammals
 - (4) Amphibian and reptiles
- Q.74** Fossil X is evolved earlier than fossil Y: Which statements is best regarding it -
- (1) Y has vestigial structures that are homologous to functional structures in fossil X
 - (2) X is structurally more complex than fossil Y
 - (3) Y is in better state of preservation than X
 - (4) Y is found in lower stratum of undisturbed sedimentary rock than X
- Q.75** What is sequence in the evolution of mammals?
- (1) Fish-amphibian-bird-mammals
 - (2) Insect-fish-bird-mammals
 - (3) Fish-amphibian-reptile-mammals
 - (4) Fish-amphibian-reptile-bird-mammals
- Q.76** There would be no evolution if :
- (1) The inheritance of acquired characters did not take place
 - (2) Somatic variations were not inheritable
 - (3) Genetic variations were not found among members of population
 - (4) Somatic variations would not transform into germinal variations
- Q.77** If population of a species is transferred to more suitable environment then it will show :
- (1) Protection against enemies
 - (2) More individuals would survive
 - (3) Unlimited food would be available
 - (4) Rapid adaptation will occur
- Q.78** Which of the following facts develop suspicions in Lamarckism?
- (1) Human females are not born with bored ear pinna although they have been bored for thousands of years.
 - (2) Giraffe had developed long neck to eat leaves of tall trees
 - (3) A stag can run fast to protect against the enemies
 - (4) lost of limbs in snakes

BIOLOGY

- Q.79** Chances of inheritable and evolutionary changes are more in such species which reproduce by :
- (1) Parthenogenesis
 - (2) Fission
 - (3) Sexual reproduction
 - (4) Asexual reproduction
- Q.80** One major criticism of Darwin's theory is that:
- (1) It presumes that environment upon earth has been changing through ages
 - (2) It does not explain variations with heredity (Genetic)
 - (3) It overestimates reproductive capacity of animals and plants
 - (4) It does not explain vestigial organs
- Q.81** Use of atomic bombs may lead to abnormalities even in upcoming generations because of :
- (1) Body changes
 - (2) Air pollution
 - (3) Changed atoms in atmosphere
 - (4) Genetic mutation
- Q.82** On Galapagos island Darwin observed variation in beaks of birds (Darwin's finches) and he concluded:
- (1) Interspecies variation
 - (2) Intraspecies variation
 - (3) Natural selection according to food
 - (4) Inheritance of acquired characters
- Q.83** Homologous organs are:
- (1) Wings of cockroach and wings of bats
 - (2) Wings of insects and wings of birds.
 - (3) Air bladder of fishes and lungs of frog
 - (4) Flipper of dolphin and forelimbs of horse.
- Q.84** Forthcoming generations are less adaptive than their parental generation due to :
- (1) Natural selection (2) Mutation
 - (3) Genetic drift (4) Adaptation
- Q.85** Which of the following are homologous organs?
- (1) Wings of birds & Locust
 - (2) Wings of birds (Sparrow) & Pectoral fins of fish
 - (3) Wings of bat & Butterfly
 - (4) Legs of frog & Cockroach
- Q.86** Convergent evolution is illustrated by :
- (1) Rat and dog
 - (2) Bacterium and Protozoan
 - (3) Devil fish and cuttle fish
 - (4) Dogfish and whale
- Q.87** Which one of the following sequences was proposed by Darwin and Wallace for organic evolution?
- (1) Overproduction, variations, constancy of population size, natural selection
 - (2) Variations, constancy of population size, overproduction, natural selection
 - (3) Overproduction, constancy of population size, variations, natural selection
 - (4) Variations, natural selection, overproduction, constancy of population size
- Q.88** Darwin in his theory of 'Natural Selection' did not believe in any role of which one of the following in organic evolution :
- (1) Small variations
 - (2) Survival of the fittest
 - (3) Struggle for existence
 - (4) Discontinuous variations
- Q.89** More precise methods, which were used recently and led to the revision of the evolutionary periods for different groups of organisms include:
- (1) Study of the conditions of fossilization
 - (2) Electron spin resonance (ESR)
 - (3) Study of carbohydrates/proteins in rocks
 - (4) Study of carbohydrates/proteins in fossils
- Q.90** What kind of evidence suggested that man is more closely related with chimpanzee than with other hominoid apes?
- (1) Comparison of chromosomes morphology only
 - (2) Evidence from fossil remains and the fossil mitochondrial DNA alone
 - (3) Evidence from banding pattern of chromosome no. 3 & 6 of human and chimpanzee
 - (4) Evidence from DNA from sex chromosomes only

Q.91 Presence of gills in the tadpole of frog indicates that :

- (1) Fishes evolved from frog like ancestors
- (2) Frogs will have gills in future
- (3) Frogs evolved from gilled ancestors
- (4) Fishes were amphibious in the past

Q.92 Which of the following statement is incorrect regarding Dryopithecus?

- (1) They walked like chimpanzees
- (2) They were primates
- (3) They were existing about 25 mya
- (4) They were more ape-like

Q.93 In a small isolated population the frequency of autosomal recessive gene p is 0.4% then what will be frequency of heterozygous individuals (2pq) in that population?

- (1) 32%
- (2) 48%
- (3) 6%
- (4) Could not be calculated by Hardy - Weinberg law

Q.94 Which of the following is known as group ancestors of dinosaurs and crocodiles?

- (1) Pelycosaurs
- (2) Thecodonts
- (3) Therapsids
- (4) Sauropsids

Q.95 Which one of the following phenomenon supports Darwin's concept of natural selection in organic evolution?

- (1) Production of 'Dolly', the sheep by cloning
- (2) Development of organs from 'stem cells' for organ transplantation
- (3) Development of transgenic animals
- (4) Prevalence of pesticide resistant insects

Q.96 There are two opposing views about origin of modern man. According to one view Homo erectus in Asia were the ancestors of modern man. A study of variation of DNA however suggested African origin of modern man even after homo erectus is in position. What kind of observation of DNA variation could suggest second view :

- (1) Greater variation in Asia than in Africa
- (2) Similar variation in Africa and Asia
- (3) Variation only in Asia and no variation in Africa
- (4) Greater variation in Africa than in Asia

Q.97 In evolution the studies can be made at molecular level. For example, the protein present in the blood of man and ape are similar. The base sequence in nucleic acids and amino acids sequence in protein in related organism is alike. These are the examples which one specifically referred to in:

- (1) Convergent evolution
- (2) Molecular analogy
- (3) Molecular homology
- (4) Homoplastic appearance

Q.98 Which of the following statement is incorrect?

- (1) Life processes are consequences of reactions that occur in an organism
- (2) Living organism are made of inorganic and organic compounds.
- (3) Life comes from pre-existing life
- (4) Genes are not responsible for the stability or changeability of species

Q.99 Select the correct statement from the following:

- (1) Darwinian variations are small and direction less
- (2) Fitness is the end result of the ability to adapt and gets selected by nature
- (3) Analogous organs show common ancestry.
- (4) Mutations are random and directional

Q.100 Which of the following are not analogous organs?

- (1) Fins of fishes and flippers of whales
- (2) Stings of honey bee and scorpion
- (3) Thorn of bougainvillea and tendril of Cucurbita
- (4) Wings of insect and wings of bird

Q.101 Adaptation of various species in common geographical area /climatic conditions:

- (1) Convergent evolution
- (2) Divergent evolution
- (3) Adaptive radiation
- (4) Speciation

Q.102 Which of the following could be consider a reason of speciation?

- | | |
|-------------------------|-----------------------------|
| (i) Mutation | (ii) Reproductive isolation |
| (iii) Natural selection | (iv) Genetic drift |
| (v) Gene migration | (vi) Hybridisation |
| (1) ii and vi | (2) Only iii |
| (3) i, ii and v | (4) All factors |

BIOLOGY

Q.103 Some other scientist performed experiment similar to S.L. Miller and they obtained –
 (1) Sugar, N₂ bases, pigments and fats
 (2) Fats, pigments and RNA
 (3) Protein, Nucleic acids, N₂ Bases
 (4) Both (2) and (3)

Q.104 The first non-cellular form of life could have originated 3.0 billion year back. This non-cellular form of life were :
 (1) Giant macro biomolecules [RNA, protein, polysaccharide]
 (2) Micro biomolecules [Amino acids, Fatty acid, Sugars]
 (3) Ultra micro biomolecules [Pyruvic acid, Acetic acid]
 (4) None

Q.105 Dinosaurs originated:
 (1) After evolution of mammals
 (2) With mammals
 (3) Much before mammals
 (4) Before mammals and they formed them

Q.106 Given below is a sketch of evolutionary history of vertebrates through geological periods with two missing members :
 Early reptiles → **A** → Pelycosaur → Therapsids → **B**
 Choose the right option which fill **A** and **B** blank / missing members :
 (1) **A** - Sauropsids, **B** - Birds
 (2) **A** - Sauropsids, **B** - Mammals
 (3) **A** - Synapsids, **B** - Mammals
 (4) **A** - Thecodonts, **B** - Dinosaurs

Q.107 What is true for genetic equilibrium ?
 (1) Gene pool remain constant from generation to generation in an evolving population
 (2) Gene and its allele frequencies in a population are stable and constant from generation to generation in non-evolving population
 (3) All the genes of a species remain constant even after genetic recombination
 (4) Genetic equilibrium is not affected by any factor which brings variations

Q.108 Select the option which contain incorrect statement?
 (1) Hardy - Weinberg law is applicable in population genetics.
 (2) Gene pool of non-evolving population remain constant
 (3) Hardy was genetist while Weinberg was mathematician
 (4) Genetic recombination and natural selection affect genetic equilibrium.

Q.109 What is true for mutation?
 (i) Mutation are advantageous and harmful both
 (ii) Mutation may be pre-adaptive
 (iii) Mutation causes variation and bring change in phenotype
 (1) i, ii, iii (2) ii, iii only
 (3) Only iii (4) None

Q.110 Given below are few information regarding **Hominid** :
 i - Arose about 1.5 mya.
 ii - Brain size 1400 cc.
 iii - Used hide to protect their body and buried their dead.
 iv - Lived in east and control Asia
 v - Developed pre-historic cave art about 18,000 year back.
 vi - Hunted with stone weapons but essentially ate fruit.
 Select the correct option :
 (1) ii, iii, iv belongs to Neanderthal man
 (2) i and vi belongs to *Homo erectus*
 (3) ii, iii, v belongs to Cro-magnon man
 (4) vi belongs to *Homo habilis*

Q.111 Given below is a small paragraph related to evolution of man with some blanks. You have to select only one option out of four which fills correctly?
 The fossils discovered in in 1891 revealed the next stage, i.e. about 1.5 mya. He had a large brain around and probably ate meat.
 (1) Africa, *Homo erectus*, 650 cc
 (2) Java, *Homo erectus*, 900 cc
 (3) Neanderthal valley, Neanderthal, 1450 cc
 (4) Africa, *Australopithecus*, 650 cc

Q.112 Coloured rock paintings were first done by:
 (1) Cro-magnon man
 (2) Java ape man
 (3) Peking man
 (4) Neanderthal man

EXERCISE-III**Previous Year Questions**

- Q.1** Praying mantis is a good example of : **[AIPMT 2006]**
- (1) Mullerian mimicry
 - (2) Warning colouration
 - (3) Social insects
 - (4) Camouflage
- Q.2** Which one of the following amino acid was not found to be synthesized in Miller's experiment : **[AIPMT 2006]**
- (1) Glycine
 - (2) Aspartic acid
 - (3) Glutamic acid
 - (4) Alanine
- Q.3** An important evidence in favour of organic evolution is the occurrence of : **[AIPMT 2006]**
- (1) Homologous and vestigial organs
 - (2) Analogous and vestigial organs
 - (3) Homologous organs only
 - (4) Homologous and analogous organs
- Q.4** Jurassic period of the Mesozoic era is characterised by : **[AIPMT 2006]**
- (1) Gymnosperms are dominant plants and first birds appeared
 - (2) Radiation of reptiles and origin of mammal like reptiles
 - (3) Dinosaurs become extinct and angiosperms appeared
 - (4) Flowering plants and first dinosaurs appeared
- Q.5** Evolutionary history of an organism is known as: **[AIPMT 2006]**
- (1) Phylogeny
 - (2) Ancestry
 - (3) Palaeontology
 - (4) Ontogeny
- Q.6** Sickle cell anemia has become very common in the African population because : **[AIPMT 2006]**
- (1) It is controlled by recessive genes
 - (2) It is not a fatal disease
 - (3) It provides immunity against malaria
 - (4) It is controlled by dominant genes
- Q.7** One of the important consequences of geographical isolation is : **[AIPMT 2007]**
- (1) No change in the isolated fauna
 - (2) Preventing Speciation
 - (3) Speciation through reproductive isolation
 - (4) Random creation of new species
- Q.8** Among the human ancestors the brain size was more than 1000 CC in : **[AIPMT 2007]**
- (1) Homo sapiens neanderthalensis
 - (2) Homo erectus
 - (3) Ramapithecus
 - (4) Homo habilis
- Q.9** Two plants can be conclusively said to belong to the same species if they : **[AIPMT 2007]**
- (1) Can reproduce freely with each other and form seeds.
 - (2) Have more than 90 percent similar genes
 - (3) Look similar and possess identical secondary metabolites
 - (4) Have same number of chromosomes
- Q.10** The Finches of Galapagos islands provide an evidence in favour of : **[AIPMT 2007]**
- (1) Special Creation
 - (2) Evolution due to Mutation
 - (3) Retrogressive Evolution
 - (4) Biogeographical Evidence
- Q.11** What is common to whale, seal and shark : **[AIPMT 2007]**
- (1) Seasonal migration
 - (2) Thick subcutaneous fat
 - (3) Convergent evolution
 - (4) Homeiothermy
- Q.12** Adaptive radiation refers to : **[AIPMT 2007]**
- (1) Adaptations due to Geographical isolation
 - (2) Evolution of different species from a common ancestor
 - (3) Migration of members of a species to different geographical areas
 - (4) Power of adaptation in an individual to a variety of environments

BIOLOGY

Q.13 When two species of different genealogy come to resemble each other as a result of adaptation, the phenomenon is termed: **[AIPMT 2007]**

- (1) Divergent evolution
- (2) Microevolution
- (3) Co evolution
- (4) Convergent evolution

Q.14 The concept of chemical evolution is based on: **[AIPMT 2007]**

- (1) Crystallization of chemicals
- (2) Interaction of water, air and clay under intense heat
- (3) Effect of solar radiation on chemical
- (4) Possible origin of life by combination of chemicals under suitable environmental conditions

Q.15 Industrial melanism as observed in peppered moth proves that: **[AIPMT 2007]**

- (1) The true black melanic forms arise by a recurring random mutation
- (2) The melanic form of the moth has no selective advantage over lighter form in industrial area
- (3) The lighter-form moth has no selective advantage either in polluted industrial area or non-polluted area.
- (4) Melanism is pollution-generated feature

Q.16 Which one of the following statements is correct? **[AIPMT 2007]**

- (1) Stem cells are specialized cells
- (2) There is no evidence of the existence of gills during embryogenesis of mammals
- (3) All plant and animal cells are totipotent
- (4) Ontogeny repeats phylogeny

Q.17 Which one of the following is **incorrect** about the characteristics of Protobionts (coacervates and microspheres) as envisaged in the abiogenic origin of life? **[AIPMT 2008]**

- (1) They were partially isolated from the surroundings
- (2) They could maintain an internal environment
- (3) They were able to reproduce
- (4) They could separate combinations of molecules from the surroundings

Q.18 Which one of the following scientist's name is **correctly** matched with the theory put forth by him? **[AIPMT 2008]**

- (1) **De Vries** - Natural selection
- (2) **Mendel** - Theory of pangenesis
- (3) **Weismann** - Theory of continuity of Germplasm
- (4) **Pasteur** - Inheritance of acquired characters

Q.19 Peripatus is a connecting link between: **[AIPMT 2009]**

- (1) Coelenterata and Porifera
- (2) Ctenophora and Platyhelminthes
- (3) Mollusca and Echinodermata
- (4) Annelida and Arthropoda

Q.20 In the case of peppered moth (*Biston betularia*) the black-coloured form became dominant over the light-coloured form in England during industrial revolution. This is an example of : **[AIPMT 2009]**

- (1) Inheritance of darker colour character acquired due to the darker environment
- (2) Natural selection whereby the darker forms were selected
- (3) Appearance of the darker coloured individuals due to very poor sunlight
- (4) Protective mimicry

Q.21 Darwin's finches are a good example of :
[AIPMT-Pre 2010]

- (1) Convergent evolution
- (2) Industrial melanism,
- (3) Connecting link
- (4) Adaptive radiation

Q.22 The most apparent change during the evolutionary history of Homo sapiens is traced in
[AIPMT-Mains 2010]

- (1) Walking upright
- (2) Shortening of jaws
- (3) Remarkable increase in the brain size
- (4) Loss of body hair

Q.23 Given below are four statements (A-D) each with one or two blanks. Select the option which correctly fills up the blanks in two statements :
[AIPMT-Mains 2010]

Statements :

- (A) Wings of butterfly and birds look alike and are the results of (i) evolution
- (B) Miller showed that CH_4 , H_2 , NH_3 and (i) , when exposed to electric discharge in flask resulted in formation of (ii)
- (C) Vermiform appendix is a (i) organ and an (ii) evidence of evolution.
- (D) According to Darwin evolution took place due to (i) and (ii) of the fittest.

Options:

- (1) (A) - (i) convergent
(B) - (i) oxygen, (ii) nucleosides
- (2) (B) - (i) water vapour, (ii) amino acids,
(C) - (i) rudimentary (ii) anatomical
- (3) (C) - (i) vestigial, (ii) anatomical,
(D) - (i) mutations, (ii) multiplication
- (4) (D) - (i) small variations, (ii) survival,
(A) - (i) convergent

Q.24 What was the most significant trend in the evolution of modern man (Homo sapiens) from his ancestors?
[AIPMT -Pre 2011]

- (1) Upright posture
- (2) Shortening of jaws
- (3) Binocular vision
- (4) Increasing brain capacity

Q.25 Evolution of different species in a given area starting from a point and spreading to other geographical areas is known as :
[AIPMT-Pre 2012]

- (1) Migration
- (2) Divergent evolution
- (3) Adaptive radiation
- (4) Natural selection

Q.26 The extinct human who lived 1,00,000 to 40,000 years ago, in Europe, Asia and parts of Africa, with short stature, heavy eye brows, retreating fore heads, large jaws with heavy teeth, stocky bodies, a lumbering gait and stooped posture was:
[AIPMT-Pre 2012]

- (1) Cro-magnon humans
- (2) Ramapithecus
- (3) Homo habilis
- (4) Neanderthal human

Q.27 Which one of the following options gives one correct example each of convergent evolution and divergent evolution?
[AIPMT-Pre 2012]

	Convergent evolution	Divergent evolution
(1)	Bones of forelimbs of vertebrates	Wings of butterfly and birds
(2)	Thorns of bougainvillea and tendrils of cucurbita	Eyes of octopus and mammals
(3)	Eyes of octopus and mammals	Bones of forelimbs of vertebrates
(4)	Thorns of Bougainvillea and tendrils of cucurbita	Wings of butterflies and birds

BIOLOGY

Q.28 The idea of mutations was brought forth by :

[AIPMT-Mains 2012]

- (1) Hardy Weinberg, who worked on allele frequencies in a population
- (2) Charles Darwin, who observed a wide variety of organisms during sea voyage
- (3) Hugo De Vries, who worked on evening primrose
- (4) Gregor Mendel, who worked on Pisum sativum

Q.29 The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of :

[NEET-UG 2013]

- (1) Analogous organs that have evolved due to divergent evolution
- (2) Homologous organs that have evolved due to convergent evolution
- (3) Homologous organs that have evolved due to divergent evolution
- (4) Analogous organs that have evolved due to convergent evolution

Q.30 The tendency of population to remain in genetic equilibrium may be disturbed by :

[NEET-UG 2013]

- (1) Lack of random mating
- (2) Random mating
- (3) Lack of migration
- (4) Lack of mutations

Q.31 The process by which organisms with different evolutionary history evolve similar phenotypic adaptation in response to a common environmental challenge, is called :

[NEET-UG 2013]

- (1) Adaptive radiation
- (2) Natural selection
- (3) Convergent evolution
- (4) Non-random evolution

Q.32 According to Darwin, the organic evolution is due to :

[NEET-UG 2013]

- (1) Reduced feeding efficiency in one species due to the presence of interfering species
- (2) Intraspecific competition
- (3) Interspecific competition
- (4) Competition within closely related species

Q.33 Variation in gene frequencies within populations can occur by chance rather than by natural selection.

This is referred to as : [NEET-UG 2013]

- (1) Genetic load
- (2) Genetic flow
- (3) Genetic drift
- (4) Random mating

Q.34 In a population of 1000 individuals 360 belong to genotype AA, 480 to Aa and the remaining 160 to aa. Based on this data, the frequency of allele A in the population is :

[AIPMT 2014]

- (1) 0.4
- (2) 0.5
- (3) 0.6
- (4) 0.7

Q.35 Forelimbs of cat, lizard used in walking; forelimbs of whale used in swimming and forelimbs of bats used in flying are an example of

[AIPMT 2014]

- (1) Analogous organs
- (2) Adaptive radiation
- (3) Homologous organs
- (4) Convergent evolution

Q.36 Which one of the following are analogous structures?

[AIPMT 2014]

- (1) Wings of Bat and Wings of Pigeon.
- (2) Gills of Prawn and Lungs of Man.
- (3) Thorns of Bougainvillea and Tendrils of Cucurbita
- (4) Flippers of Dolphin and Legs of Horse

Q.37 Which of the following had the smallest brain capacity ?

[AIPMT 2015]

- (1) Homo sapiens
- (2) Homo neanderthalensis
- (3) Homo habilis
- (4) Homo erectus

Q.38 Which is the most common mechanism of genetic variation in the population of sexually reproducing organism ? **[AIPMT 2015]**

- (1) Chromosomal aberrations
- (2) Genetic drift
- (3) Recombination
- (4) Transduction

Q.39 The wings of a bird and the wings of an insect are : **[Re-AIPMT 2015]**

- (1) Homologous structures and represent convergent evolution
- (2) Homologous structures and represent divergent evolution
- (3) Analogous structures and represent convergent evolution
- (4) Phylogenetic structures and represent divergent evolution

Q.40 Industrial melanism is an example of : **[Re-AIPMT 2015]**

- (1) Neo Lamarckism
- (2) Neo Darwinism
- (3) Natural selection
- (4) Mutation

Q.41 Which the following are most suitable indicators of SO₂ pollution in the environment ? **[Re-AIPMT 2015]**

- (1) Fungi
- (2) Lichens
- (3) Conifers
- (4) Algae

Q.42 Which of the following structure is homologous to the wing of a bird ? **[NEET-UG 2016 (Phase I)]**

- (1) Dorsal fin of a Shark
- (2) Wing of a Moth
- (3) Hind limb of Rabbit
- (4) Flipper of Whale

Q.43 Analogous structures are a result of : **[NEET-UG 2016 (Phase I)]**

- (1) Divergent evolution
- (2) Convergent evolution
- (3) Shared ancestry
- (4) Stabilizing selection

Q.44 Following are the two statements regarding the origin of life : **[NEET-UG 2016 (Phase I)]**

- (a) The earliest organisms that appeared on the earth were non-green and presumably anaerobes.
- (b) The first autotrophic organisms were the chemoautotrophs that never released oxygen.

Of the above statements which one of the following options is correct ?

- (1) (a) is correct but (b) is false.
- (2) (b) is correct but (a) is false.
- (3) Both (a) and (b) are correct.
- (4) Both (a) and (b) are false.

Q.45 Artificial selection to obtain cows yielding higher milk output represents: **[NEET 2017]**

- (1) Directional as it pushes the mean of the character in one direction
- (2) Disruptive as it splits the population into two, one yielding, higher output and the other lower output.
- (3) Stabilizing followed by disruptive as it stabilizes the population to produce higher yielding cows.
- (4) Stabilising selection as it stabilizes this character in the population.

Q.46 The similarity of bone structure in the forelimbs of many vertebrates is an example of : **[NEET 2018]**

- (1) Homology
- (2) Analogy
- (3) Convergent evolution
- (4) Adaptive radiation

Q.47 Among the following sets of examples for divergent evolution, select the **incorrect** option : **[NEET 2018]**

- (1) Forelimbs of man, bat and cheetah
- (2) Heart of bat, man and cheetah
- (3) Brain of bat, man and cheetah
- (4) Eye of octopus, bat and man

BIOLOGY

Q.48 According to Hugo de Vries, the mechanism of evolution is : **[NEET 2018]**

- (1) Multiple step mutations
- (2) Saltation
- (3) Phenotypic variations
- (4) Minor mutations

Q.49 Variations caused by mutation, as proposed by Hugo de Vries, are : **[NEET 2019]**

- (1) small and directional
- (2) small and directionless
- (3) random and directional
- (4) random and directionless

Q.50 Match the hominids with their correct brain size : **[NEET 2019]**

- | | |
|---------------------------|------------------|
| (a) Homo habilis | (i) 900 cc |
| (b) Homo neanderthalensis | (ii) 1350 cc |
| (c) Homo erectus | (iii) 650-800 cc |
| (d) Homo sapiens | (iv) 1400 cc |

Select the correct option.

- | | (a) | (b) | (c) | (d) |
|-----|-------|-------|------|------|
| (1) | (iii) | (iv) | (i) | (ii) |
| (2) | (iv) | (iii) | (i) | (ii) |
| (3) | (iii) | (i) | (iv) | (ii) |
| (4) | (iii) | (ii) | (i) | (v) |

Q.51 In a species, the weight of newborn ranges from 2 to 5 kg. 97% of the newborn with an average weight between 3 to 3.3 kg survive whereas 99% of the infants born with weights from 2 to 2.5 kg or 4.5 to 5 kg die. Which type of selection process is taking place ?

[NEET 2019]

- (1) Disruptive Selection
- (2) Cyclical Selection
- (3) Directional Selection
- (4) Stabilizing Selection

Q.52 Embryological support for evolution was disapproved by : **[NEET-2020]**

- (1) Oparin
- (2) Karl Ernst von Baer
- (3) Alfred Wallace
- (4) Charles Darwin

Q.53 Flippers of Penguins and Dolphins are examples of: **[NEET-2020]**

- (1) Natural selection
- (2) Adaptive radiation
- (3) Convergent evolution
- (4) Industrial melanism

Q.54 From his experiments, S.L. Miller produced amino acids by mixing the following in a closed flask : **[NEET-2020]**

- (1) CH₃, H₂, NH₃ and water vapour at 600°C
- (2) CH₄, H₂, NH₃ and water vapour at 800°C
- (3) CH₃, H₂, NH₄ and water vapour at 800°C
- (4) CH₄, H₂, NH₃ and water vapour at 600°C

Q.55 Which of the following refer to correct example(s) of organisms which have evolved due to changes in environment brought about by anthropogenic action? **[NEET-2020]**

- (a) Darwin's Finches of Galapagos islands.
- (b) Herbicide resistant weeds.
- (c) Drug resistant eukaryotes
- (d) Man-created breeds of domesticated animals like dogs

- | | |
|-----------------|----------------------|
| (1) Only (d) | (2) Only (a) |
| (3) (a) and (c) | (4) (b), (c) and (d) |

Q.56 Embryological support for evolution was proposed by : **[Covid-2020]**

- | | |
|--------------------|-------------------------|
| (1) Ernst Heckel | (2) Karl Ernst von Baer |
| (3) Charles Darwin | (4) Alfred Wallace |

Q.57 After about how many years of formation of earth, life appeared on this planet? **[Covid-2020]**

- | | |
|-----------------------|----------------------|
| (1) 500 billion years | (2) 50 million years |
| (3) 500 million years | (4) 50 billion years |

Q.58 The phenomenon of evolution of different species in a given geographical area starting from a point and spreading to other habitats is called :- **[COVID-2020]**

- | | |
|-----------------------|------------------------|
| (1) Saltation | (2) Co-evolution |
| (3) Natural selection | (4) Adaptive radiation |

Q.59 A Hominid fossil discovered in Java in 1891, now extinct, having cranial capacity of about 900 cc was: **[COVID-2020]**

- (1) Homo erectus
- (2) Neanderthal man
- (3) Homo sapiens
- (4) Australopithecus

Q.60 The factor that leads to Founder effect in population is : **[NEET-2021]**

- (1) Natural selection
- (2) Genetic recombination
- (3) Mutation
- (4) Genetic drift

Q.61 Match List-I with List-II

List-I		List-II	
(a)	Adaptive radiation	(i)	Selection of resistant varieties due to excessive use of herbicides and pesticides
(b)	Convergent evolution	(ii)	Bones of forelimbs in Man and whale
(c)	Divergent evolution	(iii)	Wings of butterfly and bird
(d)	Evolution by anthropogenic action	(iv)	Darwin Finches

Choose the correct answer from the options given below. **[NEET-2021]**

- | | (a) | (b) | (c) | (d) |
|-----|------------|------------|------------|------------|
| (1) | (iv) | (iii) | (ii) | (i) |
| (2) | (iii) | (ii) | (i) | (iv) |
| (3) | (ii) | (i) | (iv) | (iii) |
| (4) | (i) | (iv) | (iii) | (ii) |

ANSWER KEY
EXERCISE-I

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	4	4	1	4	4	1	1	3	4	3	2	1	2	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	2	1	2	2	4	4	3	2	2	3	4	2	2	3	4
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	3	2	3	2	1	1	3	1	1	4	2	1	3	3	4
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	3	2	2	1	1	2	1	2	4	2	2	2	4
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	2	3	4	4	2	2	2	4	4	1	3	3	3	2
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	3	3	1	4	1	2	3	3	3	4	3	2	2	4	2
Que.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Ans.	1	4	1	2	1	2	3	3	3	4	2	3	4	1	4
Que.	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	3	3	3	4	2	3	3	2	4	4	4	4	1	1
Que.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Ans.	2	2	3	1	2	2	1	1	1	1	2	3	1	3	3
Que.	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Ans.	3	3	1	1	4	3	4	3	2	4	2	3	4	3	3
Que.	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Ans.	3	1	1	3	3	3	2	1	4	3	3	3	1	3	4
Que.	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	1	1	3	4	2	4	3	2	1	3	3	1	3	3	1
Que.	181														
Ans.	4														

EXERCISE-II

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	4	3	1	1	4	3	4	4	3	2	4	1	1	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	2	1	3	2	2	4	4	1	2	3	1	2	1	1	4
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	3	3	1	4	1	3	1	2	2	3	2	3	3	2	4
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	3	1	2	3	2	1	1	4	2	3	3	4	1
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	1	4	3	3	3	3	4	1	4	2	4	3	1	3
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	3	2	1	3	2	4	3	4	2	2	4	3	4	2	3
Que.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Ans.	3	3	4	2	4	4	3	4	2	3	1	4	1	1	2
Que.	106	107	108	109	110	111	112								
Ans.	3	2	3	1	1	2	1								

EXERCISE-III

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	1	1	1	3	3	1	1	4	3	2	4	4	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	3	3	4	2	4	3	4	4	3	4	3	3	4	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	3	3	3	3	3	2	3	3	3	3	2	4	2	3	1
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	2	4	1	4	2	3	2	4	1	3	4	1	4
Que.	61														
Ans.	1														

NEET Module Details

(Total = 24)

CLASS - XII : 11 MODULES

PHYSICS

Module - 1

Ch. No.	Chapter Name
1.	Electrostatics
2.	Capacitor&R-C Circuit
3.	Current Electricity

Module - 2

1.	MEC
2.	Magnetic Materials
3.	Bar Magnets & Earth Magnetism
4.	EMI
5.	AC
6.	EMW

Module - 3

	Ray Optics
	Wave Optics

Module - 4

1.	Modern Physics
2.	Nuclear Physics
3.	Electronics - Semiconductor
4.	Principles of Communication System

CHEMISTRY

Module -1 (Physical)

Ch. No.	Chapter Name
1.	The Solid State
2.	Solutions
3.	Electrochemistry
4.	Chemical Kinetics
5.	Surface Chemistry

Module -2 (Inorganic)

1.	The p-Block Elements
2.	General Principles and Processes of Isolation of Elements (Metallurgy)
3.	The d - and f Block Elements
4.	Coordination Compounds

Module -3 (Organic)

1.	Halogen Derivatives
2.	Oxygen Containing Compound
3.	Nitrogen Containing Compound
4.	Biomolecules, Polymers & Chemistry Every Day Life

BIOLOGY

Module - 1

Ch. No.	Chapter Name
1.	Reproduction in organisms
2.	Sexual reproduction in flowering plants
3.	Human Reproduction
4.	Reproductive Health

Module - 2

1.	Principles of Inheritance and Variation
2.	Molecular basis of Inheritance
3.	Biotechnology: Principles and Processes
4.	Biotechnology and its applications
5.	Microbes in Human Welfare
6.	Strategies for Enhancement in Food Production(Plant Breeding)

Module - 3

Ch. No.	Chapter Name
1.	Origin & Evolution
2.	Human Health and Disease
3.	Animal Husbandry

Module - 4

1.	Organisms and Populations
2.	Ecological: Population, Community & Interactions
3.	Ecosystem
4.	Biodiversity and Conservation
5.	Environmental Issues

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