

Maharashtra State Board
Class XII Biology
Board Paper – 2015 Solution

SECTION I
[BOTANY]

Q. 1.

(i) (a) test cross

A test cross is a cross between an F_1 hybrid and a recessive parent. It is used to determine the unknown genotype of an individual.

(ii) (c) independent assortment

According to the law of independent assortment, the distribution of alleles of different traits is independent of their original combinations in the parents.

(iii) (a) polyblend

Ahmed Khan from Bengaluru developed polyblend. It is mixed with bitumen and is used to lay roads and increases road life.

(iv) (b) humification

Humus is formed by the process of humification which is partially decomposed organic matter.

(v) (b) transduction

The transfer of genetic material into a bacterial cell through a viral vector is known as transduction. Plasmids are the common viral vectors.

(vi) (b) 18

Endosperm is triploid ($3n$) = 27. Hence, $n = 9$. Definitive nucleus, i.e. the secondary nucleus is diploid, i.e. $2n$. Therefore, the number of chromosomes is 18.

(vii) (a) *Salvia*

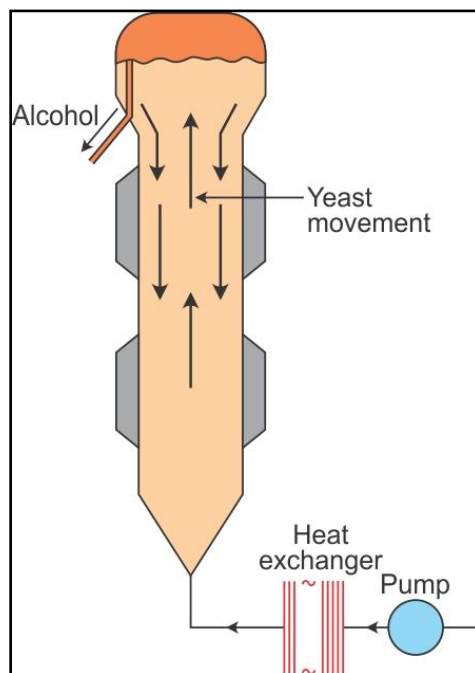
In *Salvia*, when an insect visits a flower, it pushes the lower sterile anther lobe due to which the upper fertile anther lobe bends down. The anther lobe comes in contact with the rear of the insect's body where the pollen grains get attached. When the same insect visits another flower with a mature gynoecium, the pollen grains are picked up by the receptive stigma. This process of pollination is called the lever mechanism.

Q. 2.

(A)

- (i) A pea plant pure for yellow seed colour is crossed with a pea plant pure for green seed colour. In the F_1 generation, all pea plants were with yellow seeds. Here, Mendel's law of dominance is applicable.
- (ii) The enzyme polygalacturonase is responsible for delay in ripening of tomato fruit.
- (iii) Methanogenic bacteria are responsible for converting organic acids into methane.
- (iv) Sonalika and Kalyansona were the high-yielding semi-dwarf varieties of wheat selected and introduced in India in 1963.
- (v) In angiosperms, one of the two male gametes fuses with the diploid secondary nucleus to form a triploid primary endosperm nucleus. This process is called triple fusion.
- (vi) Ecological services for the benefit of mankind are CO_2 fixation and release of oxygen.

(B) **Tubular tower fermenter:**

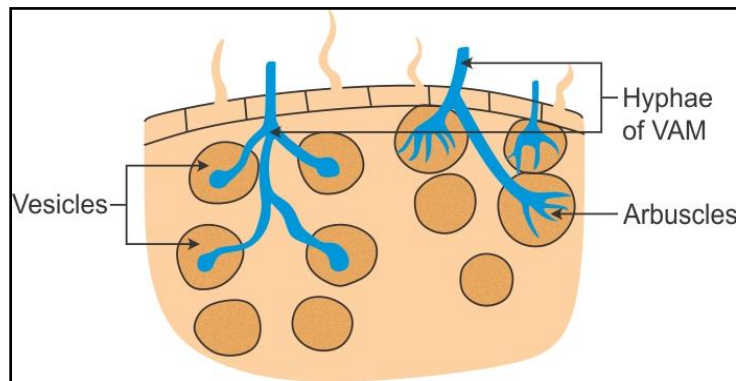


(C)

(i) Global warming is caused by the greenhouse effect:

- The heating of the Earth's atmosphere due to trapped infra red rays reflected from the Earth's surface by atmospheric gases is called the greenhouse effect.
- An increase in the amount of carbon dioxide present in the atmosphere retains heat energy of the Sun and increases the Earth's temperature. This results in global warming.

(ii) **VAM (vesicular arbuscular mycorrhizae):**



(iii) **Difference between light and dark reactions:**

Light Reaction	Dark Reaction
1. It requires the presence of light.	1. It occurs independently of the presence of light.
2. It occurs in the grana of chloroplast.	2. It occurs in the stroma of chloroplast.
3. It involves absorption of light energy by photosynthetic pigments and its conversion into chemical energy.	3. It involves the reduction of carbon dioxide into glucose.
4. NADPH ₂ and ATP are produced.	4. NADPH ₂ and ATP produced during the light reaction are used.
5. Oxygen is liberated.	5. Oxygen is not liberated.

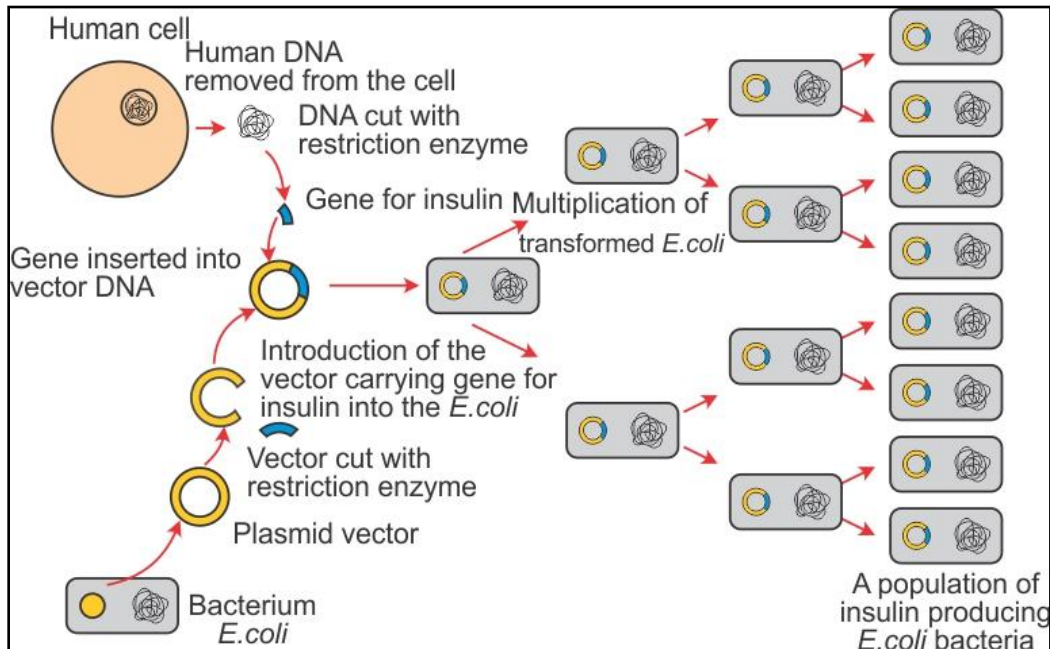
(iv) Mendel selected the garden pea *Pisum sativum* for his experiments on inheritance for the following reasons:

- Garden pea is an annual plant with a short lifespan of 3 to 4 months.
- It is self-pollinating.
- It is available in many varieties with contrasting characters.
- The flowers are large enough for easy emasculation which is required for artificial crossing and to produce fertile offspring.

Q. 3.

(A)

(i) **Steps in recombinant DNA technology:**



The following steps are involved in recombinant DNA technology:

- Isolation of genomic DNA from the donor.
- Fragmentation of the isolated DNA fragment by using restriction enzymes.
- Screening of the fragments for the desired gene.
- Insertion of the fragments with the desired gene into a cloning vector so as to develop a recombinant or chimeric DNA.
- Introduction of the recombinant vector into a competent host cell.
- Culturing of the cells containing recombinant vectors to obtain multiple copies of the desired fragment of DNA.
- Use of these copies to transform suitable host cells so as to express the desired gene.

(ii) **Tissue culture:**

The culturing or growing of isolated protoplasts or cells, tissues or organs on a nutrient medium under controlled aseptic conditions to produce a complete plant or plant parts is called tissue culture.

Methodology of tissue culture:

1. **Explant culture:**

- Explants such as parenchyma tissues or meristems are excised from the plant, sterilised and placed on a solid nutrient medium.
- The cells from the explants absorb nutrients and begin to multiply.

2. Callus formation and its culture:

- The proliferation of cells from the explants because of mitosis forms an unorganised mass of cells called callus.
- All the cells of the callus are identical.

3. Organogenesis:

- The addition of growth hormones in proper proportion induces the formation of organs.
- If auxins are more, roots are formed.
- If cytokinins are more, a shoot system is developed.

4. Formation of cells or suspension culture:

- The callus is transferred to a liquid nutrient medium and agitated constantly at 100 to 250 rpm.
- The agitation separates the cells, aerates the mixture and prevents aggregation of cells.
- Callus and suspension cultures help to achieve cell biomass production which can be used for biochemical isolation, regeneration of new plantlets, formation of transgenic plants and protoplast culture.

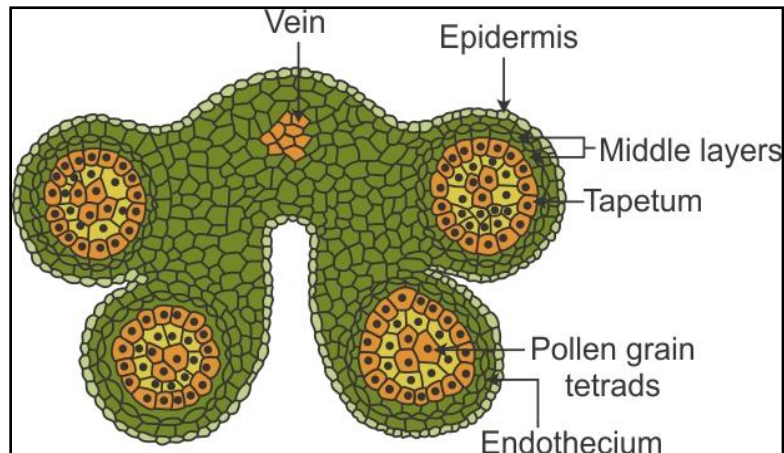
(iii) Vegetative propagation:

Reproduction which occurs through the parts of vegetative organs such as the roots, stem, leaf or bud of a plant is called vegetative propagation.

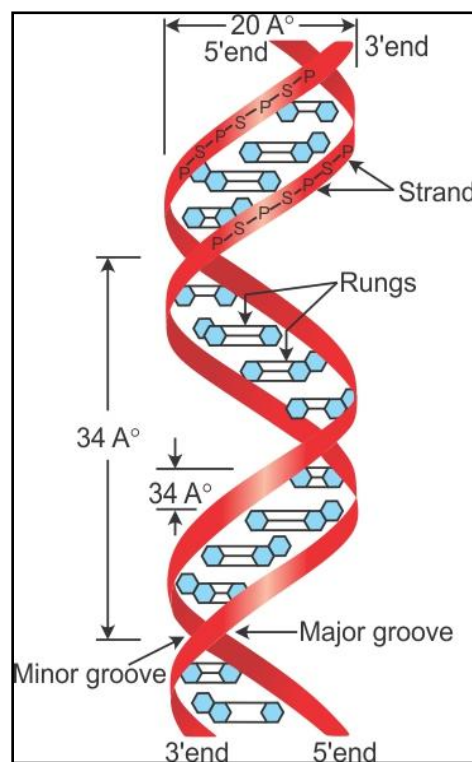
Differentiate between stem tuber and tuberous root:

Stem Tuber	Tuberous Root
1. It is an underground stem.	1. It is an underground root.
2. It has axillary buds on its surface.	2. It has adventitious buds on its surface.
3. Under favourable conditions, one of the axillary buds sprouts by suppressing the growth of the other buds.	3. All the adventitious buds sprout under favourable conditions to produce leafy shoots and adventitious roots from the base of the shoot.
4. Examples: Potato	4. Examples: Sweet potato

(B) T. S. of angiospermic anther:



Q. 4. Watson Crick model of DNA:



- In 1953, James Watson and Francis Crick proposed the structure of DNA.
- Their structure was based on the X-ray crystallographic studies provided by Maurice Wilkins and Rosalind Franklin.
- Peculiar characteristic features of this model:
- DNA as a double helix:
 - It consists of two long strands, coiled around a common imaginary central axis. This forms a double helix.
 - The helix looks like a twisted ladder with alternating major and minor grooves.

- Structure of each strand:
 - Each DNA strand consists of several nucleotides.
 - Each nucleotide is made of deoxyribose sugar, phosphate group and nitrogen base.
 - The successive nucleotides of the same strands are linked by 3'-5' phosphodiester linkages.
- Complimentary Base Pairing:
 - The nitrogen bases on one strand pair with the nitrogen bases on the opposite strand.
 - The purine base 'A' pairs with the pyrimidine base 'T' by two hydrogen bonds (A = T or T = A).
 - The purine base 'G' pairs with the pyrimidine base 'C' with three hydrogen bonds (G ≡ C or C ≡ G).
 - This base pairing is called complimentary base pairing.
 - Nitrogen bases along with hydrogen bonds constitute the rungs of the ladder.
 - The distance between the two successive rungs is 0.34 nm.
- Purine:pyrimidine ratio:
 - Because of complementary base pairing, the total number of purine bases is always equal to the total number of pyrimidine bases (1:1).
 - This is called Chargaff's rule and may be represented as follows:

$$A + G = T + C \text{ or } \frac{A + G}{T + C} = 1$$
- Polarity of strands:
 - The polarity of the DNA strand is due to the presence of the 3rd and 5th carbon atoms of the deoxyribose sugar.
 - There is a free phosphate group at the 5' end, while there is a free hydroxyl group at the 3' end.
 - One of the strands runs in the 5' to 3' direction, while the other runs in the 3' to 5' direction.
 - This arrangement of two strands of DNA is considered anti-parallel.
- Major and minor grooves:
 - The coiling of the double helix results in the formation of major or deep grooves.
 - The twisting of two strands around one another forms minor or shallow grooves.
- Dimensions:
 - The diameter of the DNA molecule is 2 nm.
 - The DNA molecule makes one complete turn of 360° after covering a distance of 3.4 nm.
 - There are 10 base pairs in one complete spiral.

OR

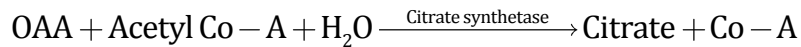
Krebs cycle:

The cyclic process through which acetyl Co-A is completely oxidised and CO₂ is released in a step-wise manner is called Krebs cycle.

Steps in Krebs cycle:

- Condensation:

- Acetyl Co-A (2C) reacts with oxaloacetate (4C) to form citric acid or citrate (6C).
- The reaction takes place in the presence of citrate synthetase.
- One water molecule is used in this reaction.
- A molecule of Co-A released is recycled for the acetylation of another molecule of pyruvate.

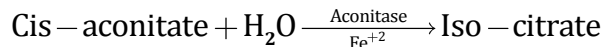


- Isomerisation:

- Citric acid is isomerised into isocitric acid in the presence of the enzyme aconitase and Fe²⁺.
- This occurs in two steps:
- 1) Dehydration during which citrate loses water molecules to form cis-aconitate (6C).

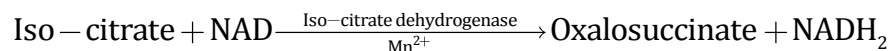


- 2) Hydration during which cis-aconitate combines with a water molecule to form iso-citrate (6C).



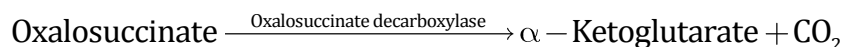
- Oxidation (Dehydrogenation-I):

- Iso-citrate (6C) is oxidised in the presence of the enzyme iso-citrate dehydrogenase and Mn²⁺ ions to form an intermediate called oxalosuccinate (6C).
- Two hydrogen atoms released during this step are taken up by the coenzyme NAD to form NADH₂.



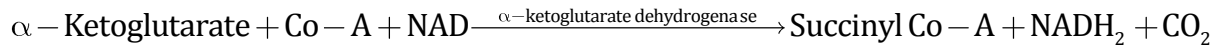
- Decarboxylation-I:

- Oxalosuccinate (6C) undergoes decarboxylation in the presence of the enzyme decarboxylase to form α-ketoglutarate (5C).



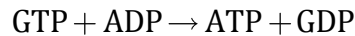
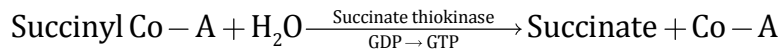
- Oxidative decarboxylation (Dehydrogenation-II and Decarboxylation-II):

- α-Ketoglutarate (5C) undergoes simultaneous dehydrogenation and decarboxylation to form the four-carbon compound succinyl Co-A.
- The reaction takes place in the presence of α-ketoglutarate dehydrogenase.



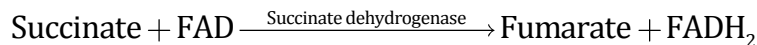
- Hydration and phosphorylation:

- Succinyl Co-A (4C) gets hydrated using a water molecule to form succinate (4C) in the presence of succinate thiokinase.
- GDP is phosphorylated to form GTP.



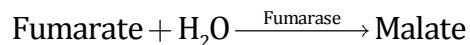
- Oxidation (Dehydrogenation-III):

- Succinate (4C) is oxidised to form fumarate (4C) in the presence of succinate dehydrogenase.
- The hydrogen atoms released in this reaction are accepted by FAD and it is reduced to FADH₂.



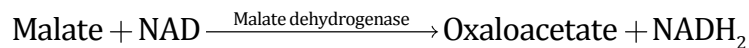
- Hydration:

- A molecule of water is added to fumarate (4C) to form malate (4C).
- The reaction takes place in the presence of fumarase.



- Oxidation (Dehydrogenation-IV):

- Malate (4C) is oxidised by the removal of hydrogen atoms to form oxaloacetate (4C) in the presence of malate dehydrogenase.
- Released hydrogen atoms are accepted by NAD and it is reduced to NADH₂.



Two turns of the Krebs cycle produce six molecules of NADH₂, two molecules of FADH₂ and two molecules of ATP.

During each turn, three molecules of water are used up and two molecules of CO₂ are released.

SECTION II
[ZOOLOGY]

Q. 5.

(i) (a) Cystic fibrosis

Pulmozyme (DNase) is an enzyme used to treat cystic fibrosis and is inhaled via a nebuliser.

(ii) (b) Webbing of neck

A missing X chromosome leads to Turner's syndrome. The symptoms in females are a receding lower jaw and a short webbed neck.

(iii) (a) Sperm

The haploid human genome can be found in the egg and sperm cells. This genome has about three billion DNA base pairs.

(iv) (d) *Biston betularia*

It is a temporary species which helps in studying industrial melanism.

(v) (d) Inbreeding

Superior females of the same breed are identified and mated in pairs.

(vi) (c) Modified cardiac muscles

Normal activities of the heart are auto-regulated by specialised muscles.

(vii) (a) Mutualism

It is a type of interaction in which both organisms are benefited.

Q. 6.

(A)

(i) A gene pool is the set or collection of all the genes in a population of any particular species.

(ii) Colour blindness and haemophilia are examples of X-linked diseases.

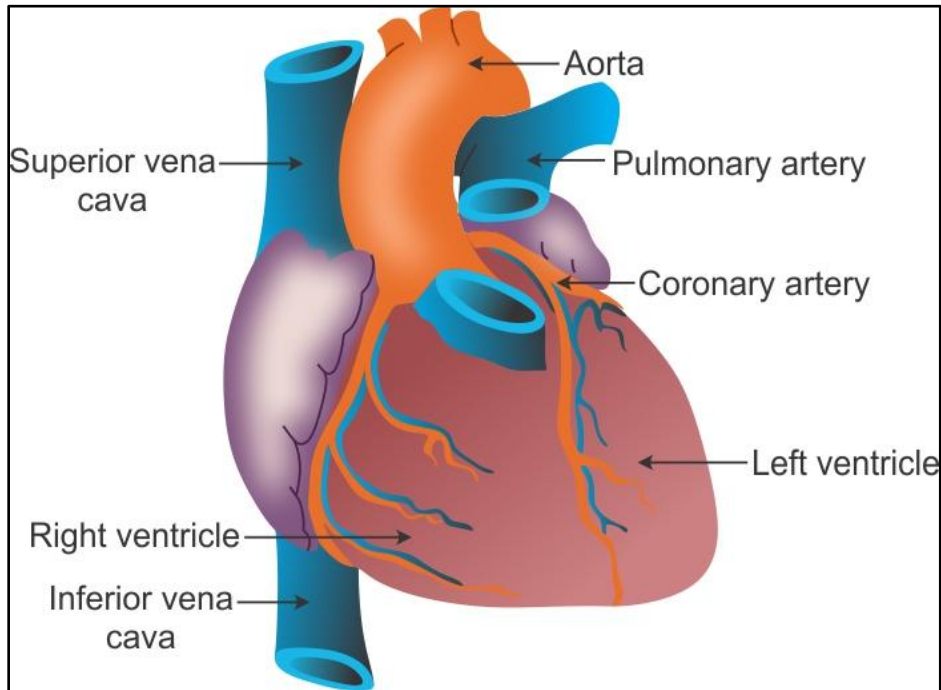
(iii) HGP stands for 'Human Genome Project'.

(iv) Tussar silk and Eri silk are two varieties of silk which are considered of inferior quality.

(v) The 'T-wave' in an electrocardiogram represents the ventricular diastole.

- (vi) The *in situ* method of biodiversity conservation includes the hot-spot method of conservation.

(B) Ventral view of the human heart:



(C)

(i) Differences between ape and man:

Ape	Man
1. Apes possess a prognathous face, slanting forehead and snout protruded with a flat nose.	1. Humans possess an orthognathous face, high forehead, dome shaped skull and elevated nose.
2. They have a cranial capacity of 400–600 c.c.	2. They have a cranial capacity of approximately 1450 c.c.
3. The chin is absent.	3. A prominently developed chin.
4. Locomotion is quadrupedal.	4. Locomotion is bipedal.

(ii) Applications of DNA fingerprinting:

- In parental disputes, the DNA fingerprinting technique is used to determine the true parents of the child.
- In forensic science, DNA fingerprinting is used to determine the culprit of the crime by matching the DNA fingerprint of the suspect with the biological evidence (hair, blood, skin cells etc.) found at the crime scene.

(iii) Cancer is divided into various types depending on the type of cells which are altered. There are five major categories of cancer based on the cell type:

- **Carcinoma:** Cancer in the cells which cover the internal and external organs of the body.
- **Sarcoma:** Cancer of the supportive tissues such as bone, cartilage, connective tissue and muscles.
- **Lymphoma:** Cancer which begins in the lymph nodes and tissues which constitute the immune system.
- **Leukaemia:** Cancer which begins in the bone marrow and accumulates in the blood stream.
- **Adenoma:** Cancer which arises in the tissues of the thyroid, pituitary and adrenal glands.

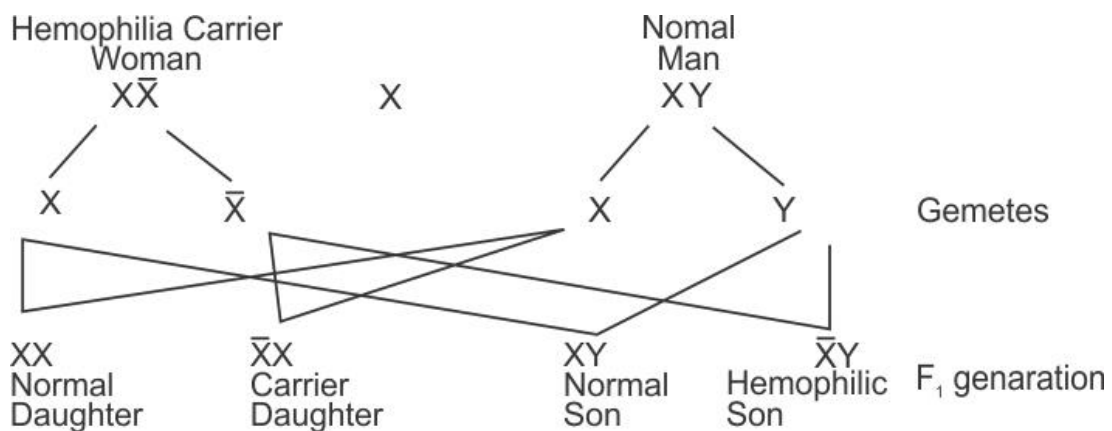
(iv) **Significance of fertilisation:**

- Fertilisation maintains the diploid number of chromosomes in the newly formed zygote.
- It combines characters from two parents bringing about variation in the offspring.
- It determines the sex of the offspring.
- Fertilisation introduces centrioles in the cell which are missing in the ovum.

Q. 7.

(A)

(i)



(ii) Compatibility of human blood groups

Blood type	Donate blood to	Receive blood from
A ⁺	A ⁺ , AB ⁺	A ⁺ A ⁻ O ⁺ O ⁻
O ⁺	O ⁺ A ⁺ B ⁺ AB ⁺	O ⁺ O ⁻
B ⁺	B ⁺ AB ⁺	B ⁺ B ⁻ O ⁺ O ⁻
AB ⁺	AB ⁺	Everybody
A ⁻	A ⁺ A ⁻ AB ⁺ AB ⁻	A ⁻ O ⁻
O ⁻	Everyone	O ⁻
B ⁻	B ⁺ B ⁻ AB ⁺ AB ⁻	B ⁻ O ⁻
AB ⁻	AB ⁺ AB ⁻	AB ⁻ A ⁻ B ⁻ O ⁻

(iii)

- (a) The conservation of endangered species is necessary to maintain the number of individuals of a species and study its life in the natural habitat. There are two types of methods of conservation of endangered species—*ex situ* conservation and *in situ* conservation.

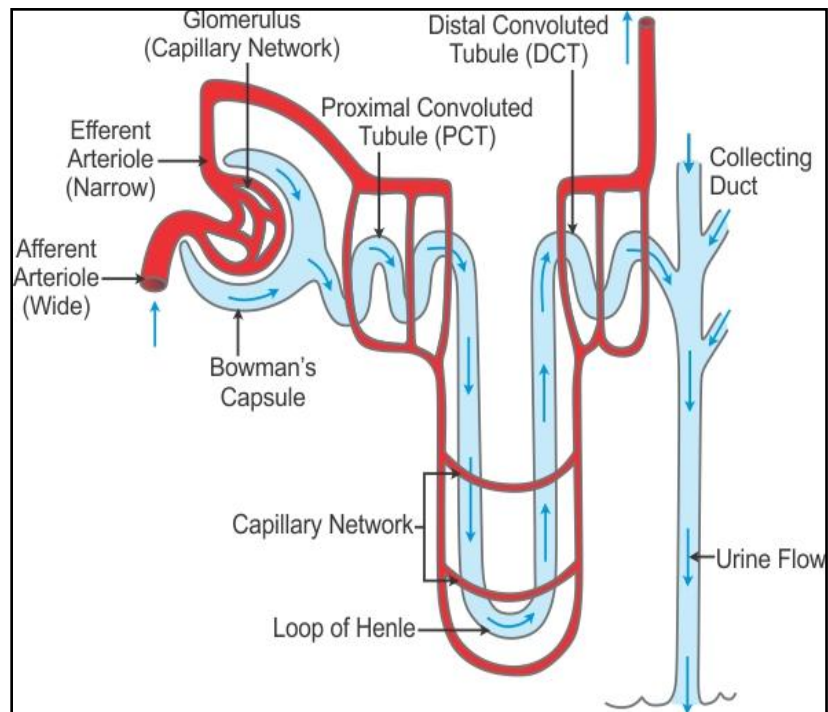
In situ conservation includes hot spots which protect, preserve and restore endangered species in their own habitats in protected areas which include grazing, cultivation etc. *In situ* conservation includes national parks, wildlife sanctuaries and biosphere reserves.

Ex situ conservation is the conservation of endangered species outside their natural habitats such as botanical gardens and zoological parks.

We can also give importance to the most vulnerable species, and the habitats of the species can be safe-guarded by preventing human disturbances.

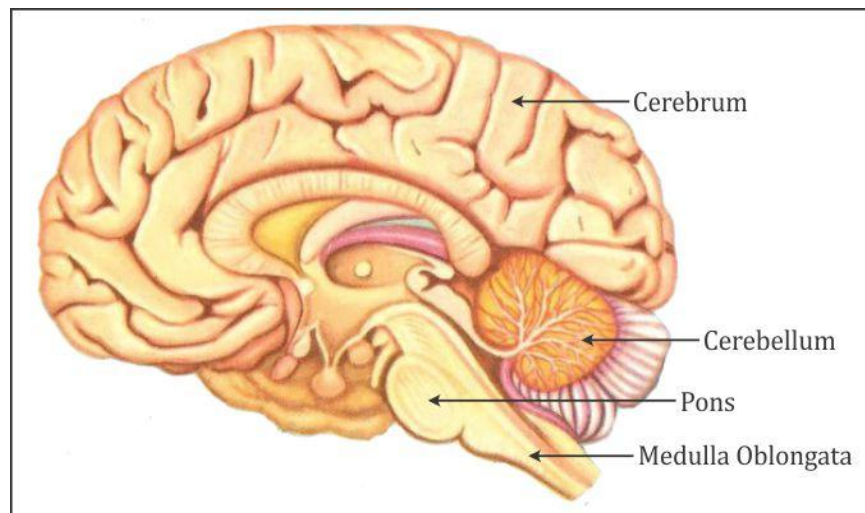
- (b) PUC (Pollution Under Control) is a certification mark issued to certify that motor vehicles in India meet emission and pollution control norms. The PUC certificate is issued after completion of the following practical measures which can control air pollution:
- Air quality standards are established.
 - Adequate legislation is mandatory for control of pollutants.
 - Devices such as the positive crankcase ventilation valve and catalytic converter should be fully checked to reduce exhaust emissions.

(B) Structure of nephron:



Q. 8.

Lateral view of the cerebrum:



Structure of the cerebrum:

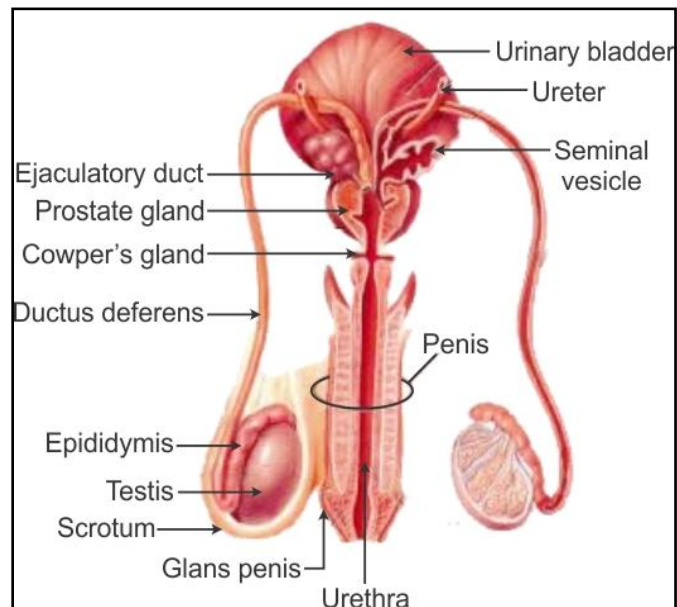
- It is the largest portion of the brain.
- It is divided into two cerebral hemispheres connected to each other by the corpus callosum.
- Each cerebral hemisphere is divided into four lobes—frontal lobe, parietal lobe, occipital lobe and temporal lobe.
- The walls have an outer cortex and inner medulla.
- The cortex contains cell bodies of the neuron and is greyish in colour; hence, it is called grey matter.
- The grey matter has many folds (i.e. gyri) and grooves (i.e. sulci). They increase the surface area to accommodate more nerve cells.
- A higher number of convolutions lead to greater intelligence.
- The medulla consists of axons of nerve fibres and is called white matter.

Two functions of the cerebrum:

- The cerebrum determines intelligence in animals.
- It is also the centre of learning and memorising in the brain.

OR

Human male reproductive system:



The human male reproductive system comprises testes, epididymis, vas deferens, Cowper's glands, prostate gland and penis.

- Testes
 - Testes produce male gametes and sperms.
 - To maintain the temperature 2–3°C lower than the body temperature, the scrotum is located outside the body cavity.

- Epididymis
 - The epididymis stores sperms temporarily.

- Vas deferens
 - Each epididymis continues further as a sperm duct or vas deferens.

- Seminal vesicles
 - The seminal vesicles produce a secretion which is responsible for the transport of sperms.

- Prostate gland
 - It is a bilobed structure which surrounds the urethra.
 - It pours an alkaline secretion into the semen.

- Cowper's glands
 - These are two small ovoid glands.
 - They open into the urethra.
 - Its secretion serves as a lubricant.

- Penis
 - The urethra passes through the penis.
 - It carries either urine or semen at a given time.