Federal Board HSSC-II Examination
Biology Model Question Paper
(Curriculum 2006)

SECTION – A

Time allowed: 25 minutes Marks: 17

Note: Section-A is compulsory. All parts of this section are to be answered on the separately provided OMR Answer Sheet which should be completed in the first 25 minutes and handed over to the Centre Superintendent. Do not use lead pencil.

Q.1 Choose the correct answer i.e. A / B / C / D by filling the relevant bubble for each question on the OMR Answer Sheet according to the instructions given there. Each part carries one mark.

1. The area in lungs where blood vessels and airways pass in and out is called:
   A. Pelvis B. Hilum
   C. Mediastinum D. Fissure

2. Antidiuretic hormone promotes the retention of water by stimulating the:
   A. Active transport of water
   B. Active transport of chloride
   C. Active transport of sodium
   D. Permeability of collecting duct to water

3. Autonomic functions of body such as heartbeat, blood pressure and respiration are controlled by:
   A. Cerebellum B. Pons
   C. Medulla D. Thalamus

4. During human embryonic development, first site of RBC formation is:
   A. Yolk sac B. Allantois
   C. Notochord D. Blastocyst

5. Some animals like fiddler crab, are busiest during the time of either dawn or dusk or both are called:
   A. Diurnal animals B. Nocturnal animals
   C. Crepuscular animals D. Circadian animals

6. The best way to prevent tetanus is using:
   A. Antibiotic B. Pain killers
   C. Vaccine D. Sedatives

7. The ability to remove wrong nucleotides if it is added mistakenly is called:
   A. Degeneracy B. Splicing
   C. Proofreading D. Primosome

8. Secondary sewage treatment is mainly due to:
   A. Mechanical processes B. Biological processes
   C. Physical processes D. Chemical processes

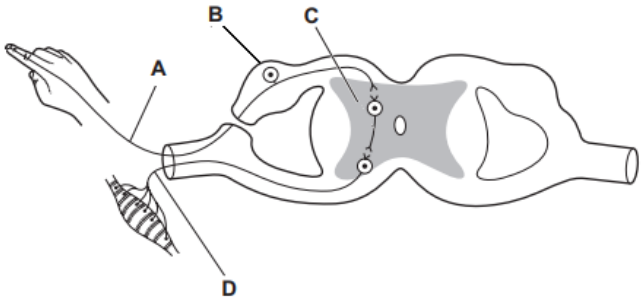
9. Vasa recta is the cluster of capillaries present in the nephron of human beings. It is derived from "X" and surrounds "Y", where "X" are arterioles and "Y" are tube like structures. Which of the following correctly identifies "X" and "Y"?

	X	Y
A	Efferent arterioles	Proximal convoluted tubule
B	Afferent arterioles	Proximal convoluted tubule
C	Efferent arterioles	Loop of Henle
D	Afferent arterioles	Loop of Henle

10 Which tRNA can bind at mRNA codon UGA?

A. tRNA with anticodon ACU
B. tRNA with anticodon ACT
B. tRNA with anticodon TGA
D. tRNA with anticodon TCU

11. The diagram shows a simple reflex arc. Which labelled part has neuron cell bodies and nonmyelinated parts of nerve fibre? Answer: C



12. Which one is not related to insulin?

A. It promotes glycogenosis.
B. It inhibits gluconeogenesis.
C. It's under secretion causes glycosuria.
D. It's under secretion causes hypoglycaemia.

13. I. Globular proteins
II. Thin thread-like structures
III. Wound around actin filaments

The feature(s) which describes tropomyosin is/are:

A. I only
B. III only
C. II and III
D. I and III

14. Which of the following recombinant DNA technology tool is incorrectly paired with its use?

A. Restriction endonuclease -------- production of RFLP
B. DNA ligase ------- production of sticky ends in restriction fragments
C. Reverse transcriptase -------- production of cDNA
D. PCR --------- gene amplification

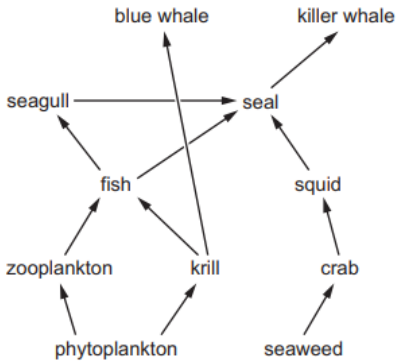
15. What are phenotypes of parents of a colour blind son and non-carrier daughter with normal colour vision?

	Father	Mother
A.	Carrier	Normal
B.	Colour blind	Carrier
C.	Normal	Carrier
D.	Normal	Colour blind

16. Which of the following is the palindromic sequence?

A. GATC
B. GGTT
C. CGAT
D. TTCC

17. The diagram shows an aquatic food web.



Which statement is correct?

A. There are two producers and three herbivores.
B. There are two primary consumers and two secondary consumers.
C. There are three producers and two primary consumers.
D. There are two herbivores and two tertiary consumers.

Answer Key SECTION-A

Sr. #	Correct Option	Sr. #	Correct Option
1	B	10	A
2	D	11	C
3	C	12	D
4	A	13	C
5	C	14	B
6	C	15	C
7	C	16	A
8	B	17	A
9	C		

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Time allowed: 2:35 hours Total Marks: 68

SECTION – B (Marks 42)

Q.2 Attempt any **FOURTEEN** parts from the following. All parts carry equal marks. (14× 3 = 42)

i. What are osmoregulators? How do they adapt in fresh water? Give example.

Answer: The organisms which can maintain internal osmotic concentration different from the surrounding medium. They are hypotonic or hypertonic to surrounding environment e.g. fresh water animals and most marine vertebrates.

Fresh water osmo-regulators face problem of excess water in their bodies being living in hypotonic environment along with problem of salts deficiency.

- They produce large volume of diluted urine
- Actively reabsorb salts and ions through kidneys and ionocytes in skin and gills
- They eat diet rich in salts and ions.

ii. Name cranial and facial bones with paired and unpaired classification.

Answer: **Cranial bones:**

There are 8 cranial bones, 2 paired and 4 unpaired

Paired bones:	**Unpaired bones:**
Parietal bones	Frontal bone
Temporal bones	Occipital bone
	Ethmoid bone
	Sphenoid bone

Facial bones:

There are 14 facial bones, 6 paired and 2 unpaired.

Paired bones	**Unpaired bones**
Maxilla	Mandible
Zygomatic	Vomer
Nasal	
Lacrimal	
Palatine	
Inferior concha	

iii. List the roles of the components of limbic system in human brain.

Answer: Limbic system: The limbic system is located as an arc between thalamus and just under cerebrum, which produce our most basic and primitive emotions, drives and behaviors. It consists of:

1. Hypothalamus 2. Amygdala 3. Hippocampus

Roles of components of Limbic system

- **Hypothalamus:** The hypothalamus through its hormone production and neural connection acts as major coordinating center between neurons and endocrine.

  It maintain homeostasis and contain centers for regulating hunger, sleep, thirst, body temperature, water balance and blood pressure, menstrual cycle and sleep wake cycle.

- **Amygdala:** It produces sensation of pleasure, punishment, love, hate, rage, altruism, fear, rage and sexual arousal.
- **Hippocampus:**It is very important in converting short term memory into long term memory.

iv. What are the different types of hormones on the basis of their chemical nature?

Answer: **Types of hormones on the basis of chemical nature:** Chemically hormones belong to following 5 categories:

- **Proteinous hormones:** e.g. Somatotropic hormone (STH), Thyroid stimulating hormone (TSH), Gonadotropic hormones (GH)
- **Amino acids derivatives:** e.g. Thyroxin
- **Peptide Hormones:** e.g. Melanocyte stimulating hormone (MSH)), Adrenocorticotrophic hormone (ACTH), Oxytocin, Vasopressin, Calcitonin and Parathormone
- **Steroid Hormones:** e.g. Cortisol and Aldosterone, Estrogen, Progesterone and Testosterone.
- **Catecholamine:** Adrenaline and Noradrenaline

v. What are the characteristics (symptoms) of different types of hypothyroidism?

Answer: **Symptoms of different types of hypothyroidism:**

Myxedema is a full blown hypothyroidism in adults. It is characterized by low metabolic rate, feeling chilled, puffy eyes, thick, scaly and dry skin with hair loss from the scalp and eyebrows, oedema tongue swelling, constipation and enlarged thyroid gland i.e. goiter.

Cretinism: It is the congenital under secretion of thyroxin in infants which is characterized by mental retardation with poor physical growth and disproportionate body size, delayed bone maturation, puberty and infertility.

vi. Define latent learning explain with example.

Answer: **Latent Learning with example:**

When an animal learns a response for a particular stimulus in its routine life without having any punishment or reward, but sometimes, when the animal is particularly exposed to that stimulus the animal suddenly responds it by quickly recalling the previous experience. This is called Latent Learning.

American psychologist K.L. Lashley put a rat (not hungry) into maze. The rat discovers location of food in maze but ignore it and tries to escape maze. When same rat (hungry) is put into maze it quickly recalls previous experience and reaches the food.

vii. Define miscarriage? What are the possible causes of miscarriage?

Answer: **Miscarriage:** The act of giving birth spontaneously leading to a fetus too premature to survive usually before the 28th week of pregnancy.

Causes:

- Abnormal implantation of embryo near the cervix and stretching of placenta across the internal cervical opening which may be torn resulting hemorrhage.
- Normally positioned placenta may also tear away from uterine wall accompanied by hemorrhage resulting in miscarriage.
- Chromosomal abnormalities in foetus. i.e. monosomy, trisomy and polyploidy
- Chronic maternal diseases such as hypertension and diabetes.

- Endocrine abnormality e.g. abnormal thyroid and progesterone hormones.

viii. What are the drawbacks of Lamarckism that lead to rejection of this theory of evolution?

Answer: **Drawbacks of Lamarckism:**

The anatomical, biochemical and behavioral characteristics displayed by an organism as it develops through life is known as **phenotype**. However, the phenotype that an individual actually developed is based on **the genotype** and **the environmental conditions**

The first point of Lamarckism i.e. use and disuse of organs may be acceptable but this doesn't affect the heritable material so the characteristics which are acquired through this process during life time have no genetic basis and therefore cannot be inherited to the next generation.

In this theory, the role of genetic material in inheritance and mutations was totally ignored as it wasn't revealed at Lamarck's time.

According to Lamarck, direction of evolution is determined by organism whereas Darwin's theory describes that its nature which decides the course and pace of evolution.

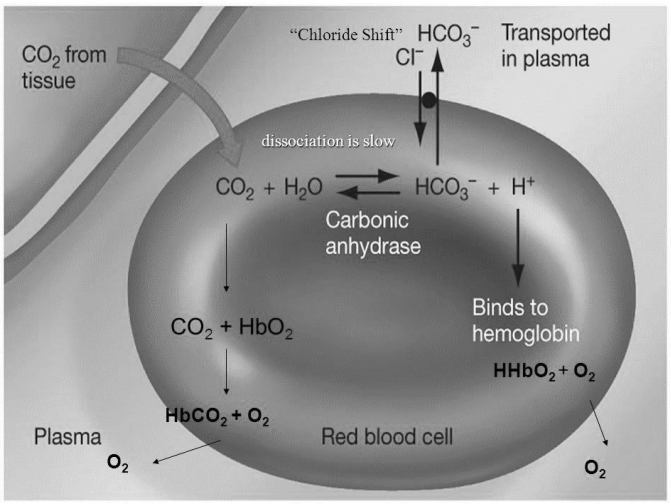
ix. Differentiate between convergent and divergent evolution with example.

Answer: Convergent and Divergent evolution:

Convergent Evolution	**Divergent Evolution**
The pattern of evolution in which different species have been evolved from different ancestors at a common habitat is called convergent evolution.	The pattern of evolution in which different species have been evolved from common ancestors at different habitat is called divergent evolution.
It is supported by analogous organs.	It is supported by homologous organs.
It occurs in organisms which are not related phylogenetically. e.g. Wings of the bird and butterfly, which have different internal structure but both are meant for flight in air.	It occurs in phylogenetically related organisms. E.g. limb bone pattern of all tetrapod which contain same sets of bones organized in similar ways despite their dissimilar functions.

x. Describe Hamburger phenomenon.

Answer: **Hamburger Phenomenon:**



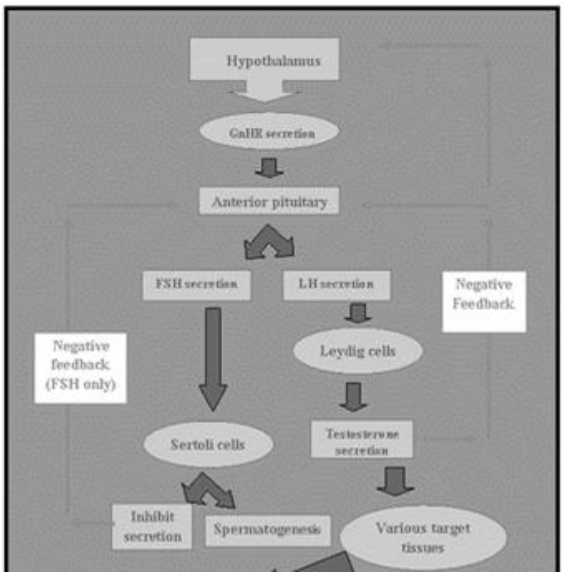
- During transport of CO_2, HCO_3^- ion is released from RBCs into the plasma. To balance this exit of HCO_3^- from RBCs, Cl^- ion enters the RBCs from plasma. This opposite flow maintains the neutrality of RBCs environment. This is also called Chloride shift.

- These movements are regulated by special bicarbonate-chloride carrier proteins that exist in RBC membrane, to maintain pH of blood at 7.4.

xi. **Discuss the hormonal control of male reproductive system.**

xii. Answer: At first (GnRH) gonadotrophin releasing factor from hypothalamus stimulates pituitary gland anterior lobe to release follicle-stimulating hormone (FSH) and interstitial cell stimulating hormone (ICSH).

- FSH acts on the Sertoli cells of seminiferous tubules for maturation of spermatids to sperms.
- Sertoli cells also release inhibin hormone to regulate normal spermatogenesis rate.
- ICSH/LH stimulates Leydig's cell to release testosterone for growth of germinal epithelium of seminiferous tubules to form sperms and it has negative feedback upon FSH and LH.



xii. **Why is Sanger's method of gene sequencing called chain termination method?**

Ans. Sanger's method is based on the use of modified nucleotides dideoxynucleoside triphosphates (ddNTPs)in addition to normal deoxynucleotides (dNTPs) found in DNA. Modified nucleotides (ddNTPs) are essentially same as common nucleotides (dNTPs) except ddNTPs have hydrogen groups (H) at both 2^{nd} and 3^{rd} carbons instead of hydroxyl (OH) groups. During DNA synthesis, when these modified nucleotides (ddNTPs)are integrated in the growing DNA strand, they prevent addition of further nucleotides because an OH group is required at 3´ end to make a phosphodiester bond with next incoming nucleotide. In this way polynucleotide chain is terminated at the modified nucleotide (ddNTP) every time when they are integrated in the strand.

xiii. **How does dominance differs from epistasis? Give example to clear the difference**.

Ans.

Sr.#	**Dominance**	**Epistasis**
1	It is relationship between alleles of same gene occupying same locus.	It is interaction between different genes occupying different loci.

2	Gene supresses the expression of its own alleles	Gene supresses the expression of alleles of different gene.
3	Only the recessive allele is supressed by its dominant allele.	Expression of both dominant and recessive alleles of another gene is suppressed by epistatic gene.
4	Effect is only due to dominant allele.	Both dominant and recessive alleles can become epistatic.
5	Expression of A, B & AB phenotypes of ABO blood group is controlled by alleles I^A & I^B on a locus of chromosome 9 by producing antigens A & B but their expression is supressed by the recessive allele "h" of gene H at a locus on chromosome 19 because gene "h" inhibits the production of antigen A & B so **Bombay phenotypes** are produced.	Expression of recessive allele "i" is suppressed by its dominant alleles I^A& I^Bin heterozygous form(I^Ai & I^Bi) all residingon the same locus. Allele for short height in pea plant (t) suppressed by its dominant allele (T) in heterozygous form (Tt).

xiv. **Explain erythroblastosis foetalis. Give its prevention and management.**

Ans. Erythroblastosis foetalis is a maternal foetal Rh incompatibility which most commonly happens when a woman with Rh-negative blood marries to a man with Rh positive blood and conceives a baby with Rh positive blood. At time of birth, foetus RBCs seep into mother circulation resulting in anti-RH antibody formation. If next foetus is Rh positive, mother's anti-Rh antibodies seep through the placenta into the blood circulation of foetus, they start haemolysis (destruction of RBCs) causing anaemia in foetus. Anaemic foetus starts to release huge amount of immature RBCs (erythroblasts) into its blood stream, therefore this disease is called erythroblastosis foetalis.

Preventions: Rh-negative mothers in every pregnancy are given injection of Rh antiserum during early pregnancy and immediately after birth. If baby is born with Rh incompatibility then baby's blood should be immediately replaced by Rh-negative blood free of anti-Rh antibodies to stop haemolytic reaction.

xv. **Gene expression is a strictly regulated process. How is gene expression regulated positively or negatively?**

Ans. Regulation of gene expression allow the cell to synthesize and express its protein when needed by turning the genes ON and OFF in response to signals from internal and external environment. There ae two possible ways of regulation of gene expression.

In positive control, regulatory protein (called activator) triggers the transcription by activating the RNA polymerase, so expression of the gene is quantitatively increased by the presence of specific regulatory protein.

In negative control, regulatory protein (called suppressor) shuts down the transcription by inhibiting or blocking the RNA polymerase, so expression of the gene is quantitatively diminished by the presence of specific regulatory protein.

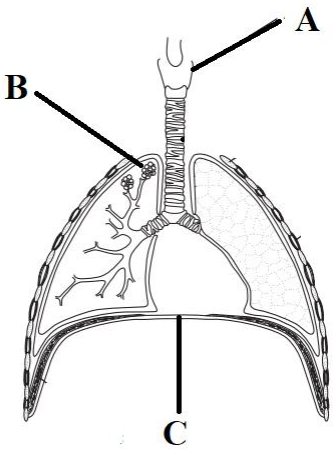
xvi. **Nuclear power is one of the important sources of energy especially in developed countries. How nuclear power generation and management may be disadvantageous?**

Ans. Problems regarding Nuclear power generation and management are failure to achieve highest levels of **surety of safe operation** and **safe disposal of wastes.**

If **Surety of safe operation** is not maintained, accidents and release of hazardous effluents may occur. To achieve optimum safety in operation and to diminish the consequences of failure following parameters of strict actions are needed. (a)high quality design and construction (b) comprehensive monitoring regular testing to detect the equipment and operator failures (c) prevention of significant radioactive release

Safe disposal of wastes: is necessary as(a) Nuclear wastes are radioactive so cause number of health hazards for any life who comes into contact with the radiation of fatal level. (b)Nuclear wastes are not biodegradable so it does not decompose naturally by microbes and other effects of atmosphere. (c) Effects of nuclear wastes are extremely long lasting and irreparable.

xvii. **Given figure shows structures in human thorax. Identify parts labelled A, B and C and describe their roles.**



Ans. A:Larynx. It controls the ventilation. Larynx has vocal cords which creates vocal sound by the vibration of their elastic fibres when air is forced between the vocal cords.

B:**Alveoli.** The alveoli are tiny, thin walled balloon shaped air sacs and are the sites of gaseous exchange (oxygen into the blood from lungs and carbon dioxide in the lungs from blood.

C: Diaphragm. It separates the thoracic cavity from abdominal cavity and also helps in breathing and involves in pushing out and pulling in the air during ventilation.

xviii. The menstrual cycle is coordinated by hormones secreted by the pituitary gland and hormones secreted by the ovaries. Figure shows some of the events that occur during the menstrual cycle.

H	FSH is secreted by the pituitary gland
J	oestrogen stimulates repair and growth of the lining of the uterus
K	one or more follicles start to develop in an ovary
L	ovulation occurs
M	oestrogen is secreted by follicle cells
N	LH is secreted by the pituitary gland
O	oestrogen inhibits secretion of FSH

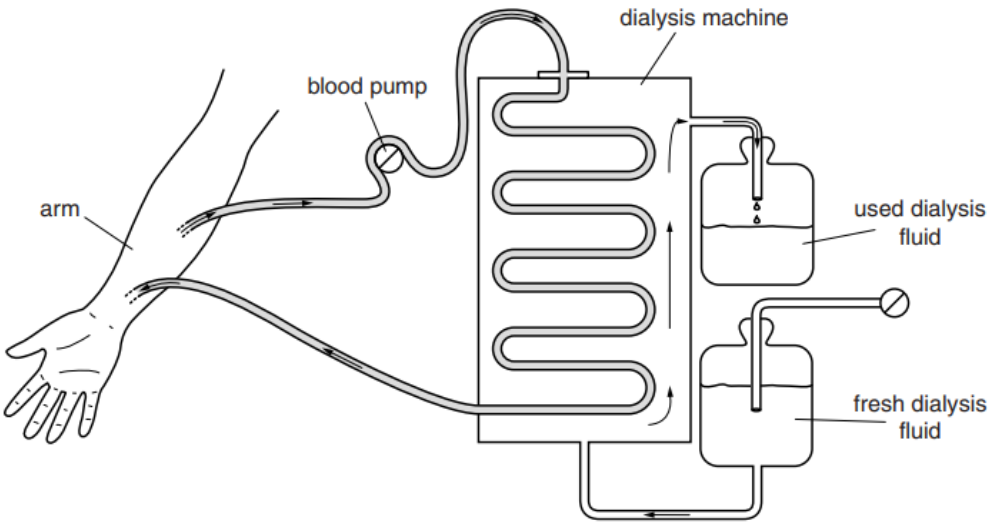
a. Put the steps (labelled H, J, K, L, M, N, O) into the correct sequence in the following table: (2)

H	K	M	J	O	N	L

b. **Name the ovulating follicle and what happens to this follicle after ovulation?** (1)

Ans. Ovulating follicle is fully matured follicle and called Graafian follicle. After ovulation ruptured follicle become yellowish glandular mass called Carpus leutum that secrets progesterone hormone.

xix. **After kidney failure, dialysis is performed. Figure shows how blood, fresh and used dialysis fluid move through a dialysis machine. The composition of the dialysis fluid changes as it passes through the dialysis machine.**



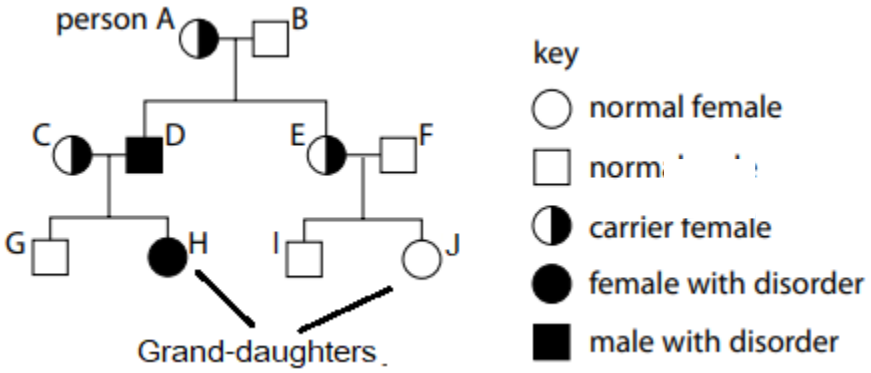
a. **Redraw and complete the table using words "low", "high", "same" or "none" to show how concentration of each substance changes in the dialysis fluid and blood.** (2)

	Concentration of substance in			
Substance	Blood before Dialysis	Fresh dialysis fluid	Used Dialysis fluid	Blood after Dialysis
Glucose	Low	High	Low	High
Salts	High	Low	High	Low
Urea	High	None	High	None
Toxin	High	None	High	None

b. Why is the blood pump used during dialysis? (1)

Ans. Blood pump is used to manage the blood pressure of the patient needed for optimum filtration. Blood pump provides a reliable and regulated blood flow through the dialysis chamber and it decreases the risk of blood clot in dialysis filter.

xx. **The given figure shows the inheritance of Duchene muscular dystrophy, which is X-linked recessive disorder.**



Describe why grand-daughter "H" of person "A" is affected with this disorder whereas grand-daughter "J" of the same person "A" is normal?

Ans. X-linked recessive inheritance is a genetic condition associated with recessive mutations in genes on the X-chromosome only. Duchene muscular dystrophy is an X-linked recessive disorder. In the above pedigree grand-daughter "H" is affected with this disorder because she carries two recessive (mutated) alleles one on her both X-chromosomes ($\mathbf{X^dX^d}$) which she received one from her affected father ($\mathbf{X^dY}$) "D" and other from her carrier mother ($\mathbf{X^DX^d}$) "C"
Whereas, grand-daughter "J" is perfectly normal ($\mathbf{X^DX^D}$) because she carries both dominant (normal) alleles one on her both X-chromosomes which she received one from her normal father ($\mathbf{X^DY}$) "F" and other from her carrier mother ($\mathbf{X^DX^d}$) "E"

(NOTE: In this pedigree, appearance of affected granddaughter "H" is hypothetical situation because affected males rarely survive up to adolescence and are not able to become fathers so this disease is limited to males only and females remain carrier).

SECTION – C(Marks 26)

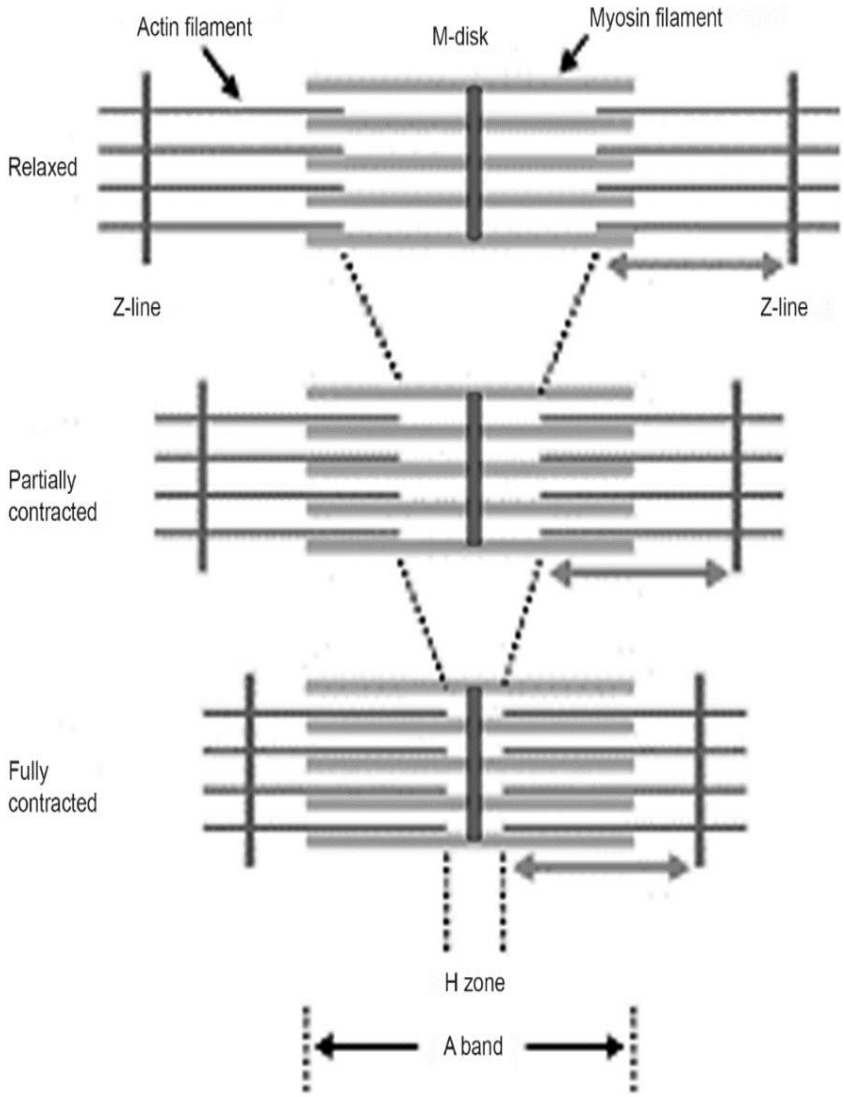
Note: Attempt any **TWO** questions. All questions carry equal marks. (2×13 = 26)

Q.3 a. Describe and sketch sliding filament model of a skeletal muscle fibre. (4+2)

Muscle Contraction – Sliding Filament Model

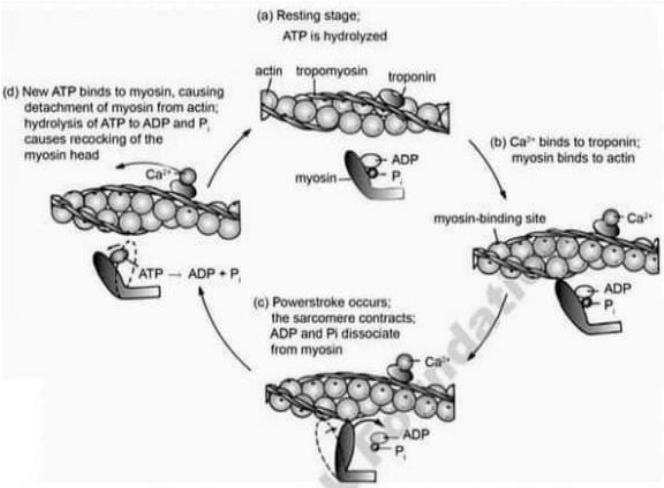
The sliding filament theory of contraction states that during contraction the thin myofilaments slide past the thick ones so that they overlap to a greater degree. In a relaxed muscle fibre, the thick and thin myofilaments overlap only at the ends of the A-band. But when muscle fibres are stimulated by the nervous system, the myosin heads are attached on to myosin binding sites on actin in the thin myofilaments, and the sliding begins. These links are called **cross bridges** which are formed and broken several times during a contraction, acting like tiny ratchets to generate tension and propel the thin myofilaments toward the centre of the sarcomere.

As this event occurs simultaneously in sarcomeres throughout the cell, the muscle cell shortens. The I-bands shorten, the distance between successive Z discs is reduced, the H-zone disappears, and the contiguous A-bands move closer together but do not change in length.



Control of cross bridges

Muscle contraction is initiated by nerve impulse arriving at the neuromuscular junction. The nerve impulse is carried through the sarcolemma to the T-tubule then to the sarcoplasmic reticulum (SR). The calcium gates of the SR open releasing calcium into the cytosol. When muscle is at rest, the tropomyosin is placed in such a way that it covers the sites on the actin chain where the heads of the myosin have to attach. When muscle is required to contract, calcium ions bind to the free site of troponin molecules and cause them to twist and move slightly. This twisting of troponin causes the tropomyosin displacement and thus expose the binding sites for myosin heads on the actin. ATP is hydrolysed to ADP and phosphate (Pi) and energy is utilized for attachment of myosin heads to actin filament thus causing the contraction of sarcomere. New ATP molecule binds again to myosin and hydrolysis of ATP causes the active uptake of calcium ion by sarcoplasmic reticulum, breakdown of cross bridges and the detachment of myosin from actin resulting relaxation of sarcomere. The formation and breakdown of cross bridges occur again and again during the sliding of the filament.



Sliding filament model of muscle contraction

b. **Draw and describe different steps of Nitrogen Cycle in detail. (3+4)**

Nitrogen Cycle

Nitrogen is required by all living organisms for the synthesis of organic molecules such as amino acids, nucleic acids and proteins. The nitrogen cycle consists of a series of processes that convert nitrogen gas to organic substances and back to nitrogen in nature. It is a continuous cycle maintained by the decomposers and other bacteria. The nitrogen cycle involves ammonification, nitrification, nitrogen fixation, assimilation and de-nitrification.

Ammonification

The nitrogenous wastes of animals and nitrogenous compounds of dead organisms are decomposed by saprophytic soil bacteria and fungi to form simple substances like water, carbon dioxide, amino acid and energy. The amino acids are converted into ammonia or ammonium ions. Production of ammonia or ammonium compounds in the decomposition of organic matter by microorganisms is called **ammonification.** Ammonification occurs in the soil, in an aerobic environment.

Nitrification

Some ammonia escapes into the soil but much of it and ammonium ions are converted into nitrates by nitrifying bacteria. It is accomplished by two groups of nitrifying bacteria. The first group of bacteria e.g., Nitrosomonas converts ammonia to nitrites and the second group of bacteria e.g., Nitrobacter converts nitrites to nitrates. This process is called **nitrification**. Nitrification takes place only in well aerated soils because the bacteria responsible for it are aerobic.

Nitrogen fixation

Nitrogen gas is composed of two atoms of nitrogen linked by a very strong triple bond. This makes it chemically unreactive and large amounts of energy are required to break the bond. Nitrogen gas can be fixed in three ways.

Atmospheric fixation: The nitrogen fixation that occurs spontaneously by lightning is called atmospheric fixation; a small amount (5-8 %) only is fixed in this way. Lightning allows nitrogen and oxygen to combine to produce various oxides of nitrogen. These are carried by the rain into the soil where they can be used by plants.

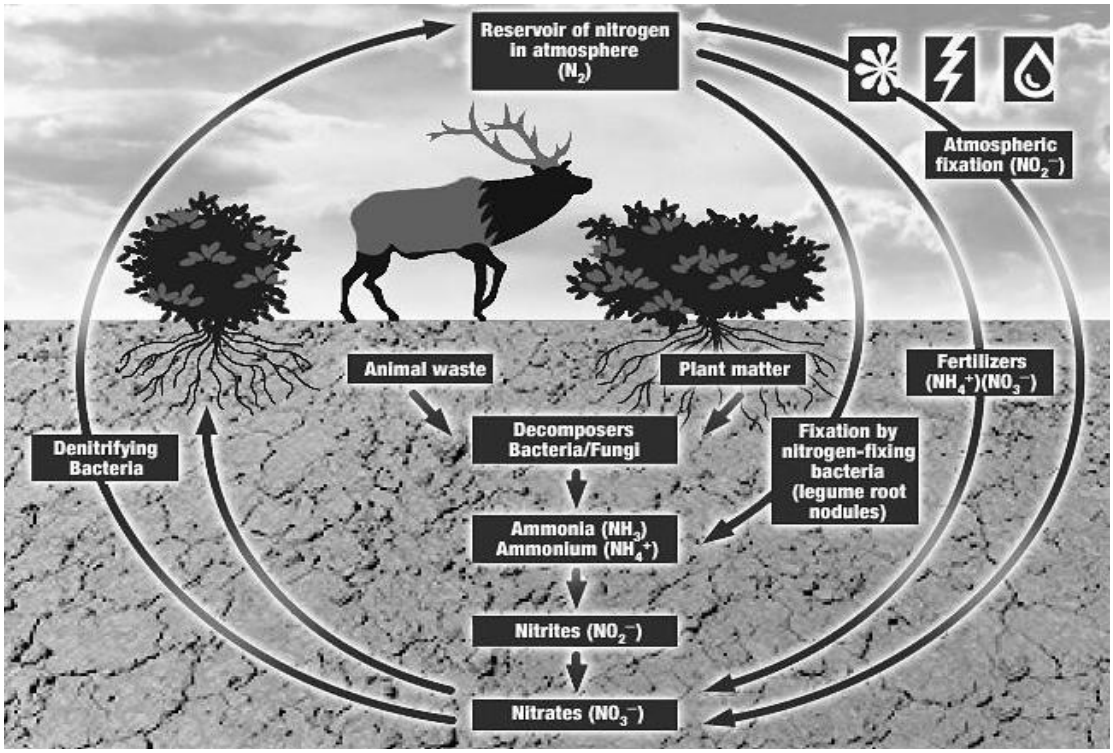
Industrial fixation: The synthesis of nitrogen containing fertilizers is called industrial fixation.

Biological fixation: Nitrogen-fixing bacteria fix 60 % of nitrogen gas in the atmosphere.

Bacteria Convert atmospheric nitrogen to ammonia.

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

Only a relatively few bacteria (the nitrogen-fixing bacteria) are able to carry out this reaction. Fixed nitrogen is made available to plants by the death and lysis of free-living nitrogen-fixing bacteria e.g., Azotobacter (aerobic) and Clostridium (anaerobic) or from the symbiotic association of some nitrogen-fixing bacteria with plants e.g. Rhizobium.



Nitrogen cycle

Assimilation

It is the process of utilization of nitrogenous compounds in living bodies. Many microorganisms are able to utilize free nitrogen directly from atmosphere but plants obtain nitrogen in the form of inorganic nitrogenous compounds like ammonia and nitrates from the soil, whereas animals take their nitrogen from the eating of plants or other animals.

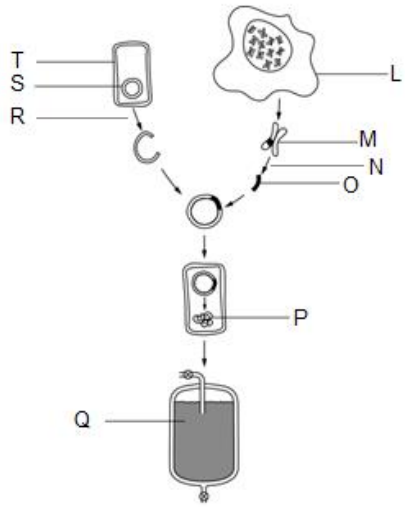
Denitrification

Nitrogen can be lost as a result of the activities of certain soil bacteria; in the absence of oxygen these bacteria breakdown nitrates releasing nitrogen back into the atmosphere and using the oxygen for their own respiration. This process is known as **denitrification** and such bacteria are called denitrifying bacteria e.g., Pseudomonas reduce nitrates in the soil to gaseous state.

$$NO_3 \longrightarrow NO_2 \longrightarrow NO + N_2O \longrightarrow N_2$$

(Nitrate) (Nitrite) (Nitrogen oxide) (Nitrogen gas)

Q.4 a. Given figure is a flow diagram showing how insulin is produced using genetic engineering.



i. **Define and describe the steps involved in recombinant DNA technology.(3)**

1. Gene of interest

A gene is identified that controls a trait in which scientists are interested. DNA containing that gene is collected from the donor organism that naturally has this gene.

2. Vector selection

Scientists isolate plasmid DNA (extra-chromosomal ring of DNA) from bacteria. This ring of DNA will carry the gene to the new organism. The plasmids or bacteriophage viruses can serve as a vector.

3. Restriction endonuclease

The donor DNA and the plasmid DNA are mixed with restriction endonuclease enzyme (cutting enzyme). This enzyme cuts both kinds of DNA into pieces at special sequence.

4. Formation of recombinant DNA

The pieces of DNA which have complementary sequences join together to make a complete plasmid. This plasmid is now a ring of DNA that has a new gene in it so it is called recombinant DNA. DNA ligase (joining enzyme) is used to make bond between two types of DNA.

5. Transfer of recombinant DNA into host

The recombinant DNA is mixed with other bacterial cells. Some of these bacteria will take the plasmids into their cells by a process called **transformation**. The cells containing the gene are identified and separated. These are genetically modified organism (GMO).

6. Growth of the GMO

Colonies of GMO are provided suitable growth conditions, as in fermenter.

7. Expression of the gene

The GMO contains the gene of interest and produces the desired product, which is separated from culture medium

ii. **At which step/s restriction endonuclease enzyme was used in this process? Why thisenzyme is named so? (1.5)**

Answer: At step R plasmid is cut with restriction endonuclease. At step N donor chromosome is cut with restriction endonuclease to isolate gene of interest.

Naturally restriction enzymes are found in bacteria, where they appear to serve as host-defence role because they chop up and inactivate **("restrict")** the DNA of infecting viruses. That's why this enzyme is named as restriction endonuclease.

iii. Complete Table as completed in first row. **(2.5)**

Letter from figure	Name	Description
M	**chromosomes**	**threads of DNA found in the nucleus**
O	**Gene of interest**	section of DNA removed from human cell
S	plasmid	**Vector; Vehicle for carrying foreign DNA**
P containing bacteria	**Transformed bacteria GMO**	type of cell that is genetically engineered
P	Desired product e.g. Insulin	specific chain of amino acids coded by the section of DNA removed from the human cell
Q	fermenter	Colonies of GMO are provided suitable growth conditions in fermenter

b. **Which factors are involved in the establishment and maintenance of resting membrane potential in a neuron? Show diagrammatically as well. (4+2)**

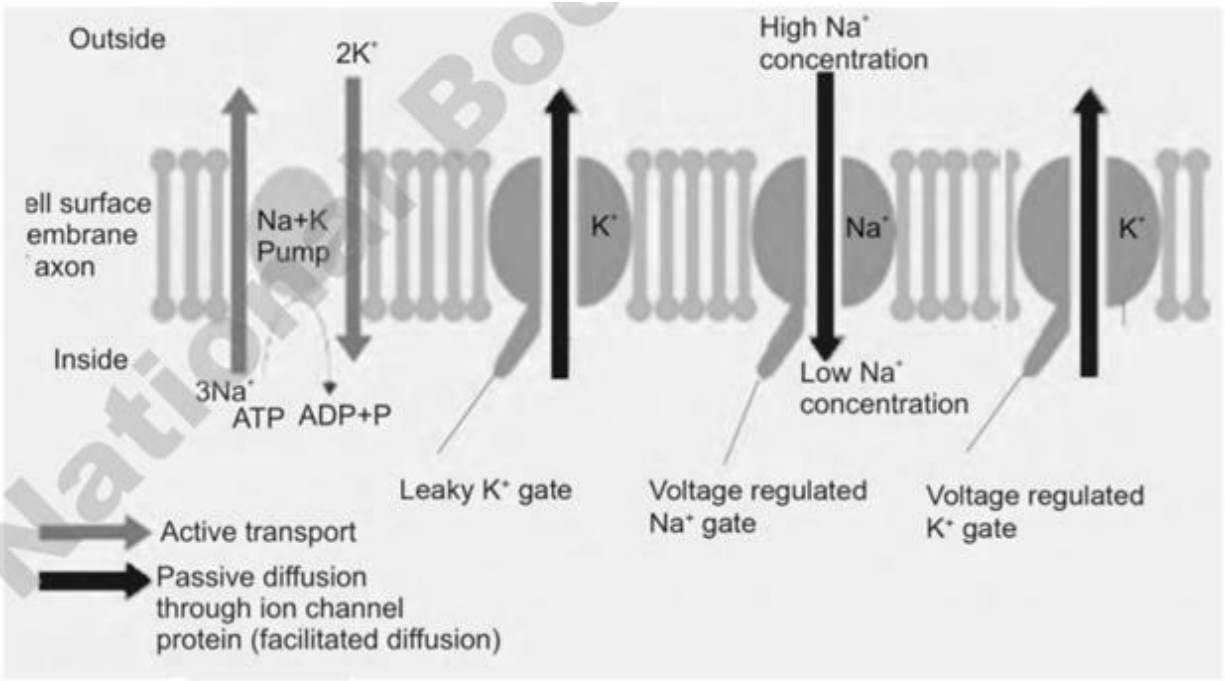
Answer: Electrical potential that exists on the surface of neuron cell is potential energy that is manifested during separation of charges across the neuron cell membrane, is called membrane potential. Neurons are always in membrane potential which are of two types; **resting membrane potential (RMP)** and **Active membrane potential (AMP)**.

When neuron is not stimulated and no impulse is passing through the neuron it is said at rest and its membrane potential is called resting membrane potential (RMP). In RMP, neuron is negatively charged from inside of the neuron andmore positive charge on the outer surface than inner surface. RMP is approximately 70 millivolts more negative than the outside (−70 mV). It is caused by unequal distribution of positive and negative ions on both surfaces (inside and outside) of neuron cell membrane.

Factors responsible in the establishment and, maintenance of RMP in a neuron are:

1. **Concentration of Na^+ and K^+ ions:** Na^+ ion is about 10 times greater in the fluid outside of the cell membrane than Na^+ ion inside the membrane, whereas K^+ ion is about 30 times greater in the fluid inside the cell than K^+ ion outside
2. **Negative organic ions:** Huge amount of negatively charged ions and organic molecules (amino acids, fatty acids, proteins and RNA) inside the cell cytoplasm than few or negligible negatively charged ion and organic molecules outside the cell. Due to relatively larger size and impermeability of membrane to negative charges, negatively charged ions rarely move across the membrane.
3. **Na^+/ K^+ pump**(active proteins inside the neuron cell membrane) performs active transport of ions. Mainly positive ions move across the cell membrane, for active transport of every two K^+ ions inside the cell there is active pumping of three Na^+ions outside the cell.
4. **Leaky channels of K^+ ions:** Cell membrane of neuron has many non-voltage regulated channel proteins called gates which continuously allow movement of K^+ ions from inside of cell to outside.

   All above factors together make the outside of the cell more positive than inside and establish the RMP. This RMP will be maintained until the membrane is not stimulated by a sufficiently strong stimulus above the threshold level.



Ionic movement across neuron membrane

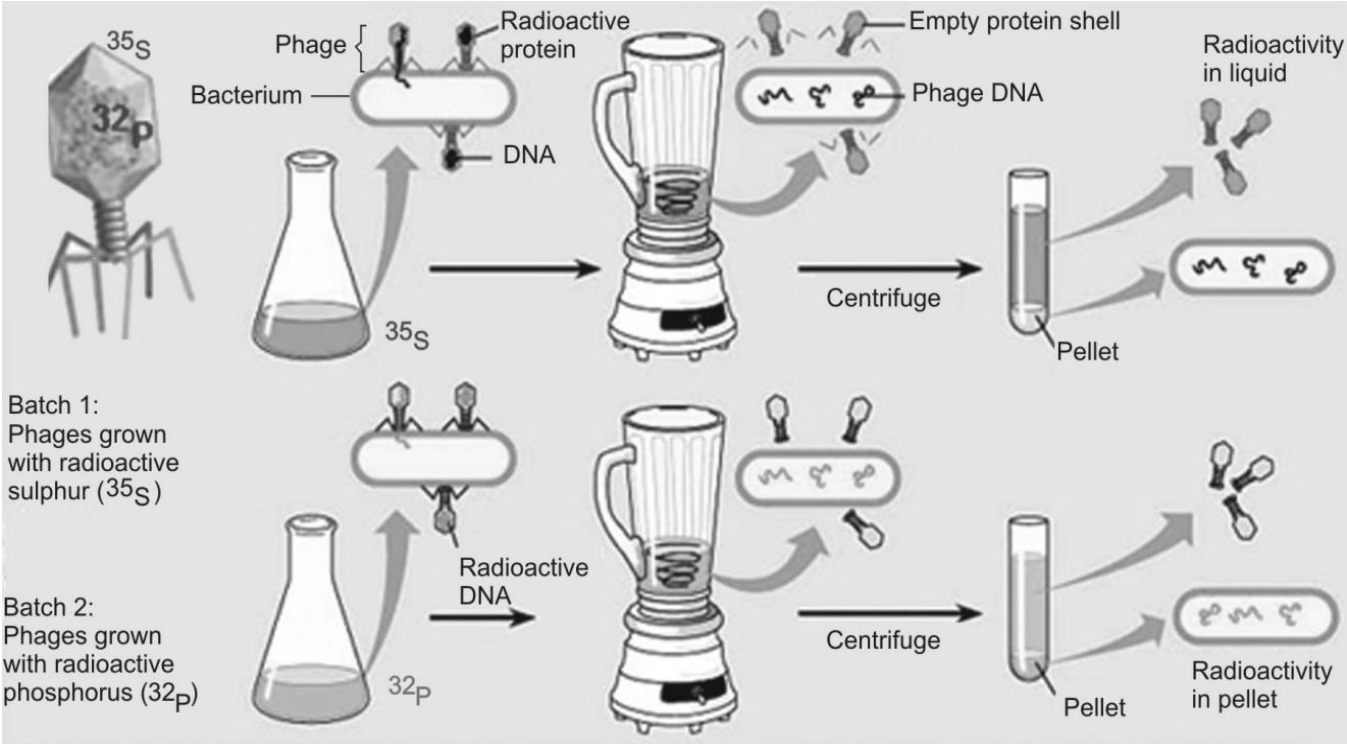
Q.5 a. Discuss Hershey and Chase experiments. What was concluded from these experiments? Draw labelled diagram. (3+2+2)

Hershey and Chase Experiment

Soon after the Avery's results, another very convincing experiment on bacteriophages was performed by Alfred Hershey and Martha Chase in 1952.

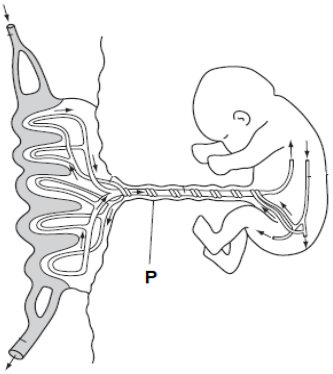
Bacteriophages are the viruses that attack upon bacteria, their body consists of DNA and protein. During infection, they multiply in the host and their many copies are emerged within 20-25 minutes. It was not known till 1952 that either DNA or protein which possesses hereditary information of bacteriophages. Even, scientists were not sure that during infection, the whole viral particle enters the host body or only its DNA or protein get entry. In 1952, Hershey and Chase set out an experiment for this purpose.

They labelled the DNA of bacteriophages with a radioactive isotope of phosphorus, ^{32}P, and also labelled their protein coats with radioactive isotope of sulphur, ^{35}S. The labelled viruses were permitted to infect bacteria. Soon after the infection, bacterial cells were separated from media contents with the help of centrifugation technique. Then media contents and bacterial cells were analysed for the activity of ^{32}P and ^{35}S. In this analysis, ^{32}P was found in the bacterial cells while ^{35}S was found in the medium. These observations clearly showed that during infection, ^{32}P labelled DNA of bacteriophage was injected into the bacterial cell while its ^{35}S labelled protein coat remained outside. Subsequently, many viral particles released outside the host. Based on these observations, Hershey and Chase claimed that the virus DNA, not the virus protein, was responsible for directing the production of new viruses.



Hershey and Chase Experiment

b. **Figure shows placenta connecting foetus to uterine wall.**



i. **Describe the structure, purpose and development of placenta along with its hormonal role during pregnancy. (4)**

The Placenta

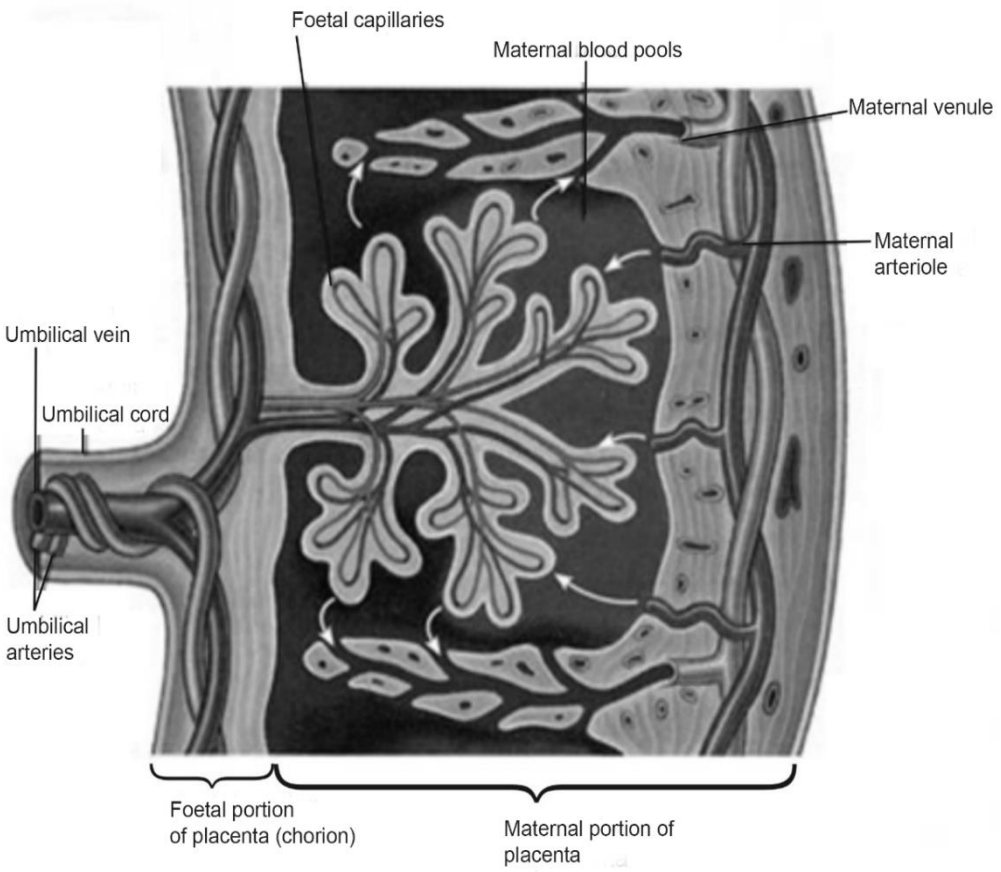
The placenta is the organ that provides nutrients and oxygen to the embryo and helps dispose of its metabolic wastes, formed of the embryo's chorion and mother's endometrial blood vessels.

Structure of placenta

The structure of the placenta consists of tissue from foetal part and maternal part. The **foetal part** consists of **chorionic villi**. This increase surface area for absorption. The **maternal part** consists of projections from endometrium. The placenta begins to develop upon implantation of the blastocyst into the maternal endometrium. The outer layer of the blastocyst becomes the trophoblast, which forms the outer layer of the placenta. The placenta grows throughout pregnancy. However, development of the maternal blood supply to the placenta is completed by the end of the first trimester of pregnancy (approximately 12–13 weeks). At this

stage, **hCG** (human chorionic gonadotropin) declines, the corpus luteum degenerates and the placenta completely takes over the production of progesterone, which maintains pregnancy.

The foetal blood in the capillaries of the chorionic villi comes in close contact with the mother's blood in the tissues between villi. However, they are always separated by a membrane through which substances may diffuse or be actively transported. Maternal and foetal blood does not normally mix in the placenta or any other place.



Structure of placenta and umbilical cord

ii. **Name the structure labelled as "P". What is its role and what happens to it after birth of baby? (2)**

Answer: P is Umbilical cord.

Umbilical cord

As the human embryo grows, the umbilical cord develops and connects the embryo to the placenta. The umbilical cord is physiologically and genetically part of the foetus containing two arteries and one vein. The umbilical vein supplies the foetus with oxygenated, nutrient-rich blood from the placenta. Conversely, the foetal heart pumps deoxygenated, nutrient-depleted blood through the umbilical arteries back to the placenta.

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