

Version No.			

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Answer Sheet No. _____

Sign. of Candidate _____

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BIOLOGY HSSC-II (2nd Set Solution)

SECTION – A (Marks 17)

Time allowed: 25 Minutes

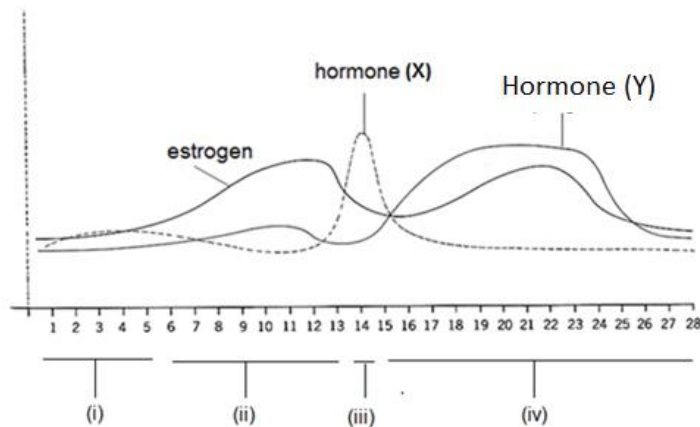
Section – A is compulsory. All parts of this section are to be answered on this page and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. **Do not use lead pencil.**

Q.1 Fill the relevant bubble for each part. All parts carry one mark.

(1) Skeletal disease which cause immobility and fusion of vertebral joints is called:

- A. Disc slip B. Sciatica
 C. Arthritis D. Spondylosis

(2) Following graph show the concentration changes of different hormones during menstrual cycle. Name the hormone represented by “X”.

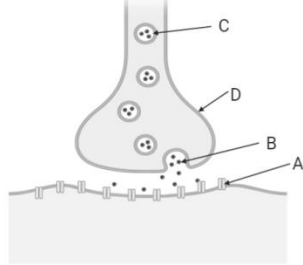


- A. FSH B. LH
 C. GnRH D. Progesterone

(3) The table show different endocrine glands with their hormones, target organs and brief functions. Identify the mismatched row.

GLAND	HORMONE	TARGET ORGAN	FUNCTION	
A	Thyroid	Calcitonin	Bone	Retains calcium in bones
B	Adrenal cortex	Adrenalin	Skeletal muscles	Prepare for fight or flight situation
C	Pancreas	Insulin	Liver	Control blood sugar level
D	Posterior lobe of pituitary	Vasopressin	Kidney	Reabsorption of water

- (4) The diagram shows a synapse. Heroin affects neuron. Which labelled part does the heroin directly affect?



- A. B.
 C. D.

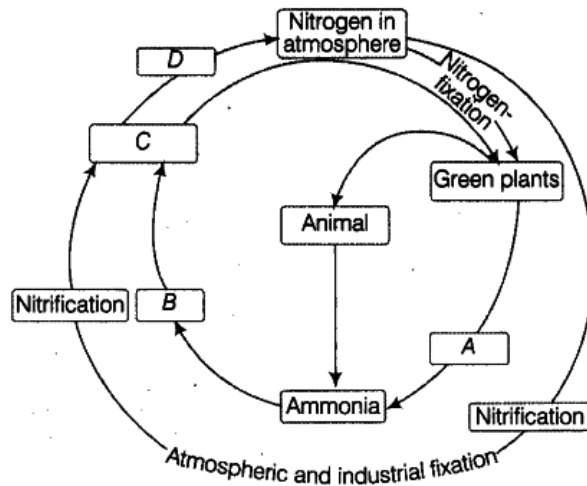
- (5) A sea slug normally responds to being poked by curling up. After being poked repeatedly the slug no longer curls up. This is an example of:

- A. Classical conditioning B. Habituation
 C. Imprinting D. Operant conditioning

- (6) Which one of the following events is likely to take place, if the nuclei from an 8-celled stage of an embryo are transplanted into enucleated eggs?

- A. Recipient egg dies
 B. Donor nuclei die in the new environment
 C. Cleavage occurs but is arrested after some time
 D. Formation of the viable embryo in the recipient eggs

- (7) Nitrogen cycle in nature is depicted in the following flowing flow chart.



Locate among the labels A/B/C/D, the one symbolizing NITRITES

- A. B.
 C. D.

- (8) According to the semi-conservative model of DNA replication, two DNA molecules result:

- A. Each strand with one new strand and one original strand
 B. Each with two new strands
 C. One with two new strands and one with both original strands
 D. Each with two original strands

- (9) How many different trinucleotides can be made using the DNA nucleotides?

- A. 4 B. 16
 C. 20 D. 64

- (10) The primary organizer during embryonic development:
- A. drives cell division during cleavage.
 - B. gives rise to extra embryonic tissues.
 - C. secretes signaling molecules to influence the fate of other cells.
 - D. folds inwards during gastrulation.
- (11) Using product rule, what proportion of offspring from the genetic cross AaBbCc x AaBbcc are expected to be heterozygous at all three genetic loci, assuming that loci are unlinked?
- A. $\frac{1}{4}$
 - B. $\frac{1}{8}$
 - C. $\frac{1}{16}$
 - D. $\frac{1}{32}$
- (12) Recalling your knowledge of epistasis based on the coat colour in *Labrador retriever*; find out the coat colour with genotype Bbee.
- A. Black
 - B. Chocolate
 - C. Yellow
 - D. White
- (13) Shorter than average height, infertility, webbed neck, low hair line at the back of neck, abnormal bone development, larger than normal number of moles on skin and edema indicates:
- A. Down syndrome
 - B. Klinefelter syndrome
 - C. Turner syndrome
 - D. Duchenne muscular dystrophy
- (14) A biochemist isolated and purified molecules needed for DNA replication. When he added some DNA, replication occurred, but the DNA molecules formed were defective. Each consisted of normal DNA strand paired with numerous segments of DNA, a few hundred nucleotides long. What had the scientist probably left out of the mixture?
- A. DNA polymerase
 - B. Ligase
 - C. Nucleotides
 - D. Primers
- (15) Virologists have discovered how to put together a bacteriophage with protein coat of phage T2 and DNA of phage T4. If this composite phage were allowed to infect a bacterium, the phages produced in the host cell would have:
- A. The protein of T2 and DNA of T4
 - B. The protein of T4 and DNA of T2
 - C. The protein and DNA of T2
 - D. The protein and DNA of T4
- (16) A paleontologist has recovered a bit of tissue from 500 years old preserved skin of an extinct bird. The researcher would like to compare DNA from the sample with DNA from a living bird. Suggest the technique that would be more useful for increasing the amount of DNA available for testing.
- A. Gel electrophoresis
 - B. RFLP analysis
 - C. Polymerase chain reaction
 - D. Tissue culture
- (17) In a population that is in Hardy-Weinberg equilibrium, 16% of the individuals show recessive trait. The frequency of dominant allele in the population is:
- A. 0.36
 - B. 0.4
 - C. 0.48
 - D. 0.6



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

Time allowed: 2:35 hours

Total Marks: 68

Note: Answer any fourteen parts from Section 'B' and attempt any two questions from Section 'C' on the separately provided answer book. Write your answers neatly and legibly.

SECTION – B (Marks 42)

Q.2 Attempt any **FOURTEEN** parts from the following. All parts carry equal marks.

(14 × 3 = 42)

- i. Compare the osmoregulatory strategies of fresh water and marine bony fishes.

Ans. **Osmoregulation in fresh water:**

Almost all the fresh water animals are osmoregulators. They are generally hypertonic. These animals deal these problems by producing large volume of diluted urine. Their kidneys reabsorb the salts that are required. They obtain salts from their food. They also have special salt cells called ionocytes with the help of which they actively transport salts from external dilute medium. Ionocytes are generally found in skin of amphibians and gills of fishes.

Marine animals:

Teleosts are osmoregulators and are hypotonic. These fishes have tendency to lose water especially across the gills epithelium. They also face problem of excess salts in the body due to drinking of sea water. Salts such as Na⁺, Cl⁻ and K⁺ are removed across the gill epithelium. Some fishes have special salt secreting glands called rectal glands that remove salts into the digestive tract which are then eliminated from the body during egestion.

- ii. How does the structure of the synapse and axon membrane ensure that nerve impulse is only able to travel in one direction? (1.5+1.5)

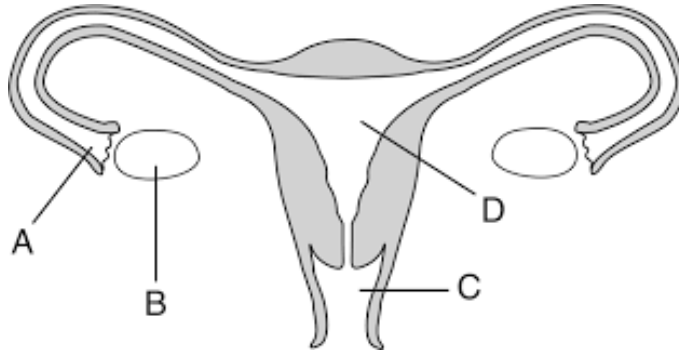
Ans. Structure of synapse and axon is well adapted to the unidirectional conduction of nerve impulse. The axons usually have several rounded synaptic knobs at their distal end, which dendrites lack. These knobs contain synaptic vesicles. When a nerve impulse reaches a knob some of the vesicles respond by releasing a neurotransmitter which diffuse across synaptic cleft and binds to receptors on the post synaptic membrane, which generates action potential in post synaptic membrane. After this synaptic transmission neurotransmitters are broken down by enzymes like acetylcholinestrace and monoamine oxidase.

- iii. What is the role of calcium ions in muscle contraction?

Ans. **Role of calcium in muscle contraction:** To enable muscle contraction, tropomyosin must change conformation and uncover the myosin-binding site on an actin molecule, thereby allowing cross-bridge formation. Troponin, which regulates the tropomyosin, is activated by calcium, which is kept at extremely low concentrations in the sarcoplasm. A nerve impulse triggers for calcium release from the sarcoplasmic reticulum into the sarcoplasm. Calcium ions bind to troponin, causing conformational changes in troponin that allow tropomyosin to move away from the myosin-binding sites on actin. Once the tropomyosin is removed, a cross-bridge can form between actin and myosin, triggering contraction. Cross-bridge cycling continues until Ca²⁺ ions and ATP is no longer available; tropomyosin again covers the binding sites on actin.

The concentration of calcium within muscle cells is controlled by the sarcoplasmic reticulum, a unique form of endoplasmic reticulum in the sarcoplasm. Muscle contraction ends when calcium ions are pumped back into the sarcoplasmic reticulum, allowing the muscle cell to relax.

iv. Following is the diagram of female reproductive system in human beings.



a. Correctly name the parts labelled as A, B, C and D. (0.25 x 4 = 1)

Ans. A. Fimbriae
B. Ovary
C. Vagina
D. Body of uterus

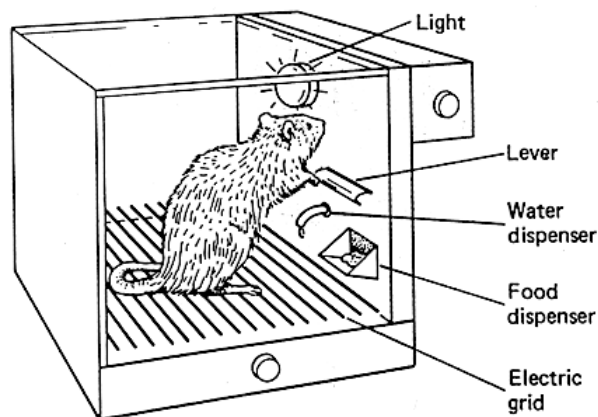
b. The foetus normally develops in structure: (01)

Ans. The foetus normally develops in the inner most spongy lining of the uterus (endometrium) Structure D.

c. Exposure to certain radiations could alter the genetic information in the gamete that form in the structure. (01)

Ans. Certain radiations such as (radiations, x-rays etc) could alter the genetic information in the gamete produced in ovary (Structure B)

v. The diagram below shows a typical Skinner box with a rat inside.



Relate this diagram with a pattern of learning behaviour and explain it briefly.

Ans. **Operant learning:**

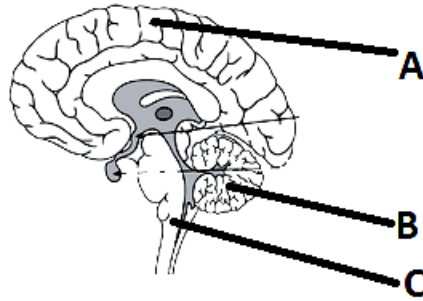
When an animal learns a response to a particular stimulus after many unsuccessful tries is called operant learning or trial and error learning. The trial and error learning occurs through experience. In the natural environment, animals are faced with naturally occurring awards and punishment and they learn by experience.

Example: Once inside the box, the rat would explore the box feverishly, running this way and that. Occasionally, it would accidentally press a lever and pellet of food would appear. At first, it would ignore the lever and continuous to move about but soon it learned to press the lever to obtain food. This type of learning is known as operant learning.

vi. Why do most synapses contain gaps across which an electrical impulse cannot pass, when a direct physical connection would enable the uninhibited passage of the impulse?

Ans. In a synapse there is no physical connection of neurons in order to control nerve impulse conduction. Synaptic gap or cleft receives neurotransmitter as a result of fusion of synaptic vesicles from presynaptic membrane. The neurotransmitter (excitatory or inhibitory) binds to receptor of post-synaptic membrane increasing or decreasing threshold stimulus. Synaptic cleft also enable the connection of various synaptic knobs (of nerve cells to one nerve cell).

vii. Observe the following diagram of human brain with labelled parts A, B, C and fill the given table.



Part	Name	Functions
A		
B		
C		

Ans.

Part	Name	Functions
A	Cerebrum	It functions in the analysis and interpretation of memory, reasoning, judgement and dreams etc. Cerebral cortex has sensory areas divided into lobes that receive sensory information from eyes, skin, ears etc.
B	Cerebellum	It controls equilibrium i.e. body position and coordination of the action of individual muscles to produce complete activities like running, walking and writing etc.
C	Medulla oblongata	Medulla controls automatic function of the body such as heart beat, blood pressure, respiration and swallowing etc.

viii. Trace the path taken by a molecule of urea from the time it is produced in the liver, to the time it leaves the body in urine.

Ans. **Path of urea:**

Urea being a detoxification by-product passes from liver into blood by hepatic vein then the blood is pumped by heart towards kidney, via renal artery which divides into afferent arteriole and then enters in glomerular capillaries and large molecules as RBCs and proteins are retained whereas H₂O and small solute and waste materials (filtrate) passes in renal tubule, after filtration process and osmoregulatory process, fluid left in collecting duct is urine containing all the urea made by liver, it passes to papillary

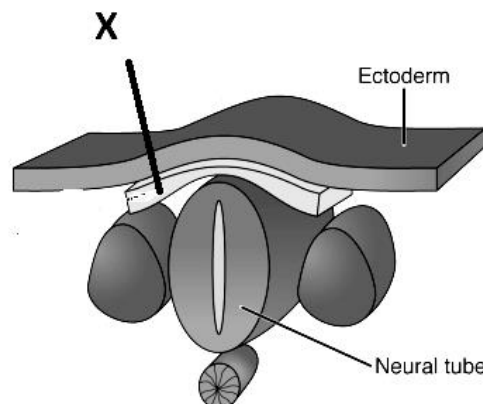
duct then renal pelvis which empties in ureter and stored in urinary bladder and escapes body via urethra during urination.

ix. If you see an angry dog barking at you, you will run as fast as you can,
 a. What hormone is secreted first in such an emergency?
 Ans. Adrenaline hormone is secreted during the time of stress or emergency by the adrenal medulla and is hence often referred to as the emergency hormone

b. State three effects of the hormone that help you to run away.
 Ans. When there is an emergency, adrenaline is secreted in the blood.

- This secretion begins reacting to a particular target organ such as the lungs, heart, blood pressure, metabolism, and such activities.
- Upon the release of adrenaline, the heart starts to beat rapidly thereby supplying a rush of oxygen to the muscles.
- This rush on supplying of oxygen to muscles has an impact on the lungs which leads to fast rapid contractions of the diaphragm and the rib muscles. As a result of the contraction, the arteries related to these muscles tend to an increased flow of blood to the skeletal system.
- The flow of blood into the skin and digestive system reduces.
- All these activities prepare the body for stressful situations.

x. In the following diagram, a stage in the process of neurulation is shown.



Elaborate the role of the part labeled as “X”

Ans. **The labelled part ‘X’ is Neural Crest:**

Early in the process of development, vertebrate embryos develop a fold on the neural plate where the neural and epidermal ectoderms meet, called the neural crest. The neural crest produces neural crest cells (NCCs), which become multiple different cell types and contribute to tissues and organs as an embryo develops. A few of the organs and tissues include peripheral and enteric (gastrointestinal) neurons and glia, pigment cells, cartilage and bone of the cranium and face, and smooth muscle. The diversity of NCCs that the neural crest produces has led researchers to propose the neural crest as a “fourth germ layer”, or one of the primary cellular structures in early embryos from which all adult tissues and organs arise.

xi. Complete the following table for the comparison of sex determination patterns in animals.

FEATURE	XY-SYSTEM	WZ-SYSTEM	XO-SYSTEM
Found in			
Sex chromosomes in body cells			
Gamete type that determine gender			

Ans.

FEATURE	XY-SYSTEM	WZ-SYSTEM	XO-SYSTEM
Found in	Human and <i>Drosophila</i>	Butterflies and birds	Protenor bug and grasshopper
Sex chromosomes in body cells	Male: XY Female: XX	Male: XX (ZZ) Female: XY (WZ)	Male: XO Female: XX
Gamete type that determine gender	Male gametes (Sperms)	Female gametes (Eggs)	Male gametes (Sperms)

xii. Carefully observe the following stretch of antisense strand of DNA
 $3'$ $5'$

TACGAGCTTCCGATTCGA

Codons for amino acids are:

GCU : Alanine AUG : Methionine CUC : Leucine

GAA : Glutamate GGC : Glycine UAA : Stop

Using the provided data, determine the primary structure of protein produced from this segment of DNA, during translation.

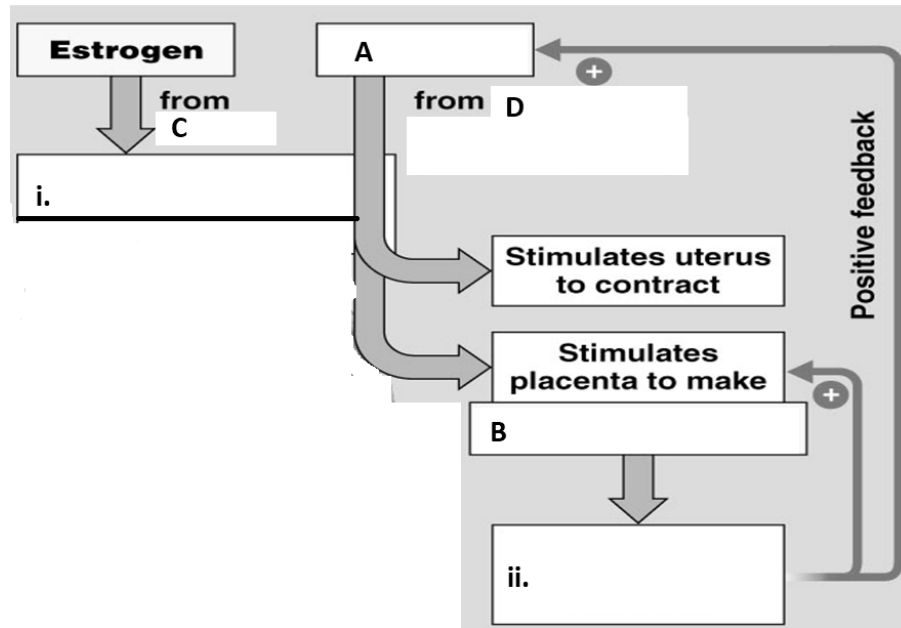
Ans. A mRNA molecule is made complementary to antisense DNA strand.

$3'$ TAC GAG CTT CCG ATT CGA $5'$ (antisense DNA)

$5'$ AUG CUC GAA GGC UAA GCU $3'$ (mRNA)

- Methionine acts as a start codon amino acid i.e. this amino acid is bound to start codon of sequence.
- Stop codon sequence is UAA which will terminate translation.
- Amino acid sequence in the primary structure of protein will be:
N-Methiorine-Leucine-Glutamate-Glycine

xiii. The following flow chart shows the role of hormones in the birth process.



a. Name the chemicals “A” and “B” in the flow chart.

Ans. (A) Oxytocin
 (B) Prostaglandins

b. Write the activity taking place at “i” and “ii”.

Ans. (i) Estrogen induces oxytocin receptors on uterus.
 (ii) Prostaglandins stimulate uterine contraction.

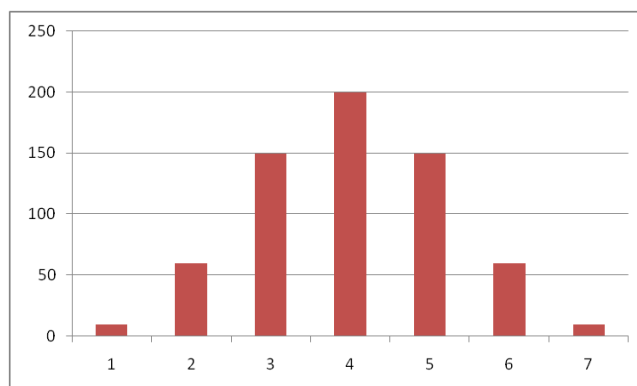
c. Name the organs “C” and “D” from which the hormones are secreted.

Ans. C: Ovaries D: Mother’s & Foetus posterior Pituitary.

xiv. a. From the following hypothetical data, construct a histogram to show the distribution of male population in different height groups.

Height of body in inches	60	63	66	69	72	75	78
Number of individuals	10	60	150	200	150	60	10

Ans.



b. How many gene pairs are controlling this trait according to the provided data?

Ans. Since there is a continuous variation of the trait, showing seven different classes with additive variation, it is an example of polygenic inheritance controlled by **THREE** gene pairs. Individual with all dominant alleles of the three gene pairs (AABBCC) will be having maximum size and the one with all recessive (aabbcc) minimum size. Other combinations will be having 1, 2, 3, 4, 5 dominant genes thus showing intermediate grades of height.

xv. Compare nervous and chemical coordination for the features listed in the following table.

FEATURES	NERVOUS COORDINATION	CHEMICAL COORDINATION
Transmission pathway		
Speed of transmission		
Duration of effect		

Ans.

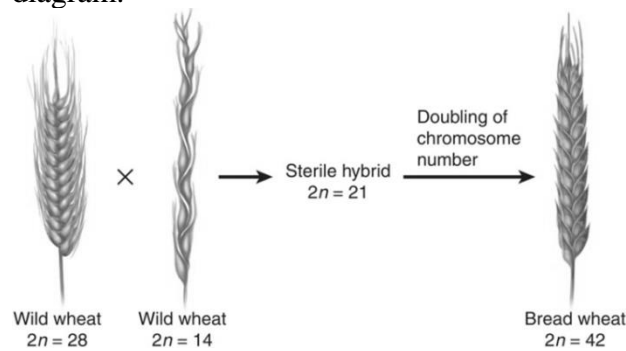
FEATURES	NERVOUS COORDINATION	CHEMICAL COORDINATION
Transmission pathway	Sensory neurons to motor neurons	blood
Speed of transmission	Fast	Comparatively slow
Duration of effect	Short duration	Long lasting

xvi. Explain the evolution of giraffe neck according to Lamarck’s theory.

Ans. **Evolution of Giraffe Neck:**

Each Giraffe during its life time would try to reach the leaves at higher branches stretching its neck and thus acquire this characteristic on the basis of “use and disuse of organs”. These acquired characteristic is passed onto generation, eventually evolving a giraffe best adaptive to its function (each longer than parent).

- xvii. The origin of bread wheat (*Triticum aestivum*) is depicted in the following diagram.



Explain the mode of speciation shown in this diagram.

Ans. **Sympatric Speciation:**

The diagram manifests sympatric speciation in which new species is formed due to reproductive isolation of same species of same habitat mostly due to polyploidy i.e. when wild wheat and wild wheat cross fertilize, a sterile hybrid is formed reproductively isolated from other types, so itself fertilizes to again form diploid species.

- xviii. Why there are few tertiary consumers in any ecosystem as compared to the number of individuals in lower trophic levels? Explain it according to the concept of energy and biomass.

Ans. Number of organisms in an ecosystem is represented by pyramid of number. Energy is passed up a food chain or web from lower to higher trophic levels. However, generally only about 10 percent of the energy at one level is available to the next level. The remaining 90 percent of energy is used for metabolic processes or given off to the environment as heat. This loss of energy explains why there are rarely more than four trophic levels in a food chain or web. Sometimes there may be a fifth trophic level, but usually there's not enough energy left to support any additional levels. With less energy at higher trophic levels, there are usually fewer organisms as well. Organisms tend to be larger in size at higher trophic levels, but their smaller numbers result in less biomass.

- xix. Construct a table to show the role of microbes (mentioning specific names) in processing of at least three household food items.

Ans. **Role of microbes (any three):**

Source/Substrate	Microbe	Food
Pasteurized milk	<i>Streptococcus thermophilus</i> , <i>Lactobacillus vulgaricus</i>	Yogurt/ Cheese
Mixture of wheat and soya beans+salt+water	<i>Aspergillus oryzae</i> , <i>Lactobacillus</i> and yeast	Soya sauce
Cereal grain flour	<i>Saccharomyces cerevisiae</i>	Bread

- xx. What are holandric traits? How are they inherited? Give any example.

Ans. **Holandric Traits:** Y-linked traits are holandric traits. They are observed only in males since genes located on non-homologous region of Y – chromosome is absent in woman as woman don't inherit Y chromosome. These traits pass from father to son but never to daughter. All sons of affected father will be affected e.g. hypertrichosis (pinna hair), toes webbing, straight body hair, TDF and minor histocompatibility gene (H-Y).

SECTION – C (Marks 26)

Note: Attempt any **TWO** questions. All questions carry equal marks.

(2×13 = 26)

Q.3 a. Describe the specific steps that occur during the process of transcription. (8)

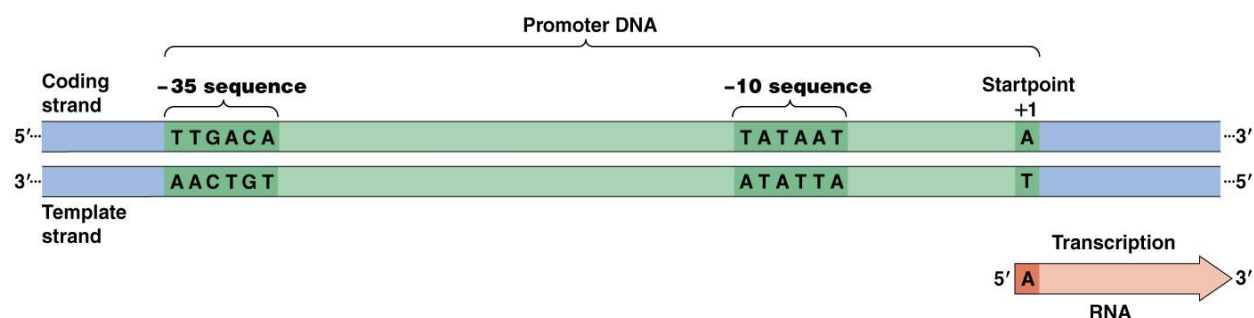
Ans. **TRANSCRIPTION:**

Transcription is the synthesis of RNA from DNA. It is the first step of gene expression. It occurs in G₀, G₁ and G₂ phases of cell cycle. It requires only one enzyme to be completed i.e., RNA polymerase. However, it is a continuous process; for convenience we can divide it into three phases: initiation, elongation and termination.

Initiation phase

Transcription begins with the binding of RNA polymerase at promoter region, a regulatory region of the gene that comprises binding sites for the attachment of RNA polymerase. In prokaryotes, these binding sites are TATAAT also called -10 sequence and TTGACA also called -35 sequence, whereas in eukaryotes, TATA (TATA box) also called -25 sequence and CAAT (CAAT box) also called -70 sequence. Names of these sequences (-10, -35 or -25, -70) refer to their position in promoter region that these sequences are located approximately how many nucleotides before the transcription start point of the gene.

RNA polymerase consists of four subunits: two alpha (α), two beta (β), called the core

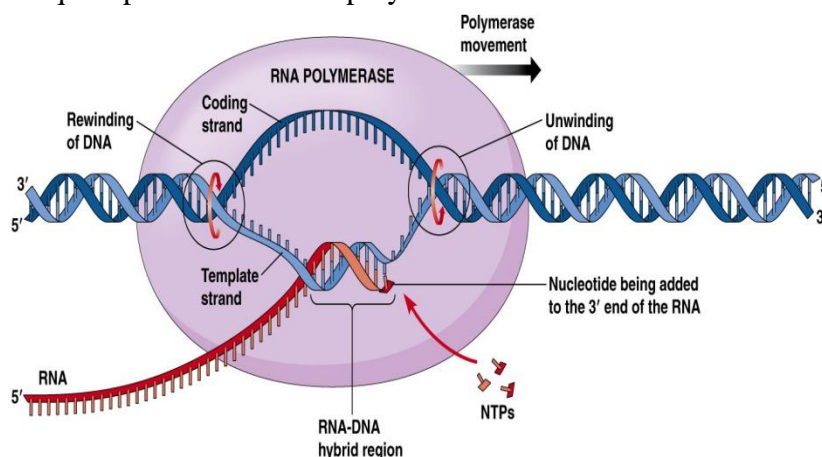


enzyme while the sigma factor is required for RNA polymerase to bind on the promoter. The core enzyme and sigma factor together constitute a holoenzyme. Once RNA polymerase is attached on promoter, the sigma factor is removed, and the core enzyme catalyses the remaining process. It is similar to the DNA polymerase in that it also adds nucleotides to the 3' end of the growing polypeptide chain but unlike DNA polymerase it does not require primer to perform polymerase activity. In prokaryotes, only one type of RNA polymerase is found while in eukaryotes, there are three types of RNA polymerases, namely RNA polymerase-I, which synthesize rRNA, RNA polymerase-II, which synthesize mRNA, RNA polymerase-III which synthesize tRNA.

As the RNA polymerase binds to the promoter, DNA duplex becomes unwind, base pairs are broken down, and a bubble like structure, the transcription bubble appears.

Elongation phase

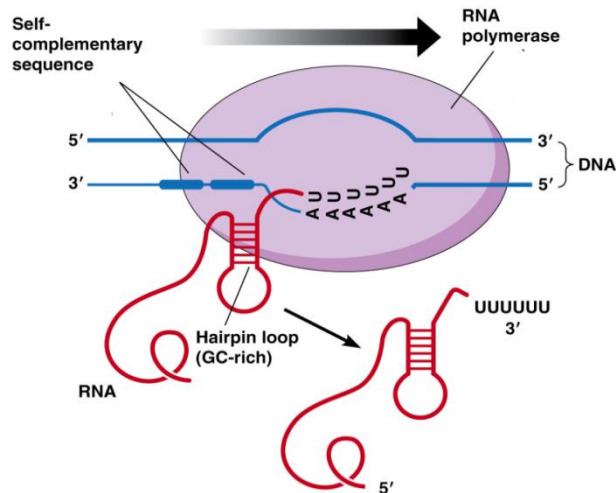
As the RNA polymerase binds to promoter, it begins to arrange and polymerise the ribonucleosides triphosphates (rNTP) or ribonucleotides complementary to the template strand of the DNA. It does not require primer to initiate polymerization. One of the two strands of the gene



acts as template for transcription. This template strand is also called antisense because mRNA is complementary to this strand. The other strand of the gene is called coding or sense strand. In elongation phase, RNA polymerase keeps on moving from 5' to 3' end of RNA towards the terminator region of the gene, beside its transcription bubble also moves along the DNA, leaving the growing RNA strand protruding from the bubble. This event continues till the RNA polymerase reaches the terminator region of the gene.

Termination phase

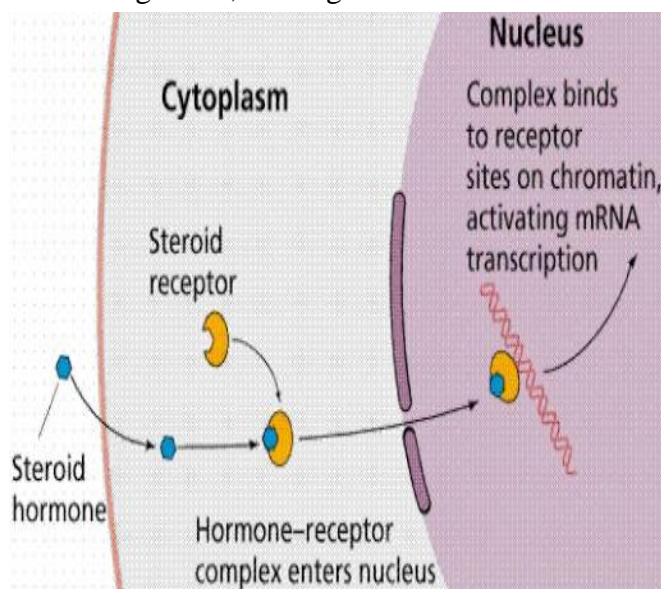
The sequence of terminator region of the gene stops the synthesis of mRNA. The terminator region consists of a series of GC base pairs followed by a series of AT base pairs. The part of mRNA which is transcribed in this region, projects to form a loop like structure called GC hairpin followed by a small tail of poly U nucleotides. The GC hairpin causes the RNA polymerase to stop the synthesis of RNA.



- b. Compare the mode of action of steroid and protein hormones. Also draw diagrams. (5)

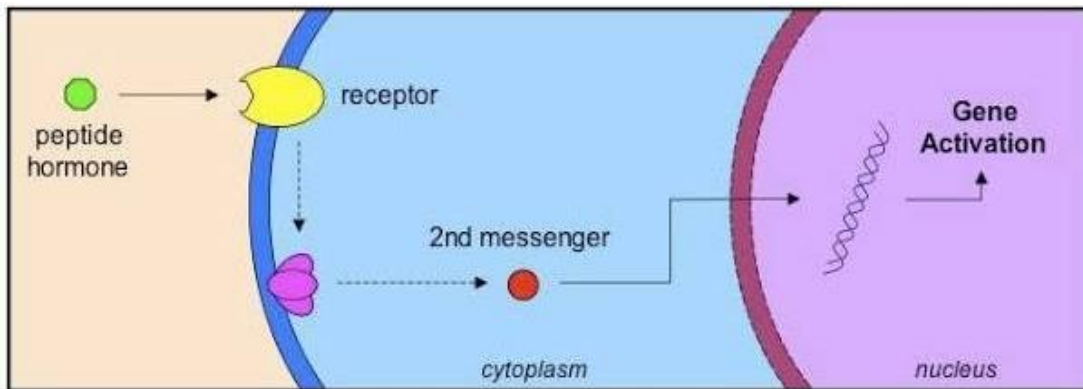
Ans. **Mode of Hormone Action:**

Protein Hormones: Protein and peptide hormones cannot pass through cells' plasma membrane because they are water soluble. These hormones (**first messenger**) bind with their receptors on the plasma membrane of target cell, starting a series of events in the cell which generates second



messenger (e.g. cAMP). The second messenger then triggers various changes in the cell including activation of enzymes, gene activation.

Steroid Hormones: Steroid and thyroid hormones can pass through plasma membrane because they are lipid soluble. Receptors for these hormones are located inside target cells, in the cytoplasm or nucleus. Hormones bind with their receptors to form hormone-receptor complex. This complex then binds with promoter region of particular gene, acting as transcription factor. mRNA of that gene is formed by transcription and translated into protein. Target cell activities are modified by the altered gene expression.



Q.4 a. Describe the events of ovaries and uterus in human menstrual cycle and explain its hormonal regulation. (7)

Ans. The female reproductive system undergoes cyclic events. Therefore the sequence of all reproductive events in female reproductive system is called female reproductive cycle or menstrual cycle. The female reproductive cycle primarily divided into two phases i.e., ovarian cycle (includes those events that occur in ovaries) and uterine cycle (includes those events that occur in uterus). The events of ovarian cycle are very well coordinated with events of uterine cycle by pituitary hormones called gonadotropins. Based upon changes and hormonal regulation the cycle can be divided into three phases i.e., menstrual phase, proliferative phase and secretory phase.

Menstrual phase (Days 1 – 5)

In this menstruation phase, the uterus sheds all but the deepest part of its endometrium. The thick, hormone-dependent functional layer of the endometrium detaches from the uterine wall, a process that is accompanied by bleeding for 3–5 days. The detached tissue and blood pass out through the vagina as the menstrual flow. At the beginning of this stage, ovarian hormones are at their lowest normal levels and gonadotropins are beginning to rise. Then FSH levels begin to rise.

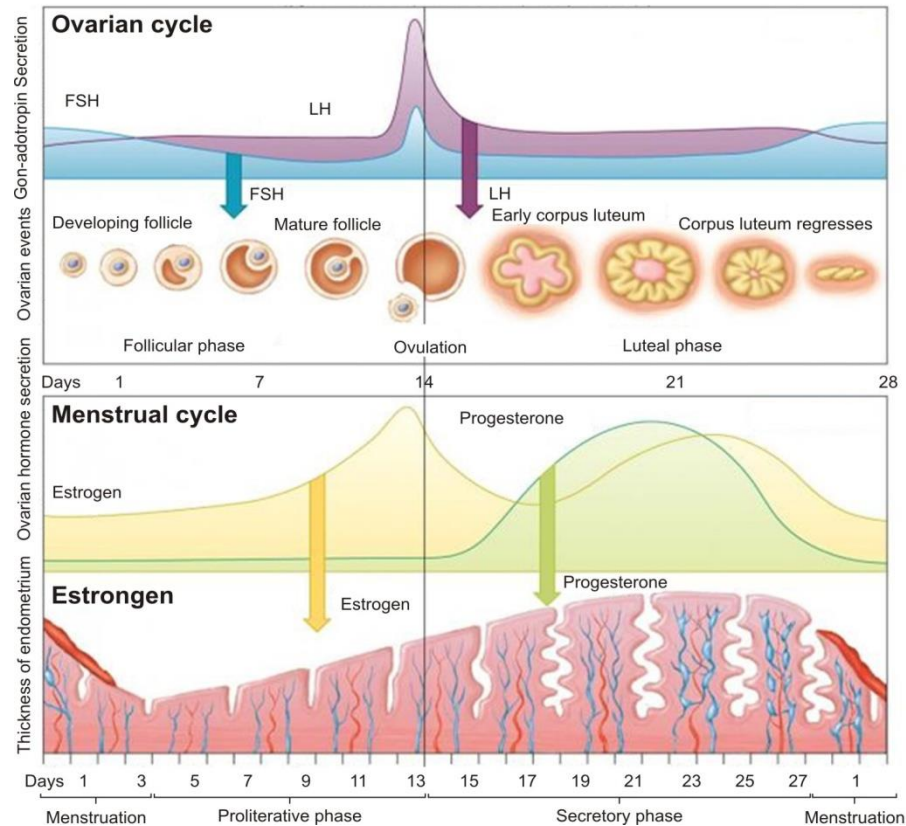
Proliferative/pre-ovulatory phase (Days 6–14)

Through the influence of a rise in follicle stimulating hormone (FSH) during the first days of the cycle, a few ovarian follicles are stimulated. These follicles compete with each other for dominance. As a result all but one of these follicles stop to grow and finally disintegrate (follicle atresia), while one dominant follicle in the ovary continue to mature and becomes mature follicle (Graafian follicle), in which oogenesis occurs.

FSH also stimulates the graffian follicle to secrete estrogen which in turn governs the vascularization of endometrial lining of uterine wall. Consequently, the endometrium once again becomes velvety, thick and well vascularized. Normally, cervical mucus is thick and sticky, but rising estrogen levels cause it to thin and become crystalline, forming channels that facilitate the passage of sperm into the uterus.

Estrogen has negative feedback upon FSH, therefore, as the concentration of estrogen rises the level of FSH falls. This is a signal for anterior pituitary to release LH, at the end of the proliferative stage (day 14). In response to the sudden release of LH from the anterior pituitary egg from the mature follicle is released into the oviduct, the event is known as ovulation, which takes less than five minutes. LH also converts the ruptured follicle to a yellowish glandular mass called corpus luteum.

Secretory/post-ovulatory phase (Days 15–28): During the secretory phase, the endometrium prepares for implantation of an embryo. Rising levels of progesterone from the corpus luteum act on the estrogen-primed endometrium, causing the arteries to elaborate and converting the functional layer to a glandular secretory layer (uterine glands). The uterine glands enlarge, coil and begin secreting nutritious glycogen into the uterine cavity. These nutrients sustain the embryo until it has implanted in the blood-rich endometrial lining. Fertilization has not occurred, the corpus luteum begins to degenerate toward the end of the secretory phase as LH blood level declines. Progesterone levels fall, depriving the endometrium of hormonal support and endometrial cells die, setting the stage for menstruation to begin on day 28.



- b. Differentiate between *in-vitro* and *in-vivo* gene therapy. Describe *in-vivo* gene therapy for treatment of cystic fibrosis. (6)

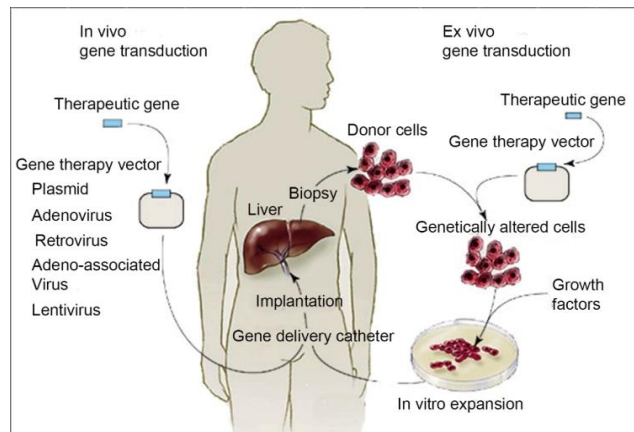
Ans. Gene Therapy:

Gene therapy is a technique for correcting defective genes responsible for disease development. Researchers may use one of several approaches for correcting faulty genes, like a normal gene may be inserted into a non specific location within the genome to replace a non-functional gene. This approach is most common.

Mechanism of gene therapy

In gene therapy treatment, normal gene is either delivered directly into the body (*in vivo*) or into the cells outside the body. Then these transgenic cells are again implanted into the body (*ex vivo*). In both cases, a "normal" gene is inserted into the genome to replace an "abnormal," disease-causing gene. A carrier molecule called a vector must be used to deliver the therapeutic gene to the patient's target cells. Currently, the most common vector is a virus that has been genetically altered to carry normal human DNA.

Some of the different types of viruses used as gene therapy vectors are Retroviruses, Adenoviruses, Herpes simplex viruses.



Role of Gene Therapy for Cystic Fibrosis

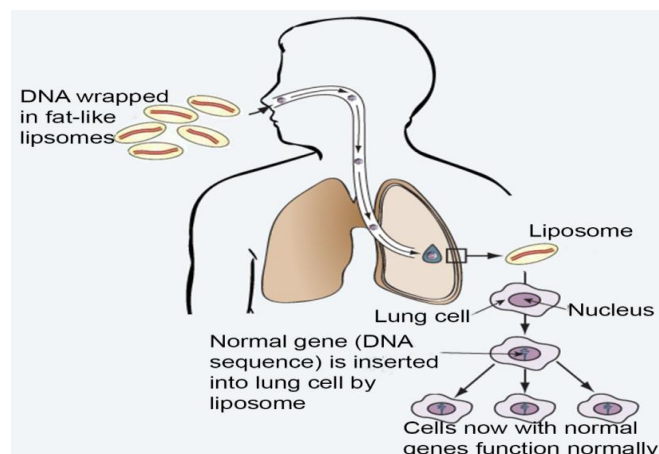
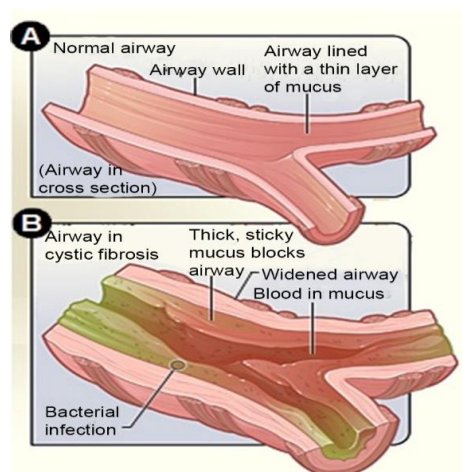
Cystic fibrosis is an inherited disease which affects the mucus and sweat glands. People with severe symptoms can have serious lung and digestive problems.

Cystic fibrosis (CF) involves a defect in the cystic fibrosis trans membrane conductance regulator (CFTR) gene that encodes a protein by which the movement of salt and water is controlled in and out of body cells. In people with cystic fibrosis, the gene does not work effectively. As a result, cells that line the passageways of the lungs, pancreas and other organs produce abnormally thick, sticky mucus. This mucus obstructs the airways and glands which causes the characteristic signs and symptoms of cystic fibrosis. On the other hand, in normal persons, mucus is watery. It keeps the linings of certain organs moist and prevents them from drying out or getting infected.

Gene Therapy of Cystic fibrosis

In 1989, experts discovered the gene that causes cystic fibrosis and identified it as the cystic fibrosis trans membrane conductance regulator or CFTR. The discovery of this defective gene posed new possibilities of a cure.

An in vivo method of treatment is being tried. Liposomes-microscopic vesicles that spontaneously form when lipoproteins are put into a solution have been coated with the gene needed to cure cystic fibrosis. Then the solution is sprayed into the patient's nostril.



Q.5 a. Write an essay on ecological succession that takes place on bare rocks? (7)

Ans. Ecological succession on bare rock is called Xerarch succession. Various stages and process of xerarch succession which results in the development of climax community may be

described briefly as follows:

Crustose-lichen stage

It is the pioneer stage. On bare rocks only crustose-lichen (crust-like lichens) can grow. These are slow growers and can withstand extreme desiccation. When there is rain they absorb water like sponges and decompose rock by secreting acids. Important members of this stage are *Licanora* and *Rhinodina*.

Foliose-lichen stage

On the little soil, which is accumulated on the rock there appear species of foliose-lichens (leaf-like lichens) and by their activities there collects a thin layer of soil. Important members of this stage are *Permelia* and *Dermatocarpom*.

Moss stage

When sufficient amounts of soil have been accumulated in the minute crevices and depressions in the rock, xerophytic mosses begin to appear. The mosses increase the amount of soil. By their death and decay, a mat may be formed on the rock surface. This can hold greater amount of water and along with the soil makes habitat suitable for herbs.

Herb stage

Herbaceous weeds, mostly annuals invade the rock. Their roots penetrate deep down, secrete acids and enhance the process of weathering. Leaf litter and death of herbs add humus to the soil. Shading of soil results in decrease in evaporation and there is a slight increase in temperature. As a result the xeric conditions begin to change and biennial and perennial herbs and xeric grasses begin to inhabit.

Shrub stage

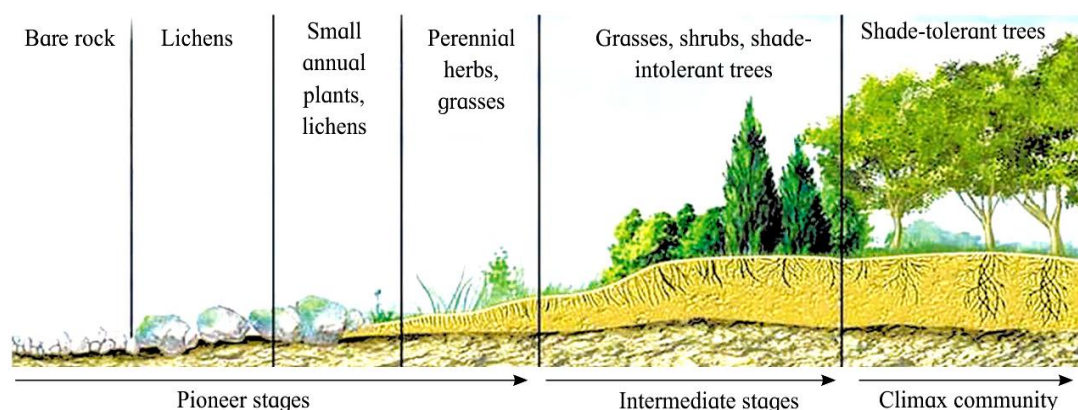
On the soil appear xeric shrubs. These shrubs (low woody plants smaller than a tree with little or no trunk, bush) may start from seeds or invade from adjacent areas by rhizomes. These make the condition unsuitable for herbs and overshadow them. The herbs are unable to compete and hence are replaced by shrubs. Early invasion of shrub is slow but once a few bushes have become established, birds invade the area and help disperse the seeds. This results in dense growth, shading the soil and making conditions unfavourable for the growth of herbs which then begin to migrate.

Tree stage

Change in environment favours colonization of tree species. The tree saplings begin to grow among the **shrub** and establish themselves. The trees form canopy and shade the area. Shade-loving plants continue to grow as secondary vegetation. Leaf litter and decaying roots weather the soil further and add humus to it making the habitat more favourable for growth of trees.

Climax stage

The first species of trees are relatively xeric. As the weathering process continue and the soil deepens, the xeric trees in turn give place to mesophytic species of trees. Ultimately, a forest may develop.



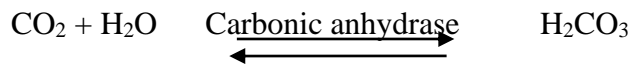
b. How carbon dioxide is transported in human blood?

(6)

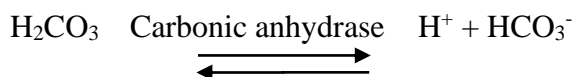
Ans: Carbon dioxide is transported in the blood in three main ways: (i) In the form of bicarbonate ions. (ii) In the form of carboxyhaemoglobin. (iii) Dissolved in plasma.

(i) As bicarbonate ions

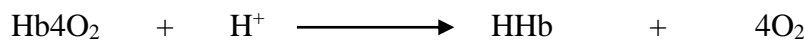
Approximately 70% of carbon dioxide is carried in the blood as bicarbonate ions. Carbon dioxide diffuses into the blood, enters the red blood cells and combines with water to form carbonic acid in the presence of enzyme carbonic anhydrase. The chemical reaction can be depicted as follows:



Carbonic acid, H_2CO_3 is an unstable compound and dissociates to form hydrogen ions and bicarbonate ions.



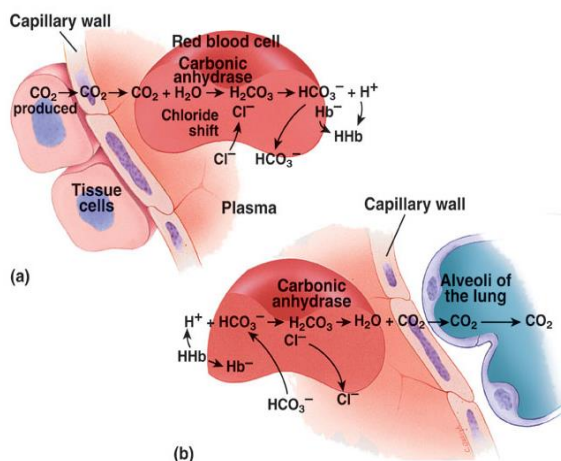
Accumulation of H^+ ions increases acidity in the blood, i.e., it leads to the decrease in pH. This does not occur since haemoglobin buffers the hydrogen formed. The hydrogen ion readily associates with oxyhaemoglobin (Hb4O_2) to form haemoglobinic acid (HHb) and oxygen is released to the tissue.



From inside of the erythrocytes negatively charged HCO_3^- ions diffuse to the plasma. This is balanced by the diffusion of chloride ions, (Cl^-), in the opposite direction. This is achieved by special bicarbonate-chloride carrier proteins that exist in the RBC membrane. This protein moves the two ions in opposite directions, maintaining the balance of ions on either side. This is called the chloride shift or Hamburger's phenomenon.

The chloride ions that enter the RBC combine with potassium (K^+) to form potassium chloride, whereas bicarbonate ions in the blood plasma combine with Na^+ to form sodium bicarbonates. The blood pH is thus maintained at approximately 7.4 by the buffer mechanism that exists in blood.

Transport of CO_2 depends on the partial pressure of CO_2 . The partial pressure of CO_2 is higher in tissues than blood so it diffuses into blood here it react with water and transported to the lungs as bicarbonate ion. In lungs process reverses and bicarbonate ions combine with hydrogen ion to release carbon dioxide and water.



(ii) As carboxyhaemoglobin (carbaminohaemoglobin)

About 23% of carbon dioxide is carried as carboxyhaemoglobin (carbaminohaemoglobin). CO_2 combines with the globin part of haemoglobin. The reaction depends upon the partial pressure of CO_2 . When the PCO_2 is higher in the tissues than blood,

formation of carboxyhaemoglobin occurs. When the PCO_2 is higher in the blood than tissues as in case of lungs, carboxyhaemoglobin releases its CO_2 .

(iii) As dissolved CO_2 in plasma

Only 7% of carbon dioxide is carried this way. This is rather inefficient way to carry carbon dioxide, but it does occur.

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