



My Success Story

**AIIMS**  
Nishita Purohit

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IN  
NEET  
OVERALL  
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Distance

**AIR 10**



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Classroom

**AIR 11**



OVERALL RANK-11  
NISHITA PUROHIT  
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**AIR 13**



OVERALL RANK-12  
ANUJ GUPTA  
Distance

**AIR 15**



OVERALL RANK-13  
HARSHIT ANAND  
Classroom

**AIR 16**



OVERALL RANK-14  
HARSH AGARWAL  
Classroom

**AIR 17**



OVERALL RANK-15  
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Scored in Total  
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Maharashtra (Girls)

In NEET-2017



**Hanmant  
Gangadhar Mirkute**  
Scored **345**  
in **BIOLOGY**  
CREATED HISTORY



**Anirudha Anil Kabra**  
**Triumphant  
Crown**  
■ JIPMER- 40<sup>th</sup> AIR  
■ NEET Total Marks **620**  
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**325**

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Anchal Kabra



Rushikesh Kendre



Priyanka Kabra

**663**  
TOTAL

**643**  
TOTAL

**641**  
TOTAL



Aniket Sonwane

**632**  
TOTAL



Prasad Joshi

**629**  
TOTAL



Yash Dad

**624**  
TOTAL



Anirudha Kabra

**620**  
TOTAL

## NEET-2017 IIB's BIOLOGY TOPPERS



Awej Choin  
**BIO-342**



Utkarsha Deshmukh  
**BIO-340**



Snehal Gite  
**BIO-340**



Achal Kabra  
**BIO-337**



Priyanka Kabra  
**BIO-337**



Aprva Chavan  
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Shubham Gade  
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Shaikh Aawej  
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Kanchan Gangewar  
**BIO-335**



Gajashri Gutte  
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12th

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AIIMS

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CET

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Rutivek Kandhare  
**611**



Amay Degloorkar  
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**591**



Sanjana Mast  
**591**



Gaurav Bhattad  
**590**



Pundalik Maske  
**590**



Kapil Marshivne  
**BIO-331**



Aditya Kamtalwar  
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Pravin Munde  
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Kailash Mise  
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XII Board 2017

**DARADE VAIBHAV**

**635**  
/720

**GHUGE MAHESH**  
**BIO-100**  
/100

**JAGTAP VAIBHAV**  
MH-Rank-2

**BENGAL ADITYA**  
MH-Rank-1

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**NEET  
TOTAL 632**

Sonawane Aniket  
Fourth in Rajarshi Shahu College, Latur

**NEET  
TOTAL 631**

Mule Rupali  
Fifth in Rajarshi Shahu College, Latur

**NEET  
TOTAL 625**

Manwatkar Sarita

**NEET  
TOTAL 620**

More Vaibhav

**NEET  
TOTAL 617**

Nawal Anuja

**NEET  
TOTAL 615**

100/100  
Ghuge Mahesh  
First in BIOLOGY Maharashtra State Board

**NEET  
TOTAL 610**

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# BIOLOGY today

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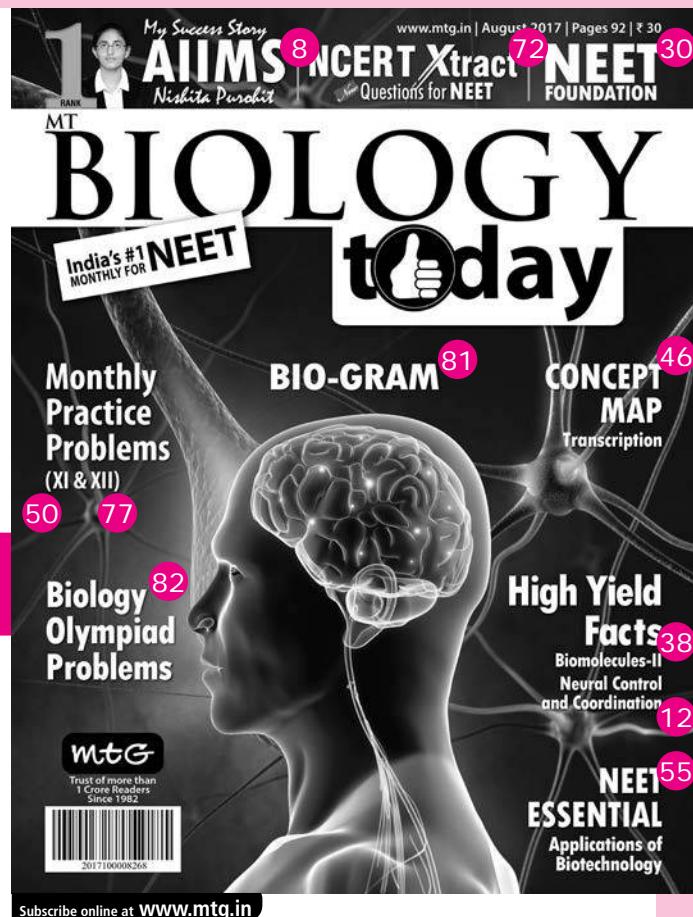
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Class XI

Class XII

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Rank

**Nishita Purohit**

# Cracking the AIIMS EXAM

- **MTG : Why did you choose medical entrance?**

**Nishita Purohit :** From childhood, I had a dream of serving the mankind. So, I thought it was the best occupation satisfying my wish. Therefore, I decided to appear for the medical entrance examinations.

- **MTG : What exams you have appeared for and what is your rank in these exams?**

**Nishita :** I also appeared for NEET and my rank was 11.

- **MTG : Any other achievements? (Please mention the name of exams and rank)**

**Nishita :** In the past two years, I had thoroughly focussed on AIIMS but still I qualified for the second stage of Physics Olympiad after clearing the first stage.

- **MTG : How did you prepare for AIIMS and other medical exams?**

**Nishita :** The main idea was to focus on all the topics as taught in the class with utmost attention and follow guidelines given in my coaching classes by Allen Career Institute, Kota.

- **MTG : What basic difference you found in various papers you cleared?**

**Nishita :** All the papers I appeared in, were of different formats and difficulty levels. So, it is very important to find out all the details regarding the test. On a personal note, difficulty level of AIIMS was at the peak followed by JIPMER and finally NEET.

**“The ideal preparation plan is nothing as such. Each person has a different way of preparation. But the basic theme is same, relevance of material, frequency of revisions and question practice.”**

- **MTG : How many hours in a day did you study to prepare for the examination?**

**Nishita :** I studied for around 5 hours in my Allen classroom and for about 4-5 hours of self-study.

- **MTG : On which topic and chapters you laid more stress in each subject?**

**Nishita :** For AIIMS, specially I laid more stress on Physics followed by Chemistry. Biology is easy and is more application based. Some chapters such as 'POC', 'Semiconductors', 'States of matter', 'Surface chemistry', 'Biomolecules', 'Polymers', 'Chemistry in everyday life' were my main topics.

- **MTG : How much time does one require for serious preparation for this exam?**

**Nishita :** Quantity of time is no factor. Qualitative and smart study is of more importance.

- **MTG : Any extra coaching?**

**Nishita :** No extra coaching.

डा. राहुल राय द्वारा संचालित 19 वर्षों से सर्वश्रेष्ठ पीएमटी कोचिंग

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Starian Selected in JIPMER 2017

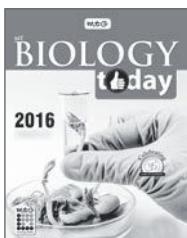
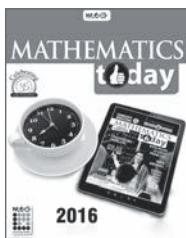
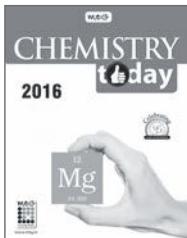
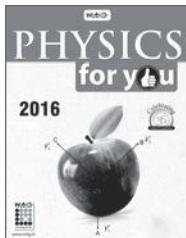
Total Medical Selection in Just 19 Years 1062



- MTG : Which Subjects/Topics were you strong/weak at?**  
**Nishita :** I was strong at Physics and weak in Chemistry.
- MTG : Which Books/Magazines/Tutorial/Coaching classes did you follow?**  
**Nishita :** I primarily followed Allen classroom material and solved few books like HC Verma, MTG-magazines and NCERT.
- MTG : In your words what are the components of an ideal preparation plan?**  
**Nishita :** The ideal preparation plan is nothing as such. Each person has a different way of preparation. But the basic theme is same, relevance of material, frequency of revisions and question practice.
- MTG : What role did the following play in your success:**
  - parents
  - teachers
  - school?**Nishita :** I firstly thank my coaching institute for nourishing me. I thank my parents, my brother, relatives and teachers for their continuous support.
- MTG : Your family background?**  
**Nishita :** My family background is towards engineering side. My dad and my brother are engineers and my mother is a pharmacist.
- MTG : What mistake you think you shouldn't have made?**  
**Nishita :** I did not focus on NCERT textbooks earlier which I regretted later and corrected my mistake. Also, I hesitated a lot in asking questions from my teachers. Students should avoid this.
- MTG : How did you de-stress yourself during the preparation? Share your hobbies and how often could you pursue them?**  
**Nishita :** I used to perform pranayam and meditation to de-stress myself. I enjoyed listening to songs whenever I got bored.
- MTG : How have various MTG products like Explorer, Books and Magazines helped you in your preparation?**  
**Nishita :** I did follow a few magazines but not regularly. However, whatever I read, I found it informative.
- MTG : Was this your first attempt?**  
**Nishita :** Yes, this was my first attempt.
- MTG : Had you not been selected then what would have been your future plan?**  
**Nishita :** If I hadn't been selected, I would have switched on to administration and civil service side.
- MTG : What do you think is the secret of your success?**  
**Nishita :** The secret was nothing but regular study and practice questions along with NCERT books.

All the Best!😊😊

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# HIGH YIELD FACTS



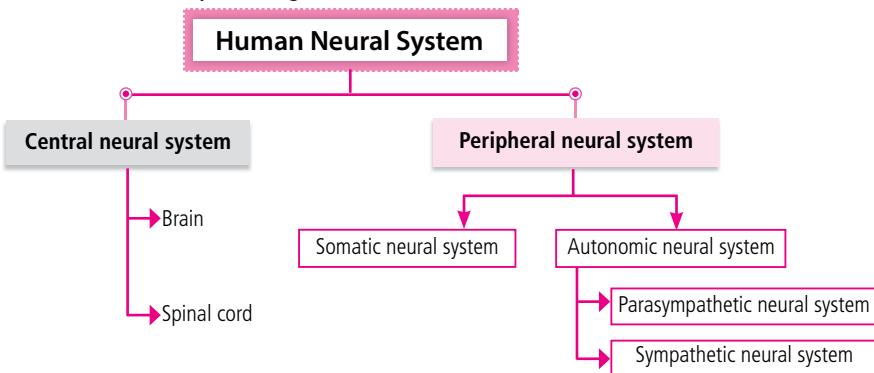
Class XI

## Neural Control and Coordination

- Nervous system (Neural system) is a system of highly specialised nerve cells, nerve fibres and organs (called receptors), that coordinate and control the activities of different parts of the body. This is done by converting the internal and external stimuli of environmental changes into the form of electrical impulses (a process called transduction) and transmit them to other specialised cells called effectors (muscles and glands) to react accordingly. Between the receptors and effectors are present the conducting cells of the nervous system, the neurons.
- Overall function of nervous system is to collect information about the external conditions in relation to the body's internal state, to analyse this information and to initiate appropriate responses to satisfy certain needs (maintain homeostasis). The most important need is survival. The nerves do not form one single system, rather they form several systems, which are interrelated. Some of these are physically separate, others are different in function only.

### NEURAL SYSTEM

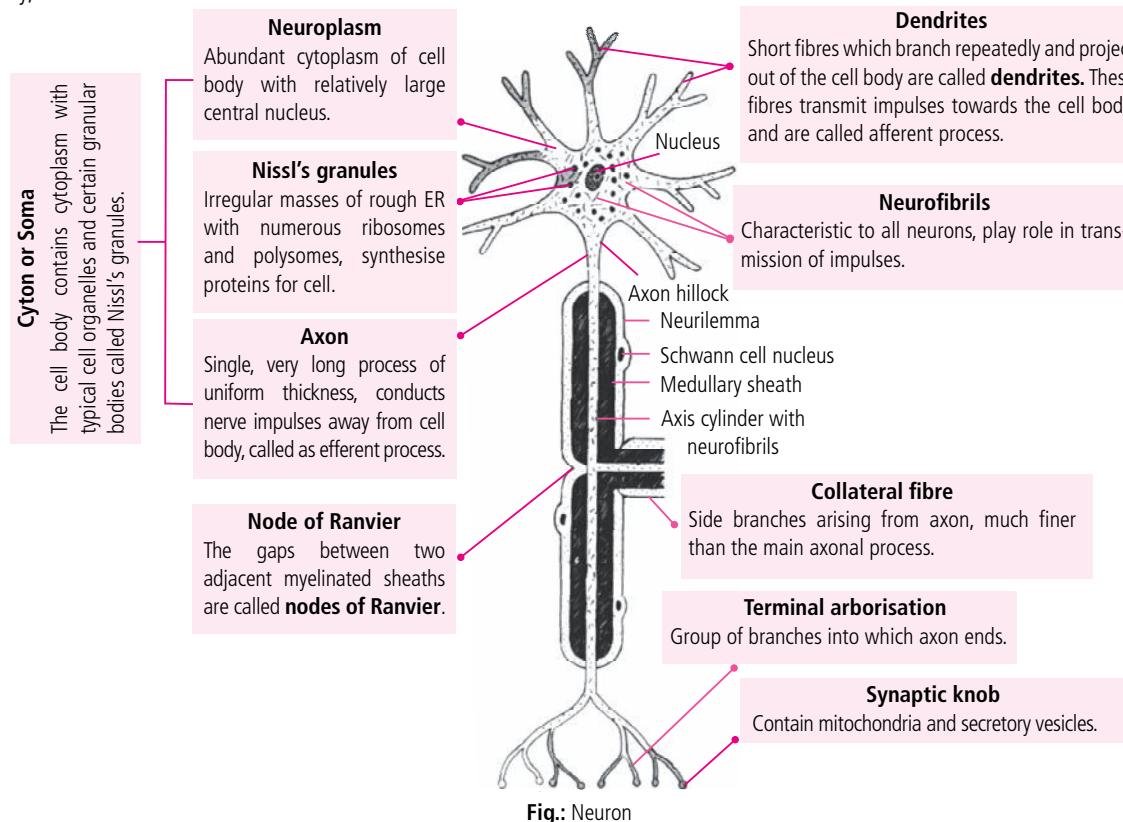
- The neural system provides an organised network of point-to-point connections for a quick coordination between various body functions. A brief classification of human neural system is given below.



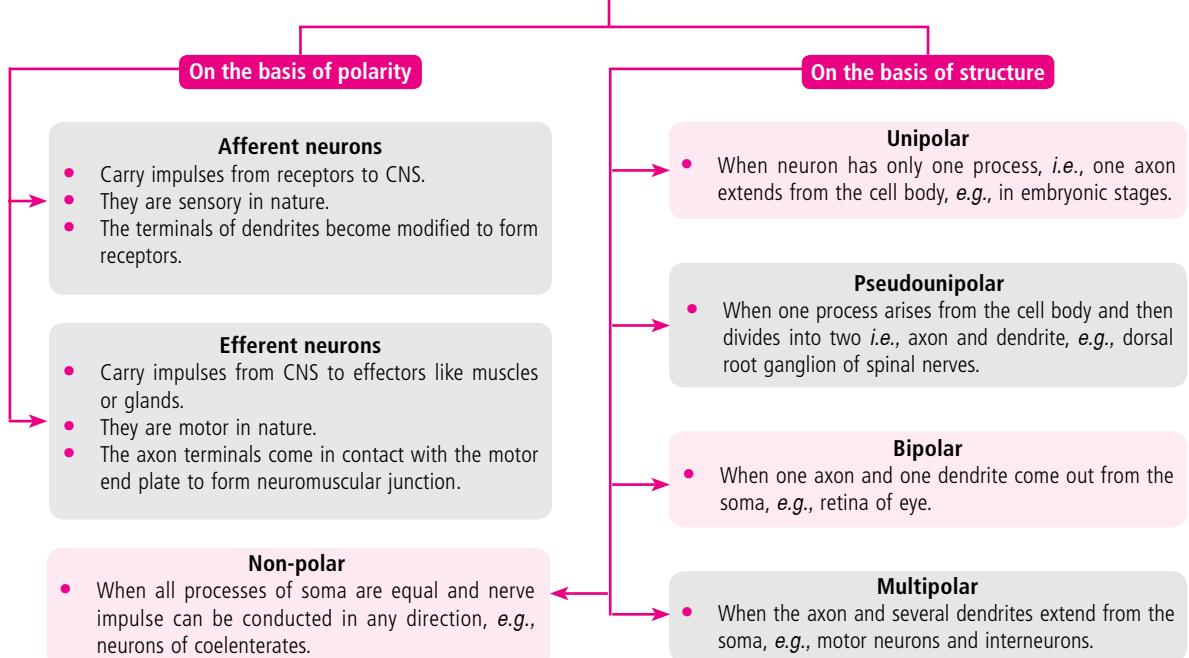
|            | Analysis of various PMTs from 2013-2017 |      |      |      |      |
|------------|-----------------------------------------|------|------|------|------|
|            | 2013                                    | 2014 | 2015 | 2016 | 2017 |
| AIPMT/NEET | 3                                       | 2    | 4    | 2    | 3    |
| AIMS       | 2                                       | 2    | -    | 1    | -    |
| AMU        | 1                                       | -    | 3    | -    | -    |
| Kerala     | -                                       | 1    | 1    | 4    | -    |
| K-CET      | 2                                       | -    | -    | -    | -    |
| J & K      | -                                       | 1    | 1    | 1    | -    |

## Neurons

- Neurons are the structural and functional unit of neural system. A neuron structurally comprises of three major parts : cell body, dendrites and axon.



### Types of Neurons

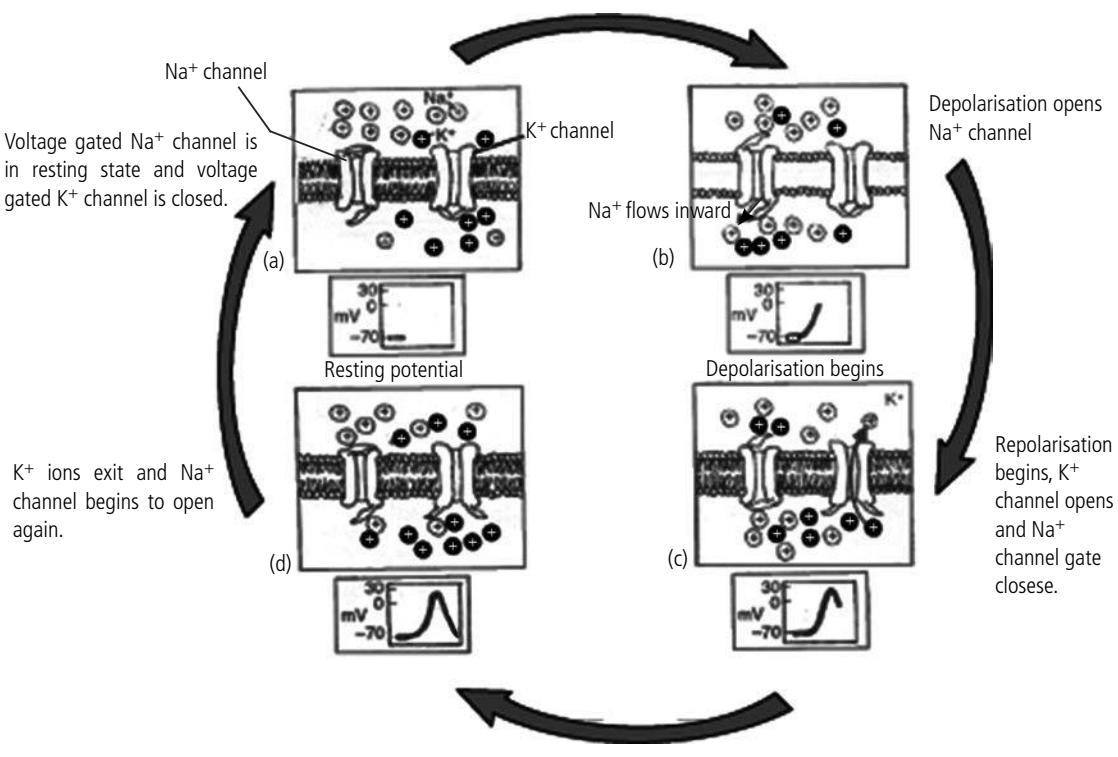


## NERVE IMPULSE

- Nerve impulse is a wave of bioelectric/electrochemical disturbance that passes along a neuron during conduction of an excitation. The nerve impulse travels along a neuron or across synapse between one neuron and another, or between neuron and an effector.
- Nature of nerve impulse or conduction of nerve impulse is an electrochemical process. It has been found that impulse conduction depends upon permeability of axon membrane (axolemma) and osmotic equilibrium and electrical equivalence between the axoplasm and extracellular fluid (ECF) present outside the axon.

## Generation and Conduction of Nerve Impulse

- When a neuron is not conducting any impulse, i.e., resting, the axonal membrane is comparatively more permeable to potassium ions ( $K^+$ ) and nearly impermeable to sodium ions ( $Na^+$ ). Similarly, the membrane is impermeable to negatively charged proteins present in the axoplasm. Consequently, the axoplasm inside the axon contains high concentration of  $K^+$  and negatively charged proteins and low concentration of  $Na^+$ . In contrast, the fluid outside the axon contains a low concentration of  $K^+$ , a high concentration of  $Na^+$  and thus forms a concentration gradient. The ionic gradients are maintained by active transport of ions by sodium-potassium pump which transports 3  $Na^+$  outwards for 2  $K^+$  into the cell. As a result, the outer surface of the axonal membrane possesses a positive charge while its inner surface becomes negatively charged and therefore is said to be polarised. **The electrical potential difference across the resting plasma membrane is called as the resting potential.**
- When a stimulus is applied, the permeability of the membrane to  $Na^+$  ions is greatly increased at the point of stimulation. It is due to the fact that the  $Na^+$  channels open and the  $K^+$  channels remain closed.
- As a result, sodium channels permit the influx of  $Na^+$  ions by diffusion. This results in the positive charge inside and negative charge outside. **The change in polarity across the plasma membrane is known as action potential and the membrane is said to be depolarised.**
- With the increase of  $Na^+$  ions inside the nerve fibre, the membrane becomes less permeable to  $Na^+$  ions and more permeable to  $K^+$  ions.  $Na^+$  influx stops and  $K^+$  outflow begins until the original resting state of ionic concentration is achieved. Thus, resting potential is restored which is called **repolarisation** of the membrane.
- When an impulse travels along a myelinated neuron, depolarisation occurs only at nodes. The action potential jumps from node to node and **impulse transmission along the myelinated axon is faster than the series of smaller local currents in a non-myelinated axon**. This type of conduction is called **saltatory conduction**.



**Fig.:** Stages in axon membrane potential during resting, depolarisation, action potential and repolarisation

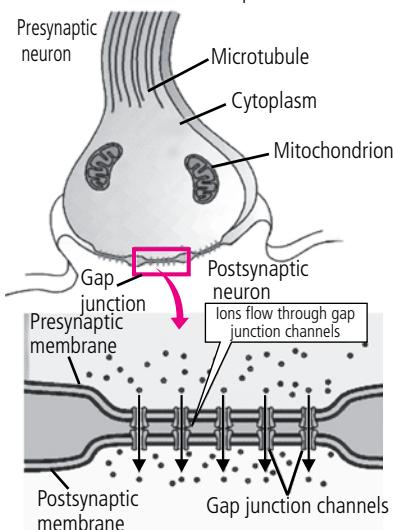
## Transmission Through Synapse

- Synapse is the junction between two neurons, across which the impulse passes from one neuron to the next.
- A synapse is formed by the membranes of a **pre-synaptic neuron** and a **post-synaptic neuron**, which may or may not be separated by a gap called **synaptic cleft**.

### Types of Synapse

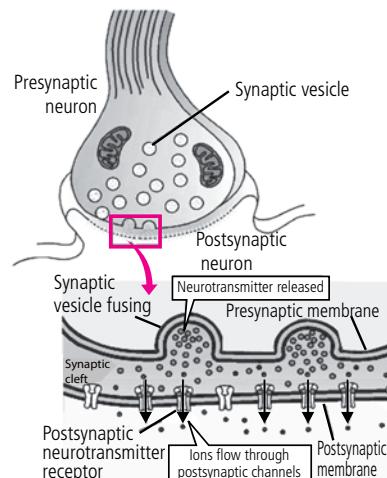
#### Electrical synapse

- At **electrical synapse** there is continuity between the pre-synaptic and post-synaptic neurons. The continuity is provided by the **gap junctions** between the two neurons. In electrical synapse there is minimal synaptic delay because of the **direct flow** of electrical current from one neuron to the other through gap junctions. Thus, **impulse transmission across an electrical synapse is always faster than that across a chemical synapse**. Impulse transfer through electrical synapses do not involve any neurotransmitter. Electrical synapses are rare, it is found in the cardiac muscle fibres, smooth muscle fibres of intestine and the epithelial cells of lens.



#### Chemical synapse

- At a **chemical synapse**, when an impulse arrives at a pre-synaptic knob, calcium ions from the synaptic cleft enter the cytoplasm of the pre-synaptic knob. The calcium ions cause the movement of **synaptic vesicles** to the surface of the knob. The synaptic vesicles are fused with the pre-synaptic membrane and get ruptured to discharge their content (neurotransmitters) into the synaptic cleft.
- The neurotransmitter of the synaptic cleft binds with **protein receptor molecules** on the post-synaptic membrane. This binding action changes the membrane potential of the post-synaptic membrane, opening channels in the membrane and allowing **sodium ions to enter the cell**. This causes the depolarisation and generation of action potential in the post-synaptic membrane. Thus, the impulse is transferred to the next neuron.



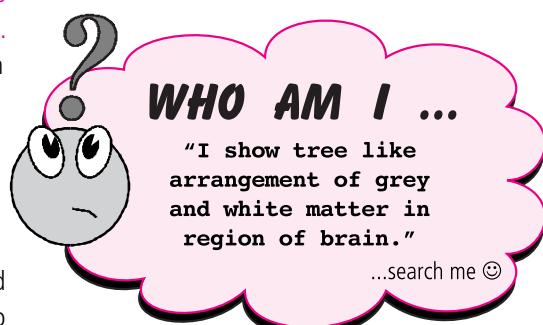
## TYPES OF NERVOUS SYSTEMS

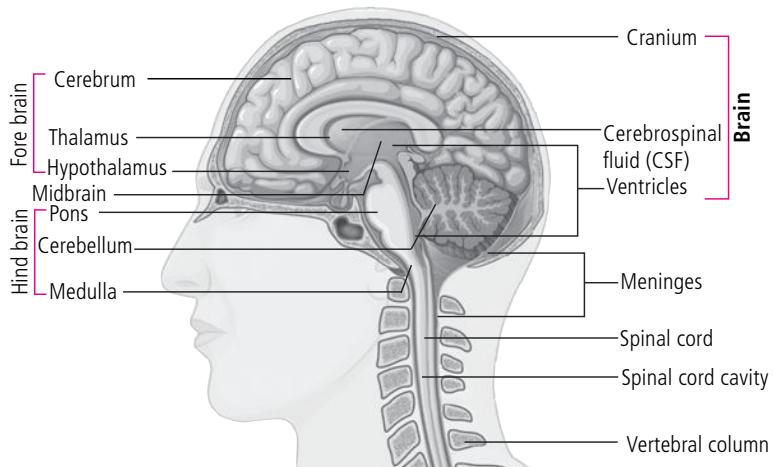
### Central Nervous System (CNS)

The central nervous system (CNS) is the **processing centre of the nervous system**.

It receives and sends information to peripheral nervous system.

The brain and spinal cord are continuous structures, which together form the CNS. They are both protected by hard bony coverings-the brain by the cranium and the spinal cord by the vertebral column and by a continuous, tough, three layered membrane called the meninges. Both the brain and spinal cord are bathed in cerebrospinal fluid (CSF), which is continuously circulated through the cerebral ventricles, the cavity of the spinal cord and the sub-arachnoid space. It serves as a pad to cushion the CNS from shocks and mechanical injuries. The CSF also carries oxygen and nutrients from the blood to the neurons and neuroglia of the CNS.

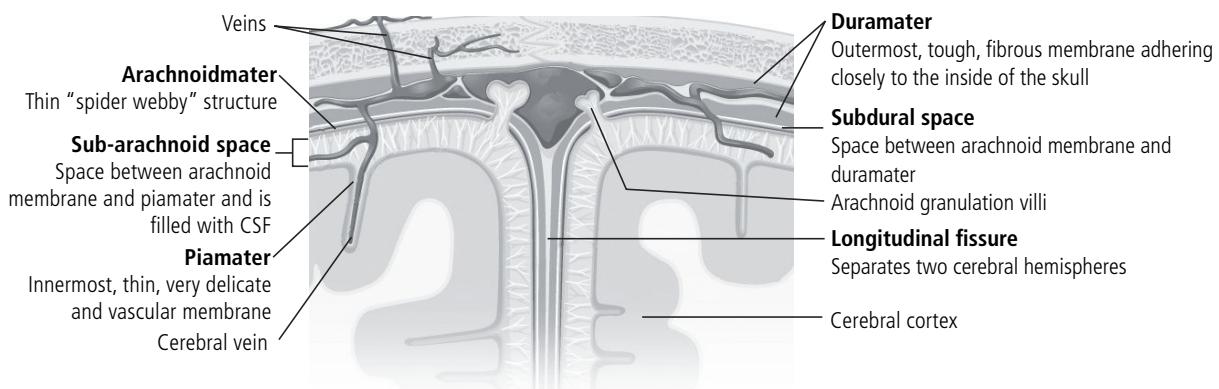




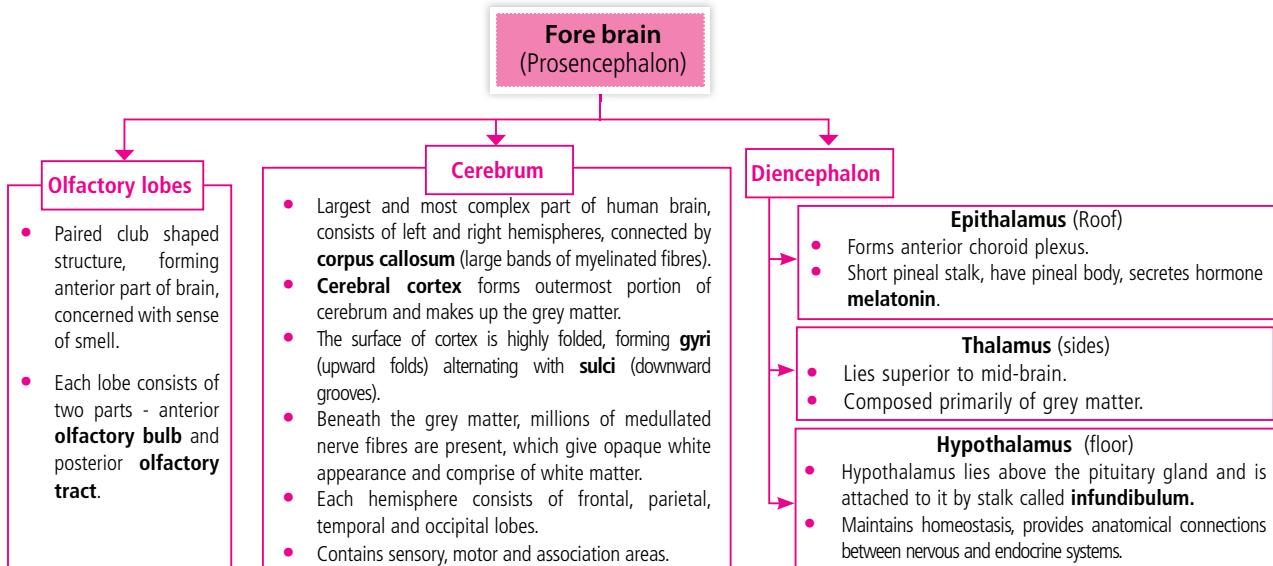
**Fig.: Overview of central nervous system**

### Human Brain

- The human brain is the command centre for the human neural system. It receives input from the sensory organs and sends output to the effectors. It processes and interprets sensory information sent from the spinal cord.
- The brain is covered by three protective layers of connective tissue called **meninges**.



**Fig.: Meninges of brain**



## Mid-brain (Mesencephalon)

- Passage to hind brain.
- Contains narrow canal called iter/aqueduct of Sylvius (mesocoel).

### Corpora quadrigemina

- 2 pairs of rounded protrusions present on upper or superior surface of mid brain are called corpora quadrigemina.
- One pair is called **superior colliculi** (concerned with sense of sight) and other pair is **inferior colliculi** (concerned with hearing).
- The superior and inferior colliculi of each side are termed **corpora bigemina**.

### Mid-brain

### Cerebral peduncles (crura cerebri)

- Crura cerebri are two bundles of fibres present on lower or inferior surface of the mid brain.
- They relay impulses back and forth between the cerebrum, cerebellum, pons and medulla.

## Hind brain (Rhombencephalon)

### Cerebellum

- Second largest part of the human brain, consists of 3 layers, outer layer of cells, cerebellar cortex and deeper cell clusters. Middle layer contains characteristically large flask shaped **Purkinje cells**.
- Cerebellum has two lateral **cerebellar hemispheres** and central worm shaped part, **vermis**.
- It contains branching tree like arrangement of grey and white matter called **arbor vitae** (tree of life).
- Functions:** Controls posture, balance and mainly involuntary activities, receives information from muscles, joints, skin, eyes.

### Pons varolii

- It is situated in front of cerebellum below the mid brain and above the medulla oblongata.
- Functions:** It relays impulses between the medulla oblongata and superior part of brain, between hemispheres of cerebellum and between cerebrum and cerebellum.
- Pneumotaxic centre present in pons varolii limits inspiration.

### Medulla oblongata

- Pyramid shaped, extends from pons varolii above and is continuous with spinal cord below.
- It has thin, non-vascular folded structure on its lower side called posterior choroid plexus.
- Functions:** Regulatory centres for heart rate, blood pressure, breathing, sneezing, salivation, coughing, etc.

### Motor Area

- Lies in the frontal lobe
- Transmit impulses to effectors
- Control of voluntary muscles

### Sensory Area

- Lies in the parietal lobe
- Receive impulses from receptors
- Perceive skin sensations (temperature, pressure, pain)

### Frontal Lobe

- Muscle movement
- Control intellectual ability to problem solving, reasoning
- Concentrating, thinking
- Behaviour, personality, mood

### Broca's Area

- Lies in the frontal lobe
- Speech control

### Temporal Lobe

- Hearing and smell comprehension
- Language
- Memory
- Emotions

### Parietal Lobe

- Sensations
- Language
- Perception
- Body awareness
- Attention

### Occipital Lobe

- Vision
- Perception

### Wernicke's Area

- Lies in the left temporal lobe
- Language comprehension

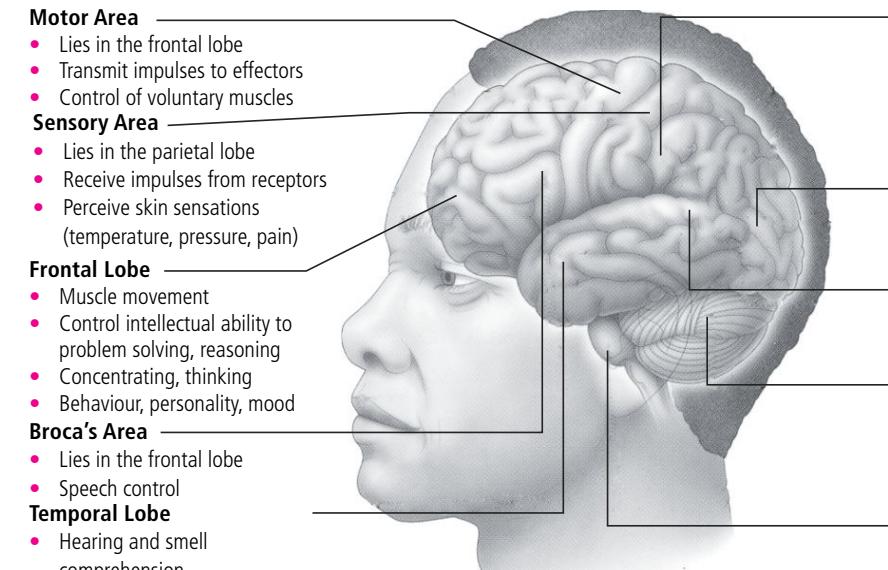
### Cerebellum

- Posture
- Balance
- Coordination of movement

### Brain Stem

- Consciousness
- Breathing
- Heart rate

Fig.: Functional areas of the brain



## Human Spinal Cord

- **Spinal cord** (42 to 45 cm long) extends from the medulla oblongata and is continuous to the level of second lumbar vertebra. It conducts impulses to and from the brain and controls most of the reflex activities.
- Inner butterfly shaped area of spinal cord is the grey matter as it lacks myelin and surrounding **grey matter** is the bundles of myelinated nerve fibres, which form **white matter**.
- The area within the vertebral column below the second lumbar vertebra contains spinal nerves that are collectively called, the **cauda equina**.
- The spinal cord ends as the **conus medullaris** from which a fine filament called **filum terminale** arises that anchors spinal cord within the vertebral column.
- The spinal cord is surrounded by three protective membranes; innermost **pia mater**, middle **arachnoid mater** and outer, tough **dura mater**. The subarachnoid space is filled with cerebrospinal fluid and the additional **epidural space**, above dura mater contains fatty and connective tissues and veins.

## Functions

- Spinal cord performs two main functions:
  - (i) The stimuli are passed from and to the brain through the spinal cord.
  - (ii) It is the centre of spinal reflex action.

## REFLEX ACTION

- Reflex action (Marshall Hall, 1833) is an immediate involuntary action of any organ or part of the body in response to a particular stimulus.
- The nervous pathway taken by nerve impulses in a reflex action is called **reflex arc**. The components that mediate a reflex, usually includes a receptor, afferent pathway, integrating centre, efferent pathway and effector. Hence, the entire impulse circuit of a reflex response is -

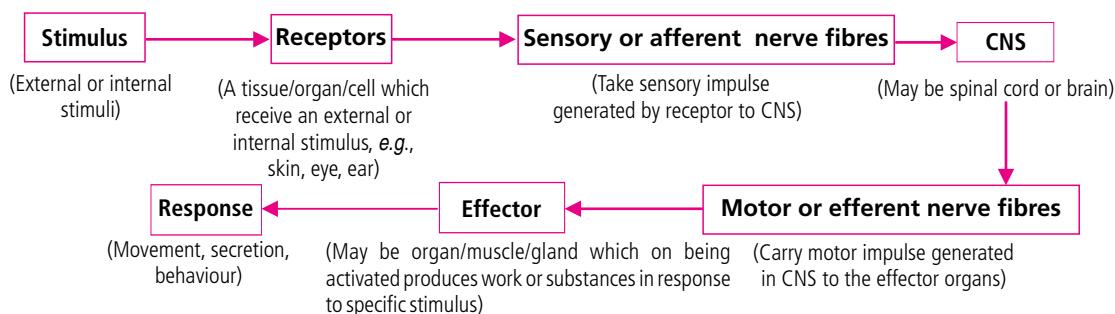


Fig.: Reflex arc

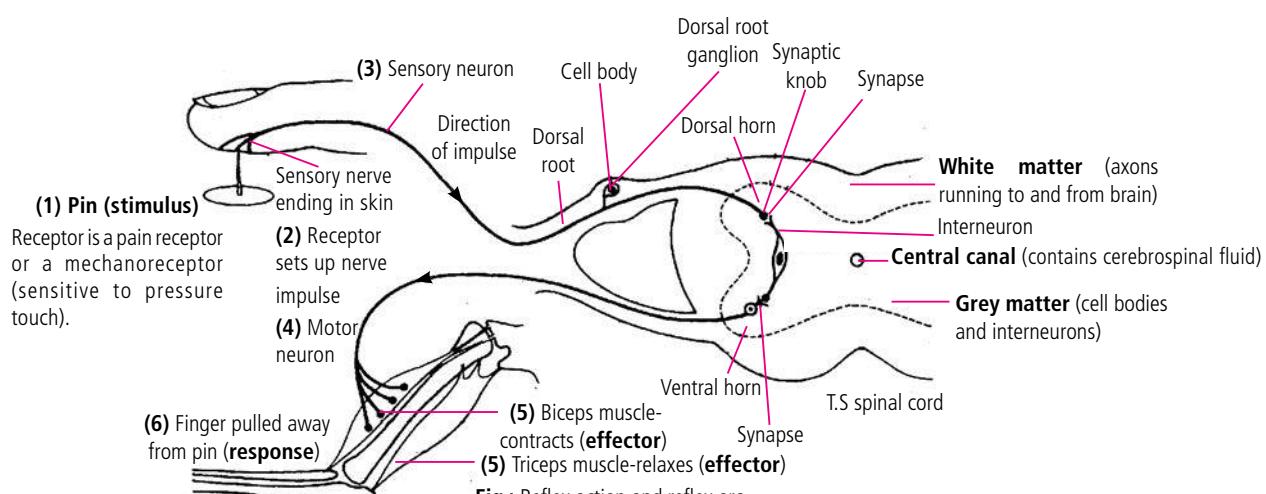


Fig.: Reflex action and reflex arc

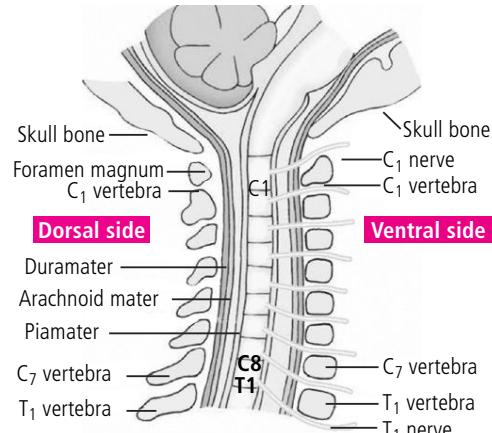


Fig. : Coverings of human spinal cord

### Types of Reflexes

#### Simple or Unconditioned reflex

- A simple reflex is inborn, unlearned response to a stimulus or any change in the environment. Most reflex actions are protective in nature.
- In this reflex, the nerve impulse is initiated when the sensory nerve endings in the receptor organ are stimulated. The impulse travels along the afferent or sensory neuron until it reaches the terminal branches of the axon forming a synapse with the dendrites of the connector neuron. In the spinal cord, the impulse proceeds along the length of this connector neuron to its axon endings which form another synapse with the dendrites of the motor neuron. At this synapse an impulse is initiated in the efferent or motor neuron. The terminal axon branches of the motor neuron end in the effector organ. The reflex or response made by the effector organ as a result of the arriving nerve impulse is either muscular contraction or glandular secretion, depending on the effector involved.

#### Conditioned reflex

- Conditioned reflexes are not inborn but are acquired during the life time of an individual. It was first demonstrated by I.P. Pavlov. He presented a hungry dog with food, which elicited a reflex of salivation by the stimulation of the taste buds in the mouth. He then rang a bell each time the dog was given the food to associate the unconditioned response (salivation) with an additional stimulus (bell). After a few trials, he was able to demonstrate that the dog salivated at the sound of the bell without the sight or smell of food. This is thus known as conditioned reflex.
- These are very important for studying the process of learning and behaviour in animals.

### Inhibition of Reflex Action

- In the infant the act of micturition and defecation are carried out by reflex action and there is no voluntary control over these processes. As the child grows, the sensory nerve tracts of the spinal cord become fully developed, the impulses from the bladder and rectum reach the brain and can be controlled. Hence, now the act of micturition and defaecation become a conscious voluntary act in the adult.

### Peripheral Nervous System

- The nerves running outside brain and spinal cord constitute peripheral neural system. These nerves are of two types: cranial nerves (nerves originating from brain) and spinal nerves (nerves originating from spinal cord).

### Cranial Nerves

- There are 12 pairs of cranial nerves. They are called so as they pass through various openings in cranial bone.
- Some cranial nerves are sensory (carry impulses from receptor to CNS), a few are motor (conduct impulses from CNS to effector) and others are mixed (have both sensory and motor neurons).

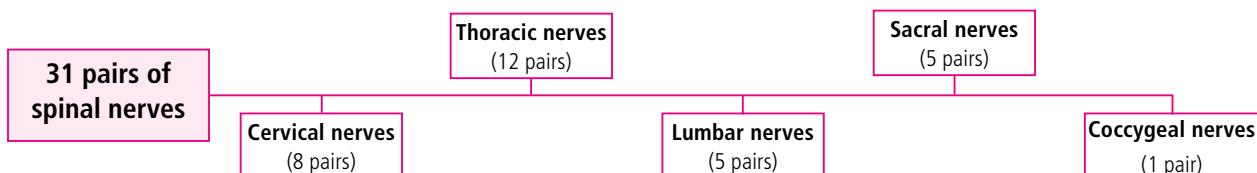
**Table: 12 pairs of cranial nerves in man**

|    | Name                                                                                                                                | Origin                               | Distribution                                                                                                                                                                                                                                                         | Nature                               | Functions                                                                  |
|----|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------------|
| 1. | Olfactory                                                                                                                           | Olfactory epithelium in nasal cavity | Olfactory bulb of olfactory lobes of brain                                                                                                                                                                                                                           | Sensory                              | Smell                                                                      |
| 2. | Optic                                                                                                                               | Retina of eye                        | Optic lobe of midbrain                                                                                                                                                                                                                                               | Sensory                              | Sight (Retina of eye)                                                      |
| 3. | Oculomotor                                                                                                                          | Floor of midbrain                    | Eye, 4 muscles of eyeball                                                                                                                                                                                                                                            | Motor                                | Movements of eye-ball, iris, lens, eyelid and constriction of pupil        |
| 4. | Trochlear<br><b>(Smallest and thinnest cranial nerve)</b>                                                                           | Floor of midbrain                    | Superior oblique muscles of eyeball                                                                                                                                                                                                                                  | Motor                                | Rotation of eye-ball                                                       |
| 5. | Trigeminal ( <b>Largest cranial nerve</b> )<br>Divided into three branches:<br>(i) Ophthalmic<br>(ii) Maxillary<br>(iii) Mandibular | Ventral surface of pons varolii      | <ul style="list-style-type: none"> <li>• Lacrimal glands, conjunctiva of eye, skin of forehead, eyelids, etc.</li> <li>• Cheeks, upper gums, upper teeth and lower eyelids</li> <li>• Teeth and gums of lower jaw, pinna of the ear, lower lip and tongue</li> </ul> | Mixed<br>Sensory<br>Sensory<br>Mixed | Skin sensations<br>Sensations<br>Sensations, tongue movements, mastication |

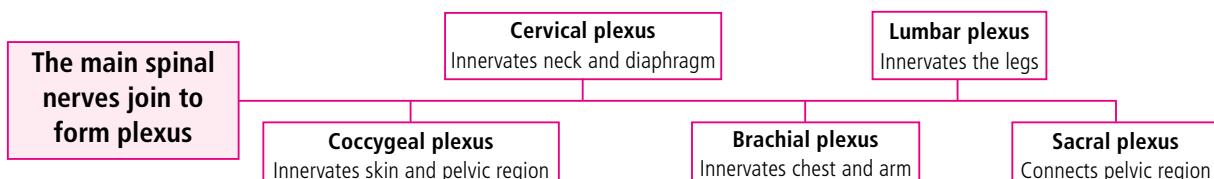
|     |                                                                                             |                                                                                                                         |                                                                                                                                      |         |                                                                                                                                                                         |
|-----|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6.  | Abducens                                                                                    | Pons varolii                                                                                                            | External rectus muscle of eye-ball                                                                                                   | Motor   | Rotation of eye-ball                                                                                                                                                    |
| 7.  | Facial (bears geniculate ganglion)                                                          | Lower part of pons varolii                                                                                              | Anterior 2/3 tongue (taste buds), muscles of face, neck and salivary glands                                                          | Mixed   | Taste, facial expression, chewing, movement of neck                                                                                                                     |
| 8.  | Auditory (also called vestibulo-cochlear)                                                   | Comes from internal ear and joins lateral side of pons varolii                                                          | Organ of Corti in cochlea, semicircular canals                                                                                       | Sensory | Hearing and equilibrium                                                                                                                                                 |
| 9.  | Glossopharyngeal                                                                            | Lateral side of medulla                                                                                                 | Posterior 1/3rd of tongue, soft palate and muscles of pharynx                                                                        | Mixed   | Taste and touch, movements (swallowing) of pharynx, salivation                                                                                                          |
| 10. | Vagus (Pneumogastric) <b>(Longest cranial nerve)</b><br>(i)<br>(ii)<br>(iii)<br>(iv)<br>(v) | Lateral side and floor of medulla<br>Superior laryngeal<br>Recurrent laryngeal<br>Cardiac<br>Pneumogastric<br>Depressor | Muscles of pharynx, vocal cords, lungs, heart, oesophagus, stomach.<br><b>Also called wandering nerve as it has maximum branches</b> | Mixed   | Vocal cords (sound production), lungs, respiratory reflexes, peristaltic intestine movements, speech, swallowing, secretion of gastric glands, inhibition of heart beat |
| 11. | Spinal accessory or accessory nerve                                                         | Both medulla and spinal cord                                                                                            | Muscles of palate, larynx, vocal cords, neck, shoulder                                                                               | Motor   | Movement of muscles of pharynx, larynx, neck, shoulder                                                                                                                  |
| 12. | Hypoglossal                                                                                 | Ventral side of medulla oblongata                                                                                       | Muscles of tongue, hyoid apparatus                                                                                                   | Motor   | Movement of tongue                                                                                                                                                      |

### Spinal Nerves

- There are 31 pairs of spinal nerves, named and numbered according to the vertebrae with which they are associated.



- Structure** - The spinal nerves are formed by union of dorsal and ventral roots shortly after they leave spinal cord. Each spinal nerve has afferent (sensory) and efferent (motor) fibres, in general, efferents come from ventral root and afferents go into dorsal root. Thus, **all spinal nerves are mixed nerves because they carry both sensory and motor impulses**.
- After leaving vertebral column, each spinal nerve divides into:
  - Posterior branch**- innervates muscles and skin of the posterior portion of the body.
  - Anterior branch**- innervates limbs and the lateral and anterior portions of the body.



### Autonomic Neural System

- Autonomic neural system (ANS)** is a special self-governed autoregulating system of ganglia and peripheral motor nerve fibres (efferent) which innervate various organs and glands of the body to stimulate, accelerate, slow down or inhibit their functions without directly consulting the will. ANS is made of two opposing divisions, **sympathetic** and **parasympathetic** neural system.

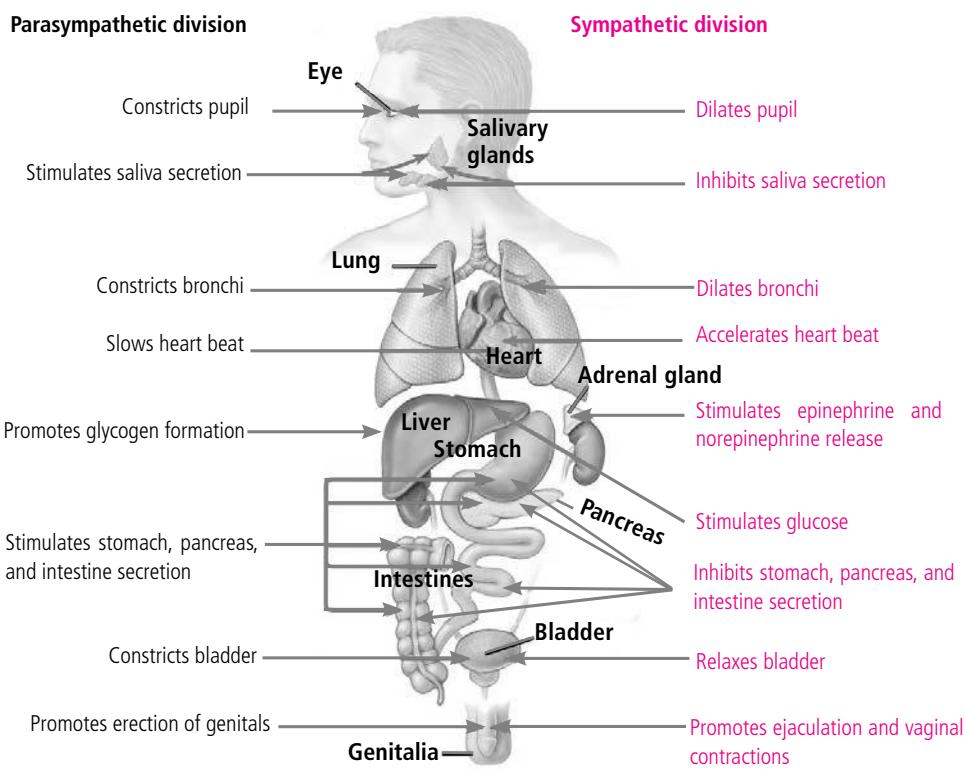


Fig.: Functions of autonomic neural system

**Table: Differences between sympathetic and parasympathetic neural system**

|                                  | Sympathetic neural system                                                                                          | Parasympathetic neural system                                                                                                                                                                                                                                 |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Anatomical differences</b>    |                                                                                                                    |                                                                                                                                                                                                                                                               |
| (i)                              | It has paired chains of ganglia and other visceral ganglia.                                                        | Chains of ganglia are absent. It has ganglia very close to the organ supplied.                                                                                                                                                                                |
| (ii)                             | Its preganglionic fibres originate from the spinal cord.                                                           | Its preganglionic fibres originate from the brain and spinal cord. Those preganglionic fibres which come from the brain run along with the III, VII, IX and X cranial nerves while those coming from spinal cord pass through 2,3 and 4 sacral spinal nerves. |
| (iii)                            | Its preganglionic fibres are shorter than the postganglionic fibres.                                               | Its preganglionic fibres are much longer than the postganglionic fibres.                                                                                                                                                                                      |
| (iv)                             | Each preganglionic fibre forms synapses with many postganglionic fibres, so many organs are affected.              | Each preganglionic fibre synapses with only a few postganglionic fibres, thus, only one organ may be affected.                                                                                                                                                |
| <b>Physiological differences</b> |                                                                                                                    |                                                                                                                                                                                                                                                               |
| (v)                              | Its postganglionic fibres are <b>adrenergic</b> i.e., release the neurotransmitter noradrenaline (norepinephrine). | Its postganglionic fibres are <b>cholinergic</b> i.e., release the neurotransmitter acetylcholine.                                                                                                                                                            |
| (vi)                             | It stimulates the medulla of the adrenal glands to release epinephrine and norepinephrine.                         | None.                                                                                                                                                                                                                                                         |

### SENSORY RECEPTORS

- The principle function of the special sensory receptors is to detect environmental stimuli and transduce their energy into electrical impulses. These are then conveyed along sensory neurons to the central nervous system, where they are integrated and processed, and a response is produced.

## Types of receptors

On the basis of stimuli they receive

### Mechanoreceptors

Respond to mechanical forces such as touch, pressure, vibration and itch by generating nerve impulses. Includes the receptors such as free nerve endings of sensory neurons, Merkel's discs, hair follicle endings, Pacinian corpuscles, muscle spindles and Golgi tendon organs.

### Thermoreceptors

Respond to temperature changes. Include free nerve endings and Krause's end bulbs.

### Chemoreceptors

Respond to chemical molecules. Include olfactory cells in the nasal mucosa and taste buds.

### Nociceptors

Respond to painful stimuli which may be damaging to tissues. Include free nerve endings.

### Photoreceptors

Respond to light energy. Include cones and rods in the retina.

- The most **complex sensory receptors**, are called sensory organs. They consist of numerous sense cells, sensory neurons and associated accessory structures, e.g., **eye** and **ear** have a level of complexity of sense organs.

## Eyes (Organs of Sight)

- Human eyes are spherical structures present in the bony sockets of the skull. Each eye is about 2.5 cm in diameter and consists of tissues present in three concentric layers:
  - Outer most layer consists of sclera and cornea.
  - Middle vascular layer consists of choroid, ciliary body and iris (also called uvea).
  - Inner most layer consists of retina.

## DAVID BALTIMORE



**D**avid Baltimore is an American biologist, University administrator and a Nobel laureate in Physiology or Medicine. From 1997 - 2006, he served as President of California Institute of Technology (Caltech) and is currently the President Emeritus and Robert Andrews Millikan Professor of Biology at Caltech.

He was born on March 7, 1938 in New York City to Gertrude and Richard Baltimore. He graduated from Great Neck High School in 1956 and earned his Bachelor's degree in Chemistry from Swarthmore College Pennsylvania in 1960. He developed his interest in molecular biology at cold spring harbor laboratory. He obtained his PhD in 1964 from Rockefeller University, New York. He made fundamental discoveries on virus replication and its effect on cell metabolism, including the first description of RNA replicase.

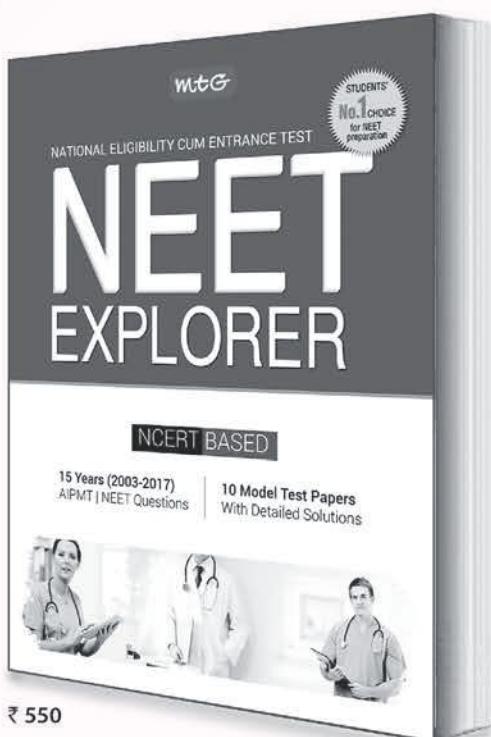
In February, 1965, Baltimore was recruited by Renato Dulbecco to the newly established Salk Institute for Biological Studies in La Jolla, there he investigated poliovirus RNA replication. He joined the faculty of MIT in 1968, accompanied by Alice S. Huang, a post doctoral fellow and the two worked together on vesicular stomatitis virus (VSV). Baltimore and Huang showed that vesicular stomatitis virus, an RNA virus reproduced itself by means of an enzyme RNA-dependent RNA polymerase that copies RNA by a process not involving DNA. In 1972, he was awarded tenure as a professor of Biology at MIT. In 1973, he became a professor of Microbiology at an American Cancer Society. He then turned his

attention to two RNA tumour viruses—Rauscher murine leukemia virus and Rous sarcoma virus. It was through these experiments that he discovered reverse transcriptase. This discovery proved an exception to the "central dogma" of genetic theory. Since its discovery reverse transcriptase has become an invaluable tool in recombinant DNA technology. Reverse transcriptase is essential for the production of retroviruses, allowing such viruses to turn viral RNA strands into DNA strands. They published these findings in the prestigious journal Nature.

In 1974, Baltimore was honored as a Fellow of the American Academy of Arts and Sciences. In 1975, he shared the Nobel Prize for Physiology or Medicine with Howard Temin and Renato Dulbecco. In 1980, Baltimore and his group published a paper regarding Abelson murine leukemia virus (AMuLV) and showed it was a member of new class of protein kinase that used the amino acid tyrosine as a phospho-acceptor. In 1999, Former U.S. President Bill Clinton awarded Baltimore, the National Medal of Science for his contribution to the scientific world. In 2005, he became member of the Encyclopedia Britannica Editorial Board Advisor and was elected in 2006 as President of American Association for advancement in science (AAAS). His laboratory at Caltech focus on two major research areas understanding the mammalian immune system and creating viral vectors to make the immune system more effective in resisting cancer. In recent research led by Jimmy Zhao, Baltimore's team has discovered a small RNA molecule called microRNA-146a and bred a strain of mice that lacks miR146a. Their results suggest that microRNA-146a protects HSCs during chronic inflammation and that its lack may contribute to blood cancers and bone marrow failure.



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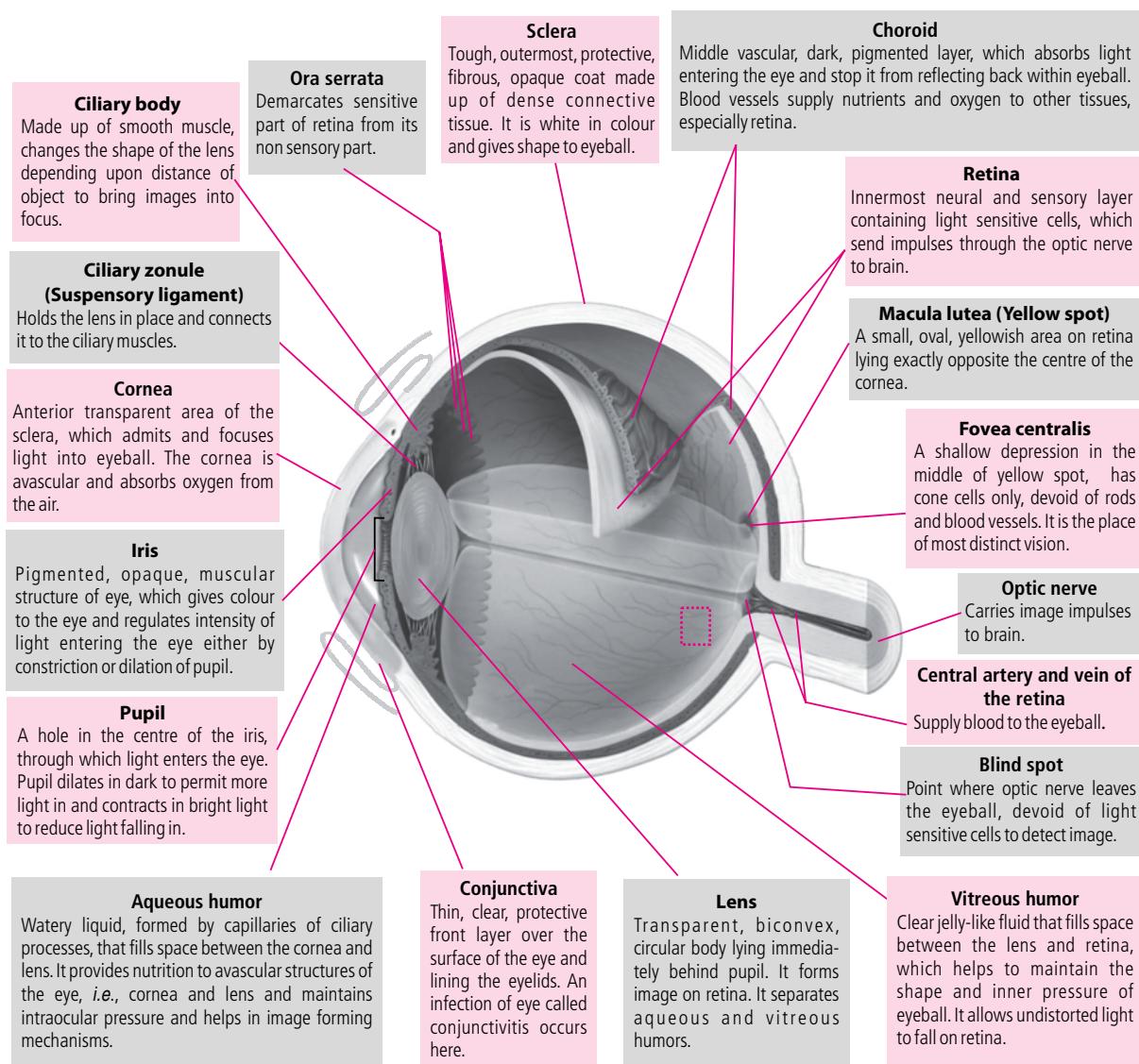


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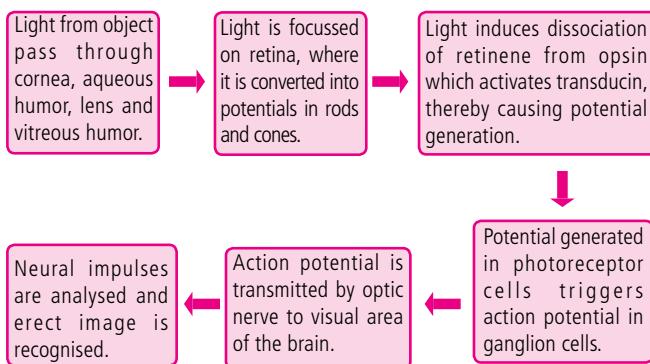
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## Structure of Human Eye



### Mechanism of Vision



### UNSCRAMBLED WORDS

JUNE 2017

- |                      |                   |
|----------------------|-------------------|
| 1-c- ENDOMETRIUM     | 2-a- MONGOLISM    |
| 3-b- ANGIOPLASTY     | 4-g- TROPHALLAXIS |
| 5-h- ERYTHROPOIETIN  | 6-e- FUCOXANTHIN  |
| 7-d- INTERDIGITATION | 8-f- PHYTOPHAGOUS |
| 9-j- APOSPORY        | 10-i- RAMENTA     |

Winners: Chaitanya Vattam (Hyderabad), Aswini Mura (Purba Medinipur), Pranjal Meshram (Chattisgarh), Prakriti Saini (Rohtak), Jennifer Minz (Bengaluru)

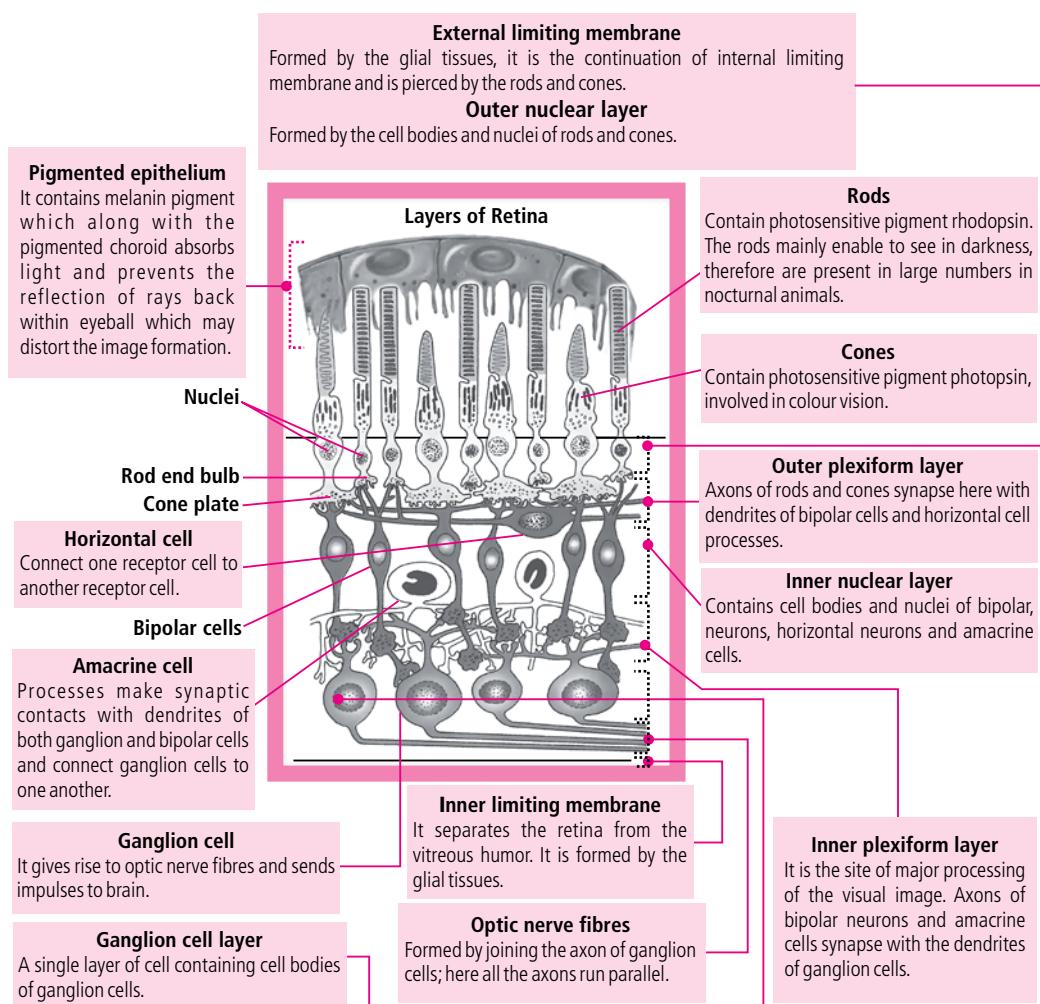
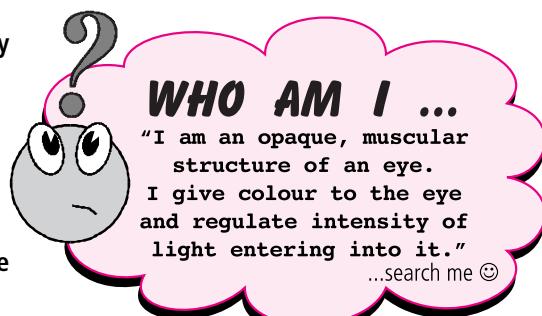


Fig.: Schematic diagram to show layers of retina and main structures therein

## Ear (Organs of Hearing)

- The ear is the organ that detects sound. It not only acts as a receiver for sound, but plays a major role in the balance and position of the body. It contains receptors that respond to movements of the head and receptors that convert sound waves into nerve impulses.
- Anatomically, the ear can be divided into three major sections: external, middle and inner ear.
- External ear** comprises of two parts, **pinna** and **external auditory canal**.
- Pinna is an oval, somewhat funnel-shaped, skin-covered flap of elastic cartilage and muscles. It collects sound waves and directs them into the external auditory canal.
- Middle ear** is formed of an air-filled cavity called **tympanic cavity** in the temporal bone that opens via the **auditory (Eustachian) tube** into the nasopharynx.
- The **tympanic membrane** separates the tympanic cavity from the external auditory canal.



- **Ear ossicles** are present which are a flexible chain of three small bones: the **malleus**, the **incus** and the **stapes**. The function of the ossicles is to transmit and amplify sound waves across the tympanic cavity from the tympanic membrane to the oval window of the inner ear (**fenestra ovalis**).
- **Inner ear** is a delicate, irregular organ called **membranous labyrinth** surrounded by **bony labyrinth** and separated from it by a narrow **perilymphatic space**. This space contains a watery fluid called **perilymph**. The membranous labyrinth is filled with another fluid called **endolymph**.
- The coiled portion of the labyrinth is called **cochlea**. It is the **main hearing organ** connected to the saccule. Internally, it consists of three fluid-filled chambers or canals. The middle chamber, called **scala media**, bears an upper membrane, the **Reissner's membrane**, and lower membrane, **basilar membrane**. On the basilar membrane a sensory ridge, the **organ of Corti** is present. Organ of Corti consists of **hair cells** (phonoreceptors), which bear 'hair' at the free surface and have synaptic contacts with the dendrites of neurons at the bases. The tips of 'hair' are embedded in a thin elastic membrane called **tectorial membrane** that determines the vibrations of sound waves.
- The inner ear also contains a complex system called **vestibular apparatus**. The vestibular apparatus is responsible for maintenance of balance of the body and posture.

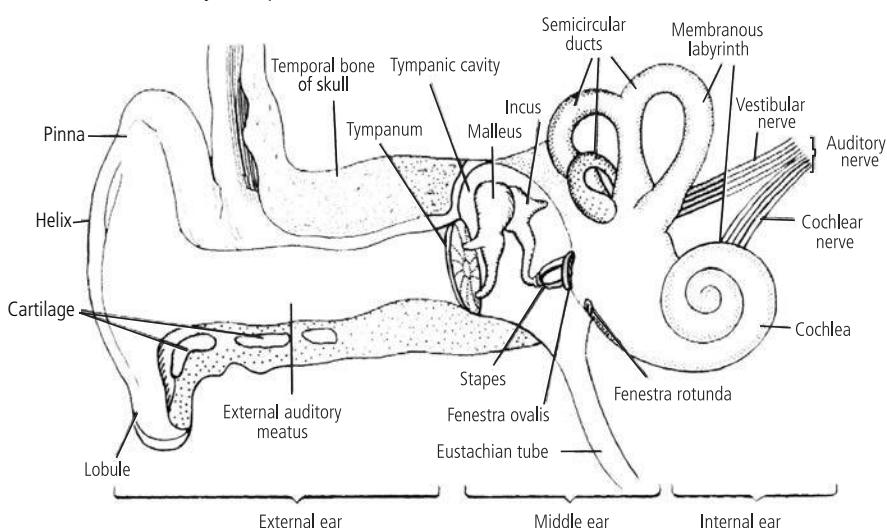
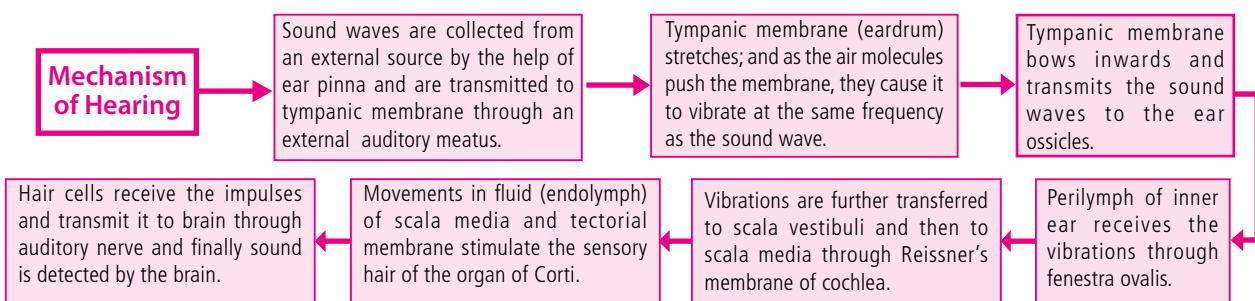


Fig.: The parts of human ear



#### MPP-4 CLASS XII

#### ANSWER KEY

- |         |         |         |         |         |
|---------|---------|---------|---------|---------|
| 1. (a)  | 2. (d)  | 3. (c)  | 4. (d)  | 5. (c)  |
| 6. (b)  | 7. (d)  | 8. (a)  | 9. (a)  | 10. (c) |
| 11. (c) | 12. (c) | 13. (a) | 14. (d) | 15. (c) |
| 16. (b) | 17. (a) | 18. (b) | 19. (b) | 20. (b) |
| 21. (d) | 22. (c) | 23. (d) | 24. (b) | 25. (c) |
| 26. (d) | 27. (a) | 28. (b) | 29. (a) | 30. (a) |
| 31. (d) | 32. (b) | 33. (d) | 34. (c) | 35. (a) |
| 36. (c) | 37. (d) | 38. (a) | 39. (b) | 40. (c) |

## Spellingon Winners

June-2017

1. Nidhi Agarwal, Dwarka (New Delhi)
2. Shobhit Singh (Meerut)

# SPEED PRACTICE

1. Increased olfactory sensation refers to
  - (a) hyperosmia (b) ageusia
  - (c) diplopia (d) alexia.
2. Select correct sequence of conduction of nerve impulse.
  - (a) High concentration of  $K^+$  in axoplasm  $\rightarrow$  Threshold stimulus  $\rightarrow$  Influx of  $Na^+$   $\rightarrow$  Action potential generation  $\rightarrow$  Efflux of  $K^+$
  - (b) High concentration of  $Na^+$  in axoplasm  $\rightarrow$  Depolarisation  $\rightarrow$  Threshold stimulus  $\rightarrow$  Repolarisation  $\rightarrow$  Action potential generation
  - (c) High concentration of  $K^+$  in the fluid outside axon  $\rightarrow$  Threshold stimulus  $\rightarrow$  Influx of  $K^+$   $\rightarrow$  Action potential  $\rightarrow$  Efflux of  $Na^+$
  - (d) Resting potential  $\rightarrow$  Depolarisation  $\rightarrow$  Threshold stimulus  $\rightarrow$  Efflux of  $Na^+$   $\rightarrow$  Action potential  $\rightarrow$  Repolarisation
3. Which of the following pair is incorrect?
 

| <b>Cerebral lobe</b> | <b>Function</b>                                         |
|----------------------|---------------------------------------------------------|
| (a) Parietal lobe    | – Register and communicate information from environment |
| (b) Occipital lobe   | – Interpretation of shape and colour                    |
| (c) Frontal lobe     | – Judgement and decision making                         |
| (d) Temporal lobe    | – Controls intellectual ability                         |
4. Which of the following pair is an example of unconditioned reflex?
  - (a) Breastfeeding and watering of mouth on seeing food
  - (b) Blinking of eyes and cycling
  - (c) Swallowing in new born baby and blinking of eyes
  - (d) Salivation on seeing food and cycling
5. The part of the brain associated with regulation of body temperature is
  - (a) corpus callosum (b) cerebellum
  - (c) hypothalamus (d) corpora bigemina.
6. Select an option that correctly fills the blanks.
  - I. Abducens nerve controls the movement of \_\_\_\_\_.
  - II. \_\_\_\_\_ is the longest cranial nerve.
  - III. The \_\_\_\_\_ nerves are motor nerves.
  - IV. All spinal nerves are of \_\_\_\_\_ type.

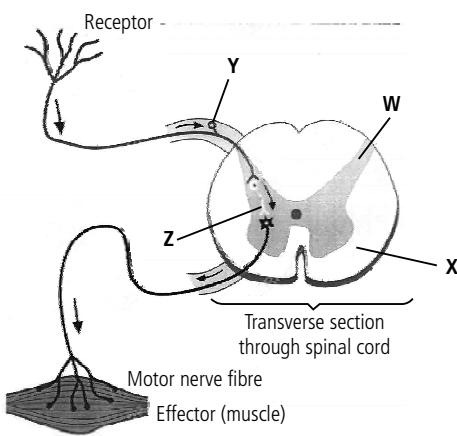
| I            | II         | III                        | IV      |
|--------------|------------|----------------------------|---------|
| (a) shoulder | Trochlear  | optical and oculomotor     | motor   |
| muscle       |            |                            |         |
| (b) pharynx  | Mandibular | facial and olfactory       | sensory |
| (c) tongue   | Trigeminal | facial and vagus           | mixed   |
| (d) eye ball | Vagus      | hypoglossal and oculomotor | mixed   |
7. Which part of human eye corresponds to light hole of camera?
  - (a) Lens (b) Pupil
  - (c) Retina (d) Cornea
8. Identify A, B, C and D in the given figure showing T.S. of cochlea and select the incorrect option.
  - (a) A and D are connected with other through helicotrema.
  - (b) B determines the patterns of vibration of sound waves.
  - (c) C is a sensory ridge present on the Reissner's membrane.
  - (d) D is filled with endolymph.
9. Match the following and select the correct option.
 

| <b>Column I</b>                    | <b>Column II</b>               |
|------------------------------------|--------------------------------|
| A. Pons varolii                    | (i) Thirst and centres satiety |
| B. Cerebellum                      | (ii) Cardiac centre            |
| C. Hypothalamus                    | (iii) Maintains body posture   |
| D. Medulla oblongata               | (iv) Limits inspiration        |
| (a) A-(iv), B-(iii), C-(i), D-(ii) |                                |
| (b) A-(iii), B-(i), C-(ii), D-(iv) |                                |
| (c) A-(ii), B-(i), C-(iii), D-(iv) |                                |
| (d) A-(iv), B-(i), C-(iii), D-(ii) |                                |
10. Which of the following functions is performed by the cerebrospinal fluid?
  - (a) Excretion of harmful metabolic wastes
  - (b) Transport of hormones to the brain
  - (c) Provides buoyancy to brain
  - (d) All of these
11. Select the incorrect difference between sympathetic and parasympathetic neural system.
 

| <b>Sympathetic Neural system</b>          | <b>Parasympathetic Neural system</b>   |
|-------------------------------------------|----------------------------------------|
| (a) Inhibits salivary gland secretion.    | Stimulates salivary gland secretion.   |
| (b) Promotes glycogen breakdown.          | Promotes glycogen formation.           |
| (c) Constricts urinary bladder.           | Dilates urinary bladder.               |
| (d) Postganglionic fibres are adrenergic. | Postganglionic fibres are cholinergic. |

- 12.** Read the given statements and select the correct option.
- The continuity between the pre-synaptic and post-synaptic neurons is provided by gap junctions in chemical synapses.
  - Release of calcium ions from pre-synaptic knob stimulates the release of neurotransmitter into synaptic cleft.
  - More energy is required for impulse conduction through myelinated neurons due to saltatory conduction.
  - After transmission of impulse, neurotransmitter is hydrolysed by an enzyme present at synapse.
- (a) I and II are correct but III and IV are incorrect.  
 (b) I and IV are correct but II and III are incorrect.  
 (c) I, II and III are correct but IV is incorrect.  
 (d) I, II and III are incorrect, but IV is correct.
- 13.** Which receptors respond to the heat?
- (a) Nociceptors      (b) Algesireceptors  
 (c) Caloreceptors      (d) Tangoreceptors
- 14.** Meninx piamater of brain is
- (a) innermost, vascular layer  
 (b) innermost layer with spider webby structure  
 (c) middle, tough fibrous layer  
 (d) outermost, avascular layer.
- 15.** Read the given statements and select the incorrect one.
- (a) Fenestra rotunda, an opening of middle ear into inner ear is covered by foot plate of the stapes.  
 (b) The iris controls the amount of light entering the eye by contracting the radial and circular muscles in dim and bright light respectively.  
 (c) Glands of Moll and glands of Zeis in eye are modified sebaceous glands which produce oily secretion to lubricate the corneal surface.  
 (d) Transformation of the vibrations into nerve impulses for relay to brains takes place in the internal ear.
- 16.** Photosensitive pigment found in cones
- (a) scotopsin      (b) photopsin  
 (c) rhodopsin      (d) porpyrosin.
- 17.** Read the given passage and select the correct option to fill the blanks.
- Neurons are the structural and functional unit of neural tissue and are longest cells in the body. Fully formed neurons remain in (i) of cell cycle throughout the life. Neurons with flask shaped cytons are called (ii) and are located in (iii) part of the brain.
- |                          |                |              |
|--------------------------|----------------|--------------|
| <b>(i)</b>               | <b>(ii)</b>    | <b>(iii)</b> |
| (a) G <sub>0</sub> phase | Purkinje cells | Cerebrum     |
| (b) Interphase           | Purkinje cells | Cerebellum   |
| (c) Interphase           | Perikaryon     | Pons varolli |
| (d) G <sub>1</sub> phase | Schwann cells  | Diencephalon |
- 18.** Read the given statements and select an option stating which ones are true (T) or false (F).
- Ageing neurons contain a pigment made up of a residual bodies derived from lysosomes.
  - Axon and cyton contains numerous mitochondria, Golgi apparatus, lysosomes, etc.
  - Cyton depends on axon for supply of proteins synthesised by Nissl's granules.
- |          |           |            |
|----------|-----------|------------|
| <b>I</b> | <b>II</b> | <b>III</b> |
| (a) T    | T         | F          |
| (b) T    | F         | F          |
| (c) F    | T         | T          |
| (d) F    | F         | T          |
- 19.** Read the following statements and select the correct option.
- Statement A :** Sweat secretion is under the control of autonomic neural system.
- Statement B :** Involuntary activities of various organs are under control of autonomic neural system.
- (a) Both statements A and B are correct.  
 (b) Statement A is correct but statement B is incorrect.  
 (c) Statement A is incorrect but statement B is correct.  
 (d) Both statements A and B are incorrect.
- 20.** Which plexus formed by spinal nerves innervates the pelvic region?
- (a) Cervical plexus      (b) Sacral plexus  
 (c) Lumbar plexus      (d) Coccygeal plexus
- 21.** Scattered masses of grey matter present in limbic system are
- (a) septal nuclei      (b) amygdala nuclei  
 (c) basal ganglia      (d) mammillary bodies.
- 22.** Which branch of largest cranial nerve have both sensory and motor fibres?
- (a) Maxillary      (b) Ophthalmic  
 (c) Mandibular      (d) Both (b) and (c)
- 23.** Which of the following statements is incorrect regarding vitreous humour present in an eye?
- (a) It is semi-solid jelly like substance present between cornea and lens.  
 (b) It maintains shape of an eyeball and provides nutrients to lens and cornea.  
 (c) It is continuously secreted by ciliary processes and is drained into canal of schlemm.  
 (d) None of these
- 24.** Action of which neurotransmitter is inactivated by an enzyme monoamine oxidase?
- (a) Acetylcholine      (b) Norepinephrine  
 (c) GABA      (d) Serotonin

25. Refer to the given figure and identify the correct option.



- (a) W is the grey matter containing bundles of myelinated nerve fibres.  
(b) X represents white matter of spinal cord and is so named as it lacks myelin.  
(c) Y is dorsal root ganglion containing cell bodies of sensory neurons.  
(d) Z is interneuron that forms synapse with cell bodies of motor neurons confined to grey matter.
26. The area of the cerebral cortex responsible for understanding speech and writing words is  
(a) parietal association area  
(b) Broca's area  
(c) Wernicke's area  
(d) Frontal association area.

27. During nerve impulse conduction, a membrane gets depolarised at

- (a) 0 mV (b) +30 mV  
(c) -70 mV (d) -55 mV.

28. The neurotransmitter released at all neuromuscular junctions between motor neurons and skeletal muscle cells is

- (a) norepinephrine (b) dopamine  
(c) acetylcholine (d) serotonin.

29. Which disease is caused due to destruction of neurons of basal ganglia that produce dopamine?

- (a) Neuralgia  
(b) Multiple sclerosis  
(c) Parkinson's disease  
(d) Korsakoff's syndrome

30. \_\_\_\_\_ is continuous with central canal of the spinal cord.

- (a) Cerebral aqueduct (b) Fourth ventricle  
(c) Foramen of Monro (d) Third ventricle

### ANSWER KEY

1. (a) 2. (a) 3. (d) 4. (c) 5. (c)  
6. (d) 7. (b) 8. (d) 9. (a) 10. (d)  
11. (c) 12. (d) 13. (c) 14. (a) 15. (a)  
16. (d) 17. (b) 18. (b) 19. (a) 20. (d)  
21. (c) 22. (c) 23. (d) 24. (b) 25. (d)  
26. (c) 27. (a) 28. (c) 29. (c) 30. (b)



## UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

### Column I

1. ALIMANINR
2. TEMEGAENISS
3. ONEDENRUUMI
4. SULGETINL
5. MECITINRS
6. LAPONYGOYL
7. MSAKC
8. LOHAPOARISETS
9. HDZTAIARIANC
10. OCOLTSUMR

### Column II

- (a) A layer of connective tissue that surrounds the myelinated nerve fibre.
- (b) Food reserve found in Sargassum.
- (c) Alternation of asexual and sexual phases in hydrozoans.
- (d) Drug obtained as by-product of heroin synthesis.
- (e) Parasites that are completely dependent on the host for their nutrition.
- (f) Secretion from mammary glands of a mother for the first 2-3 days after child birth.
- (g) Disorder in infants caused due to deficiency of thyroid hormone.
- (h) Natural insecticide obtained from margosa extract.
- (i) Group of storage proteins found in cereal grains.
- (j) Study of external morphology of mature pollen grains.

Readers can send their responses at [editor@mtg.in](mailto:editor@mtg.in) or post us with complete address by 25<sup>th</sup> of every month to win exciting prizes.

Winners' names will be published in next issue.



# NEET

## FOUNDATION

Class-11

Maximise your chance of success in NEET by reading this article. This section is specially designed to optimise your preparation by practising more and more. It is a unitwise series having chapterwise question bank, allowing you to prepare systematically and become more competent.

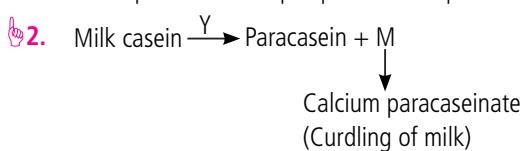
- 👉 Recall question or single concept question – indicated by a single finger.
- 👉 Application question or question which requires 2 or 3 concepts - indicated by 2 fingers.
- 👉 Application question or question which requires 3 or more concepts - indicated by 3 fingers.

### UNIT-IV : HUMAN PHYSIOLOGY

#### CHAPTER-16 : DIGESTION AND ABSORPTION

##### Multiple Choice Questions

- ↳ 1. Which of the following options correctly depicts the flow of bile from liver?  
(a) Liver → cystic duct → hepatic duct → gall bladder → bile duct → hepatopancreatic ampulla → duodenum  
(b) Liver → hepatic duct → gall bladder → cystic duct → bile duct → hepatopancreatic ampulla → duodenum  
(c) Liver → hepatic duct → gall bladder → cystic duct → bile duct → hepatopancreatic ampulla → ileum  
(d) Liver → cystic duct → gall bladder → bile duct → hepatic duct → hepatopancreatic ampulla → duodenum



In the above question letter 'Y' and 'M' denote

- (a) rennin and  $\text{Ca}^{++}$  respectively
- (b)  $\text{Ca}^{++}$  and renin respectively
- (c) rennin, HCl and  $\text{Ca}^{++}$  respectively
- (d) renin and  $\text{Ca}^{++}$  respectively.

- ↳ 3. The opening of bile duct before it unites with pancreatic duct is guarded by  
(a) ampulla of Vater      (b) sphincter of Oddi  
(c) Thebasian valve      (d) sphincter of Boyden.

- ↳ 4. The process by which liver cells synthesise glycogen by the action of insulin is called  
(a) glyconeogenesis      (b) glycolysis  
(c) glycogenolysis      (d) glycogenesis.
- ↳ 5. The salivary amylase is inactivated in stomach due to  
(a) absence of thiocyanate ions  
(b) presence of somatostatin  
(c) denaturation of enzyme by acidic pH in stomach  
(d) inhibition by enterokinase.
- ↳ 6. Which of the following options correctly describes the sequence of enzymes involved in digestion of proteins?  
 $\xrightarrow{\text{(i)}} \text{Proteins} \xrightarrow{\text{(ii)}} \text{Peptones} \xrightarrow{\text{(iii)}} \text{Dipeptides} \xrightarrow{\text{(iv)}} \text{Amino acids}$   
(a) (i) Pepsin ; (ii) Carboxypeptidase ; (iii) Trypsin  
(b) (i) Pepsin; (ii) Chymotrypsin; (iii) Trypsin  
(c) (i) Pepsin; (ii) Chymotrypsin; (iii) Dipeptidase  
(d) (i) Trypsin; (ii) Pepsin; (iii) Dipeptidase
- ↳ 7. Which of the following statements is correct regarding absorption of different nutrients?  
(a) Fructose is absorbed by active transport in stomach and small intestine.  
(b) Amino acids are absorbed in small intestine by passive transport.  
(c) Fatty acids and fat soluble vitamins are absorbed via facilitated transport in small intestine.  
(d) Water soluble vitamins are absorbed by simple diffusion in small intestine.

- 8.** Which of the following options is incorrect regarding digestion of fats?
- Lipase is present in pancreatic juice but absent in intestinal juice.
  - Emulsification of fat increases the action of lipase on fat.
  - Most of the fat is digested by pancreatic lipase in the small intestine.
  - Bile salts convert fat droplets into smaller ones by reducing their surface tension.
- 9.** Which one of the following is the correct matching of the site of action on the given substrate, the enzyme acting upon it and the end product ?
- Small intestine : Proteins  $\xrightarrow{\text{Pepsin}}$  Amino acids
  - Stomach : Fats  $\xrightarrow{\text{Lipase}}$  Micelles
  - Duodenum : Triglycerides  $\xrightarrow{\text{Trypsin}}$  Monoglycerides
  - Small intestine : Starch  $\xrightarrow{\alpha\text{-amylase}}$  Disaccharide (maltose)
- 10.** A typical tooth consists of crown, neck and root regions. Which of the following parts come under the crown region?
- Enamel, Dentine, Periodontal ligament
  - Enamel, Dentine, Cement
  - Enamel, Dentine, Odontoblasts
  - Enamel, Dentine, Gum

### Match The Columns

- 11.** Match Column I with Column II.
- | <b>Column I</b>       | <b>Column II</b>                          |
|-----------------------|-------------------------------------------|
| A. Valves of Kerkring | (i) Controls peristalsis                  |
| B. Auerbach's plexus  | (ii) Controls intestinal secretion        |
| C. Lacteal            | (iii) Increase surface area of absorption |
| D. Meissner's plexus  | (iv) Absorb fatty acids                   |
- 12.** Match Column I with Column II. (There can be more than one match for items in Column I).

| <b>Column I</b>           | <b>Column II</b>                                                   |
|---------------------------|--------------------------------------------------------------------|
| A. Gastrin                | (i) Inhibits the release of pancreatic juice                       |
| B. Pancreatic polypeptide | (ii) Stimulates gastric mobility                                   |
| C. Somatostatin           | (iii) Secreted by F-cell                                           |
| D. Glucagon               | (iv) Stimulates glycogenolysis                                     |
| E. Secretin               | (v) Slows down absorption of nutrients from gastrointestinal tract |
|                           | (vi) Secreted by $\alpha$ -cells                                   |
|                           | (vii) Inhibits secretion of glucagon and insulin                   |

- Decreases gastric secretion
- Increases secretion of bile
- Secreted by G-cell

### Passage Based Question

- 13.** Complete the given passage with appropriate words or phrases.

The enzymatic digestion of food starts in (i) where digestion of starch is carried out by (ii) in a slightly (iii) environment. Presence of (iv) in stomach inhibits action of gastric amylase on starch. When chyme reaches duodenum, Brunner's glands secrete (v) to withstand the acidity under the influence of vagus nerve and (vi). (vii) of pancreatic juice digests the remaining starch into maltose, isomaltose and (viii). These are further broken down by enzymatic action and converted into (ix). These are absorbed in stomach and (x) by active and facilitated transport.

### Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

- if both A and R are true and R is the correct explanation of A
- if both A and R are true but R is not the correct explanation of A
- if A is true but R is false
- if both A and R are false.

- 14. Assertion :** Many babies experience neonatal jaundice.  
**Reason :** Neonatal jaundice is caused due to poor functioning of liver for a week after birth.

- 15. Assertion :** Fatty acids are converted to chylomicrons and transferred into lymph capillaries called lacteals.  
**Reason :** Fatty acids cannot be directly absorbed into blood capillaries by simple diffusion.

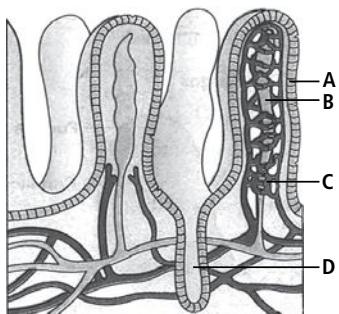
- 16. Assertion :** Sodium glycocholate present in bile activates proelastase.  
**Reason :** Sodium ions of sodium glycocholate act as cofactor of proelastase.

- 17. Assertion :** Protein digestion starts in the stomach, not in the buccal cavity.  
**Reason :** An absence of acidic environment in buccal cavity fails to activate proteases and peptidases.

- 18. Assertion :** *E.coli* inhabits the colon but is not killed by body defense system.  
**Reason :** *E.coli* produces cobalamin, thiamine and riboflavin.

### Figure Based Questions

- 19.** Refer to the following figure showing a longitudinal section of small intestinal mucosa and answer the following questions.



- (a) Identify the structures A, B, C and D.  
 (b) State the importance of finger-like foldings A.  
 (c) Name the cells which are present in structure D. What are the functions of these cells?
- 20.** Observe the figure showing salivary glands and their ducts in human and answer the following questions.
- 
- (a) Write the name of glands A, B and C. What are the functions of these glands?  
 (b) These glands release their secretions into the oral cavity through ducts P, Q and R. Name these ducts.
- CHAPTER-17 : BREATHING AND EXCHANGE OF GASES**
- Multiple Choice Questions**
- 1.** Select the incorrect statements.
- 97% of oxygen is carried as oxyhaemoglobin in the blood.
  - 70% of carbon dioxide is transported as bicarbonate ions in blood plasma.
  - 7% of carbon dioxide is transported in dissolved form in blood plasma.
  - 5% of oxygen is transported by blood in dissolved form.
- 2.** Which of the following set of conditions will shift the oxygen haemoglobin dissociation curve to left?
- Low pH, high temperature, increase in  $pCO_2$
  - High pH, low temperature, decrease in  $pCO_2$
  - High pH, high temperature, decrease in  $pCO_2$
  - Low pH, low temperature, increase in  $pCO_2$
- 3.** Which of the following shows the correct sequence of airflow from atmosphere to alveoli of lungs?
- External nares → Internal nares → Nasal cavities → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveolar duct → Alveoli
- 4.** Select the incorrectly matched pair.
- Respiratory membrane - Capillary endothelium
  - Trachea - Ciliated cuboidal epithelium
  - Alveoli - Squamous epithelium
  - Larynx - Ciliated columnar epithelium
- 5.** Bohr's effect is the phenomenon in which
- low pH of blood due to increase in  $CO_2$  concentration results in decreased dissociation of oxyhaemoglobin
  - high pH of blood due to increase in  $O_2$  concentration results in increased dissociation of oxyhaemoglobin
  - low pH of blood due to increase in  $CO_2$  concentration results in increased dissociation of oxyhaemoglobin
  - high pH of blood due to increase in  $CO_2$  concentration results in decreased dissociation of oxyhaemoglobin.
- 6.** Read the following statements and select the correct one.
- The volume of gas that diffuses through the membrane per minute for a pressure difference of 1 mm Hg is defined as diffusing capacity.
  - The high  $pCO_2$  in deoxygenated blood allows the release of  $CO_2$  from blood into the alveoli.
  - Diffusion of oxygen is 20 times faster than  $CO_2$  and that of  $CO_2$  is two times faster than nitrogen at the particular pressure difference.
  - Binding of oxygen with haemoglobin is important in promoting  $CO_2$  transport and its exchange in tissues and lungs.
- I, II and IV
  - II, III and IV
  - III and IV
  - All of these
- 7.** The respiratory disorder which leads to irreversible distension and loss of elasticity of alveoli of lungs is
- bronchitis
  - bronchial asthma
  - emphysema
  - SARS.

**MPP-4 CLASS XI**

**ANSWER KEY**

- |         |         |         |         |         |
|---------|---------|---------|---------|---------|
| 1. (d)  | 2. (c)  | 3. (b)  | 4. (c)  | 5. (c)  |
| 6. (a)  | 7. (c)  | 8. (c)  | 9. (c)  | 10. (b) |
| 11. (c) | 12. (d) | 13. (b) | 14. (a) | 15. (a) |
| 16. (c) | 17. (c) | 18. (a) | 19. (a) | 20. (b) |
| 21. (b) | 22. (b) | 23. (c) | 24. (a) | 25. (a) |
| 26. (c) | 27. (a) | 28. (a) | 29. (d) | 30. (a) |
| 31. (c) | 32. (a) | 33. (d) | 34. (d) | 35. (d) |
| 36. (c) | 37. (d) | 38. (b) | 39. (c) | 40. (c) |

- 8.** Hamburger's phenomenon can be described as the transport of  
 (a) chloride ions from RBCs into plasma  
 (b) bicarbonate ions from RBCs into plasma  
 (c) chloride ions from plasma into RBCs  
 (d) bicarbonate ions from plasma into RBCs.
- 9.** The functional residual capacity can be represented by  
 (a) IC + ERV                          (b) TLC – FRC  
 (c) ERV + RV                           (d) IC + RV.
- 10.** During the exchange of gases between lung alveoli and pulmonary capillaries, if the partial pressure of oxygen in alveolar capillaries is 95 mm Hg and the partial pressure of CO<sub>2</sub> is 45 mm Hg in deoxygenated blood. Based on this identify the correct statement.  
 (a) The partial pressure of oxygen will be highest, i.e., 104 mm Hg in alveoli.  
 (b) The partial pressure of nitrogen will remain same in both blood and alveoli.  
 (c) The partial pressure of CO<sub>2</sub> is less in pulmonary veins as compared to pulmonary arteries.  
 (d) All of these

### Match The Columns

**11.** Match Column I with Column II.

| <b>Column I</b>                       | <b>Column II</b>             |
|---------------------------------------|------------------------------|
| A. Bronchial asthma                   | (i) Pulmonary oedema         |
| B. Mountain sickness                  | (ii) Fibrosis                |
| C. Pneumonia                          | (iii) Release of histamine   |
| D. Occupational respiratory disorders | (iv) Inflammation of bronchi |
| E. Bronchitis                         | (v) Inflammation of alveoli  |

**12.** Match Column I with Column II. (There can be more than one match for items in Column I).

| <b>Column I</b>              | <b>Column II</b>                                                                                         |
|------------------------------|----------------------------------------------------------------------------------------------------------|
| A. Dorsal respiratory group  | (i) Dorsal part of pons Varolii                                                                          |
| B. Ventral respiratory group | (ii) Dorsal part of medulla oblongata                                                                    |
| C. Pneumotoxic centre        | (iii) Limits inspiration                                                                                 |
| D. Apneustic centre          | (iv) Ventrolateral part of medulla oblongata                                                             |
| E. Larynx                    | (v) Adam's apple<br>(vi) Lower part of pons Varolii<br>(vii) Initiates inspiration<br>(viii) Vocal cords |

- (ix) Initiates both inspiration and expiration
- (x) Controls depth of inspiration.

### Passage Based Question

**13.** Complete the given passage with appropriate words or phrases.

The exchange of gases between lung alveoli and pulmonary capillaries is called (i). It occurs through (ii). This membrane consists of alveolar epithelium, (iii), a thin interstitial space, (iv) and (v). All these layers form a membrane of (vi) mm thickness. The respiratory membrane has a limit of gaseous exchange between alveoli and pulmonary blood called (vii). The diffusing capacity is dependent on (viii) of the diffusing gases. The diffusion of gases from a higher to lower concentration leads to the movement of (ix) from alveoli to (x).

### Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

- (a) if both A and R are true and R is the correct explanation of A
- (b) if both A and R are true but R is not the correct explanation of A
- (c) if A is true but R is false
- (d) if both A and R are false.

**14. Assertion :** The conversion of CO<sub>2</sub> into bicarbonate ions is thousand times faster in RBCs.

**Reason :** RBCs contain carbonic anhydrase enzyme.

**15. Assertion :** Exhalation becomes more difficult in patients of emphysema.

**Reason :** In emphysema patients, the surface area for gas exchange is greatly reduced.

**16. Assertion :** External intercostal muscle is considered as the principle muscle of inspiration.

**Reason :** The external intercostal muscle contract to pull the ribs downward and inward increasing the volume of thoracic cavity.

**17. Assertion :** In women, thoracic breathing is predominant.

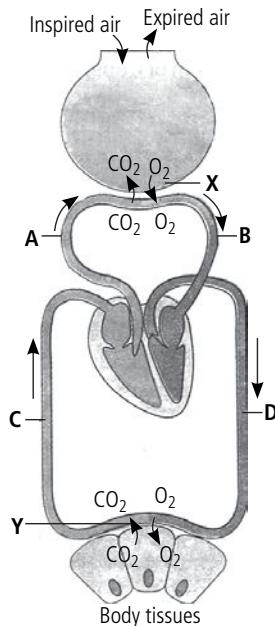
**Reason :** Breathing in women occurs through lateral movement of thorax.

**18. Assertion :** Mammals show positive pressure breathing.

**Reason :** Positive pressure breathing reduces the chances of blocking the trachea to allow eating and breathing simultaneously.

## **Figure Based Questions**

19. Refer to the given figure and answer the following questions.

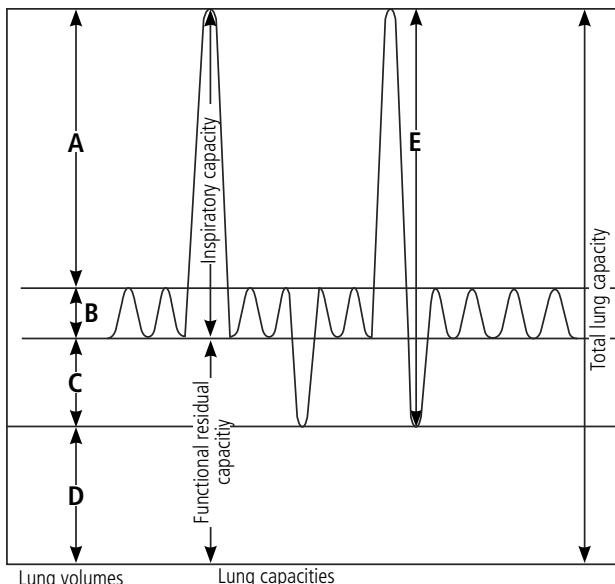


- (a) Identify the labelled parts A, B, C and D.

(b) Mention the partial pressure of  $O_2$  and  $CO_2$  at A and B.

(c) Which processes are represented by 'X' and 'Y'? Explain.

**20.** Refer to the given graph and answer the following questions.



- (a) Identify A, B, C and D.
  - (b) Define D mentioned in the above figure and state its volume.

- (c) Identify E and give the formula for calculating it. Suggest an example where volume of 'E' is found to be higher than normal.

## **CHAPTER-18 : BODY FLUIDS AND CIRCULATION**

## Multiple Choice Questions

- 7.** Which of the following statements is correct for cardiac cycle?
- The ventricular systole is stimulated by the SA node.
  - The first heart sound coincides with the closure of semilunar valves and relaxation of ventricles.
  - The blood flows from auricles to ventricles during the atrial systole via bicuspid and tricuspid valves.
  - The fall in ventricular pressure causes the closure of semilunar valve to prevent the back-flow of blood into ventricles.

- 8.** Select important functions of lymph.
- It absorbs and transports fat and fat soluble vitamins from intestine.
  - It regulates the pH of the body.
  - It transports nutrients, hormones, etc., to the body cell.
  - It destroys invading microorganisms.
- (i) only
  - (i), (iii) and (iv)
  - (i) and (ii) only
  - (i), (ii), (iii) and (iv)

- 9.** If the heart rate of a person has increased but the stroke volume is same. The cardiac output will
- increase
  - decrease
  - remains same
  - first increase then decrease.

- 10.** Which of the following statements is correct?
- Peripheral circulation is the flow of deoxygenated blood from the right ventricle to the lungs and return of oxygenated blood from the lungs to the left atrium.
  - Pulmonary circulation carries deoxygenated blood from pulmonary and bronchial arteries.
  - Hepatic portal system is a unique vascular connection which exists between digestive tract and heart.
  - Coronary circulation is the flow of oxygenated blood from ascending aorta to heart muscle and return of deoxygenated blood from heart muscle to the right atrium.

### Match The Columns

- 11.** Match Column I with Column II.

| Column I<br>(Types of leucocytes) | Column II<br>(Amount present in total leucocytes) |
|-----------------------------------|---------------------------------------------------|
| A. Lymphocytes                    | (i) 2-3%                                          |
| B. Basophils                      | (ii) 60-65%                                       |
| C. Eosinophils                    | (iii) 20-25%                                      |
| D. Neutrophils                    | (iv) 0.5-1%                                       |

- 12.** Match Column I with Column II (There can be more than one match for items in Column I).

| Column I             | Column II                                           |
|----------------------|-----------------------------------------------------|
| A. SA node           | (i) Transmits excitatory impulses to the ventricles |
| B. Sympathetic nerve | (ii) Increases cardiac output                       |

- AV node
- Parasympathetic nerve
- Pacemaker
- Decreases cardiac output
- Pacesetter
- Decreases the rate of heart beat
- Generates action potential
- Increases the rate of heart beat

### Passage Based Question

- 13.** Complete the given passage with appropriate words or phrases.

Cardiac cycle is a regular sequence of three events namely auricular systole, (i) and (ii). The number of cardiac cycles performed per minute are (iii). and the duration of one cardiac cycle is (iv). During a cardiac cycle, each ventricle pumps out approximately 70 mL of blood which is called (v). The amount of blood pumped by heart per minute is called (vi) which is approximately (vii) in a healthy individual. In an (viii) it will be higher than that of an ordinary man.

### Assertion & Reason

- In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :
- if both A and R are true and R is the correct explanation of A
  - if both A and R are true but R is not the correct explanation of A
  - if A is true but R is false
  - if both A and R are false.

- 14.** **Assertion :** Blood clot can be prevented in a test tube by adding a little oxalate.

**Reason :** Oxalate ions bind with Mg<sup>++</sup> ions and prevent them from forming prothrombinase.

- 15.** **Assertion :** Atherosclerosis occurs when there is fat deposition in tunica interna of large arteries.

**Reason :** Atherosclerosis is indicated by a flat T-wave in an electrocardiogram.

- 16.** **Assertion :** The pressure of blood in ascending aorta is more as compared to that in descending aorta.

**Reason :** The diameter of lumen of ascending aorta is slightly less than that of descending aorta.

- 17.** **Assertion :** Foramen ovale is the opening between two atria in fetus.

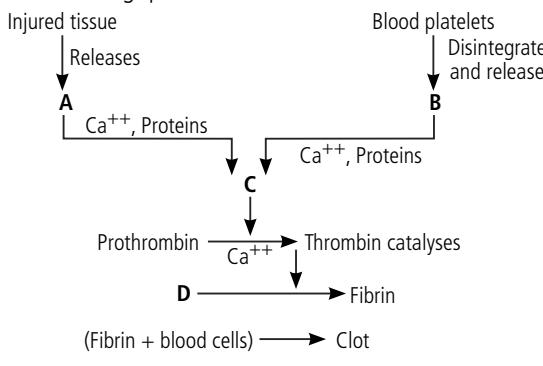
**Reason :** Foramen ovale compensates for the underdeveloped pulmonary circulation.

- 18.** **Assertion :** Aortic semilunar and pulmonary semilunar valves are open during joint diastole stage.

**Reason :** The opening of these valves results in filling the right and left ventricles with blood.

### Figure Based Questions

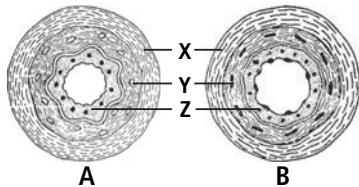
- 19.** Study the given flow chart of blood clotting and answer the following questions.



- (a) What does A and B represent?

- (b) Identify enzyme C formed from A and B.  
 (c) Thrombin acts as enzyme and brings depolymerisation of D. Identify D and state its significance.

- 20.** Refer to the given figure and answer the following question.



- (a) What do the figures A and B represent?  
 (b) Identify the labels X, Y, Z and mention their components.  
 (c) State any two significant differences between A and B with respect to their contribution in blood circulation.

### SOLUTIONS

#### CHAPTER-16 : DIGESTION AND ABSORPTION

1. (b)      2. (a)      3. (d)      4. (d)
5. (c)      6. (c)      7. (d)      8. (a)
9. (d)      10. (c)
11. A - (iii); B-(i); C-(iv); D-(ii)
12. A - (ii), (x); B-(i), (iii); C- (v), (vii); D-(iv), (vi), E-(viii), (ix)
13. (i) buccal cavity      (ii) salivary amylase  
 (iii) acidic      (iv) HCl  
 (v) mucoid fluid      (vi) secretin  
 (vii)  $\alpha$ -amylase      (viii)  $\alpha$ -dextrins  
 (ix) monosaccharides (x) jejunum
14. (a)      15. (c)      16. (d)      17. (c)
18. (b)
19. (a) A is villi, B is lacteal, C are capillaries and D is crypt of Lieberkuhn.  
 (b) The innermost lining of alimentary canal mucosa have small finger like foldings called villi. These are covered by a layer of columnar cells which have a 'brush border' appearance due to presence of microvilli. These modifications increase the absorptive surface of intestine.  
 (c) Following cells are present in crypts of Lieberkuhn-  
 (i) Goblet cells - secrete mucus that protects the duodenal wall from getting digested.  
 (ii) Argentaffin cells - synthesise secretin hormone and 5-hydroxytryptamine (5-HT).

- (iii) Paneth cells - secrete lysozyme and are capable of phagocytosis.

- 20.** (a) A is parotid gland, B is sublingual gland and C is submandibular gland. The parotid glands secrete much of salivary amylase or  $\alpha$ -amylase (= ptyalin). Sub-lingual and sub mandibular glands secrete salivary amylase and mucus. The fluids secreted by the salivary glands constitute saliva.  
 (b) P - Stenson's duct  
 Q - Ducts of Rivinus  
 R - Wharton's duct

#### CHAPTER-17 : BREATHING AND EXCHANGE OF GASES

1. (d)      2. (b)      3. (c)      4. (b)
5. (c)      6. (a)      7. (c)      8. (c)
9. (c)      10. (d)
11. A - (iii), B-(i), C-(v), D-(ii), E-(iv)
12. A - (ii), (vii), B-(iv), (ix), C-(i), (iii); D-(vi), (x); E- (v), (viii)
13. (i) external respiration      (ii) respiratory membrane  
 (iii) epithelial basement      (iv) capillary basement membrane  
 (v) capillary endothelium      (vi) 0.2  
 (vii) diffusing capacity      (viii) solubility  
 (ix) oxygen      (x) blood
14. (a)      15. (b)      16. (c)      17. (a)
18. (d)
19. (a) A - Pulmonary artery      B - Pulmonary vein  
 C - Systemic veins      D - Systemic arteries

- (b) The partial pressure of O<sub>2</sub> and CO<sub>2</sub>  
At A pO<sub>2</sub> = 40mm Hg  
pCO<sub>2</sub> = 45mm Hg  
At B pO<sub>2</sub> = 95mm Hg  
pCO<sub>2</sub> = 40mm Hg.
- (c) X represents the exchange of gases between lung alveoli and pulmonary capillaries which is called external respiration. Here the gases diffuse from a higher to lower concentration, thus oxygen enters blood from alveoli and CO<sub>2</sub> diffuses into alveoli from blood. Y represents the exchange of gases between blood capillaries and tissue cells, known as internal respiration. Here also, due to high partial pressure, oxygen enters tissue cells from the capillaries and CO<sub>2</sub> diffuses out from cells into the capillaries via tissue fluid.
20. (a) A - Inspiratory reserve volume (IRV)  
B - Tidal volume (TV)  
C - Expiratory reserve volume (ERV)  
D - Residual volume (RV)
- (b) Residual volume is the volume of air which still remains in the lungs, after the most forceful expiration. Its volume is about 1100 ml to 1200 ml.
- (c) E is vital capacity. It is defined as the maximum volume of air a person can breathe in after a forced expiration or maximum volume of air a person can breathe out after forced inspiration.  
It can be calculated as  $\Rightarrow VC = TV + IRV + ERV$ .  
(Tidal Volume + Inspiratory Reserve Volume + Expiratory Reserve Volume)  
Its capacity varies from 3400 mL to 4800 mL.  
Vital capacity is observed to be higher in athletes and mountain dwellers.
- CHAPTER-18 : BODY FLUIDS AND CIRCULATION**
1. (b)    2. (c)    3. (c)    4. (c)  
5. (a)    6. (a)    7. (c)    8. (b)  
9. (a)    10. (d)  
11. A - (iii), B-(iv), C-(i), D-(ii)  
12. A - (iii), (vii); B- (ii), (viii); C- (i), (v); D- (iv), (vi)  
13. (i) ventricular systole    (ii) joint diastole  
(iii) 72                                  (iv) 0.8 seconds  
(v) stroke volume                      (vi) cardiac output  
(vii) 5 litres                            (viii) athlete  
14. (c)    15. (b)    16. (c)    17. (a)  
18. (d)
19. (a) A - Thromboplastin    B - Platelet factor - 3  
(b) Enzyme prothrombinase is formed by the combination of factor A and B with Ca<sup>2+</sup> ions.  
(c) D is fibrinogen. Fibrinogen is a plasma protein that undergoes polymerisation to form insoluble polymer called fibrin that results in clot formation.
20. (a) Figure A represents T.S. of artery while figure B-represents T.S. of vein.  
(b) In the given figures,  
X is tunica adventitia or tunica externa, made up of connective tissue, Y is tunica media, made up of elastic connective tissue and smooth muscle fibres and Z is tunica interna, formed of elastic tissue of yellow fibres, i.e., elastic membrane and flattened squamous epithelial cells, i.e., endothelium.  
(c) The two significant differences between A (artery) and B (vein) are :  
(i) Arteries carry oxygenated blood (except pulmonary artery) and distribute blood away from heart to different parts of body, while veins carry deoxygenated blood (except pulmonary vein) and collect blood from different parts of body into the heart.  
(ii) The flow of blood is fast and under great pressure in arteries, therefore, they possess thick and muscular walls. On the other hand the flow of blood is not fast and under low pressure, therefore, veins have thin, non muscular walls. They also possess valves to prevent backward flow of blood.

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### SOLUTIONS TO JUNE 2017 CROSSWORD

|                 |                 |                 |                |                 |                 |                 |                 |                 |                 |                 |   |                 |                 |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---|-----------------|-----------------|-----------------|
| <sup>1</sup> C  | <sup>2</sup> H  | E               | <sup>3</sup> T | E               | R               | O               | C               | Y               | <sup>4</sup> S  | T               |   | <sup>5</sup> S  | <sup>6</sup> P  | <sup>7</sup> P  |
| O               |                 |                 | U              |                 | <sup>8</sup> P  | L               | A               | S               | T               | <sup>9</sup> I  | D | T               | E               | E               |
| N               | <sup>10</sup> P | E               | R              | O               | X               | I               | N               | <sup>11</sup> S | I               | N               |   | E               | D               | C               |
| G               | <sup>12</sup> C | H               | I              | T               | <sup>13</sup> I | N               | <sup>14</sup> P | U               | M               | H               |   | R               | I               | T               |
| R               | <sup>15</sup> F |                 | O              |                 | R               |                 | E               | B               | U               | I               |   | O               | C               | I               |
| E               | L               |                 | N              |                 | I               | P               | E               | L               | B               | <sup>16</sup> M | I | E               | N               |                 |
| S               | E               |                 | S              |                 | S               | O               | R               | U               | I               | Y               | D | L               | A               |                 |
| S               | X               | <sup>17</sup> C | Y              | A               | N               | O               | S               | I               | S               | N               | O | S               | <sup>18</sup> H | S               |
| I               | O               |                 |                | <sup>19</sup> A | U               | X               | I               | N               | <sup>20</sup> G | E               | M | M               | A               | <sup>21</sup> E |
| O               | R               | <sup>22</sup> P | A              | T               | E               | L               | L               | A               |                 |                 | A | <sup>23</sup> L | P               | C               |
| N               |                 |                 |                | <sup>24</sup> G | E               | N               | O               | M               | I               | C               | S | I               | T               | A               |
| <sup>25</sup> R | E               | S               | I              | N               |                 | <sup>26</sup> C | A               | N               | O               | P               | Y | C               | E               | D               |
| <sup>27</sup> T | A               | N               | S              | L               | E               | Y               |                 |                 |                 |                 |   | H               | N               | S               |
| <sup>28</sup> P | L               | A               | S              | M               | I               | D               | <sup>29</sup> H | I               | L               | U               | M | E               | S               |                 |
| <sup>30</sup> D | I               | A               | P              | E               | D               | E               | S               | I               | S               |                 |   | N               |                 |                 |

# HIGH YIELD FACTS



Class XI

## Biomolecules-II

- In the previous issue, we have discussed most of the macromolecules comprising the cellular pool *i.e.*, carbohydrates, lipids, proteins, nucleic acids, etc.
- The remaining important biomolecules such as enzymes are discussed here in continuation.

### ENZYMES

- Enzymes are usually the most remarkable and highly specialised proteins having an extraordinary catalytic power and high degree of specificity for their substrates.
- Enzymes are core to every biochemical process as they catalyse the stepwise reactions involving degradation of nutrient molecules, conservation and transformation of chemical energy as well as synthesis of biological macromolecules from simple precursors.
- Since enzymes are capable of catalysing reactions of biological origin and are synthesised by living cells only they are called biocatalysts.
- The term 'enzyme' was first coined by **Kuhne** (1877) for catalytically active substances.
- However the enzymes were first discovered and isolated by **Buchner** (1897). For this he was awarded Nobel Prize in 1903.
- Depending on their functioning inside or outside the cells, enzymes may be
  - Exoenzymes** : Functional outside living cells, *e.g.*, enzymes of digestive juices, lysozymes of tears etc.
  - Endoenzymes** : Functional inside living cells, *e.g.*, enzymes of Krebs' cycle (inside mitochondria) and glycolysis (in cytoplasm).

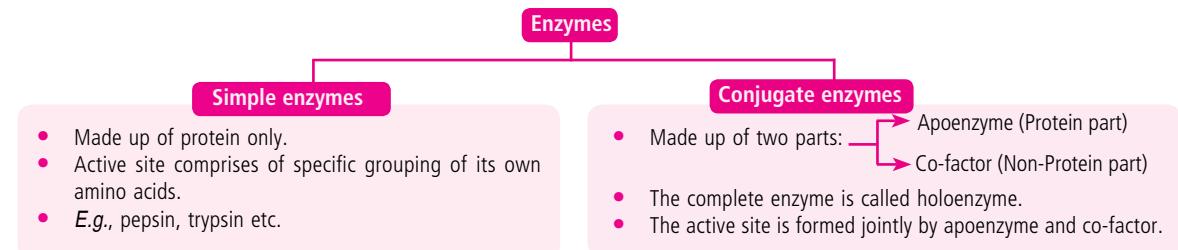
### Chemical Nature of Enzymes

- With the exception of a small group of catalytic RNA molecules, *e.g.*, ribozymes and ribonuclease P, all enzymes are globular proteins.
- Some enzymes may also contain non-proteinaceous molecules and metal ions that participate directly in substrate binding or catalysis.

|            | Analysis of various PMTs from 2013-2017 |      |      |      |      |
|------------|-----------------------------------------|------|------|------|------|
|            | 2013                                    | 2014 | 2015 | 2016 | 2017 |
| AIPMT/NEET | 4                                       | 2    | 2    | 6    | 2    |
| AIMS       | 2                                       | 1    | 4    | 2    | -    |
| AMU        | 5                                       | 10   | 3    | -    | -    |
| Kerala     | -                                       | 5    | 5    | -    | -    |
| K-CET      | -                                       | 1    | 1    | -    | -    |
| J & K      | -                                       | 2    | 2    | -    | -    |



- Based on presence or absence of non-protein group, enzymes are of two types:



- Co-factor** is small, heat stable and dialysable part of conjugate enzyme which may be organic or inorganic in nature.
- Organic co-factors are of two types: **Co-enzymes** and **prosthetic groups**.
- Co-enzymes** are easily separable non-protein organic co-factors that act as transient carriers of specific functional groups. Co-enzymes require two apoenzymes one for picking up the group and second for transferring the group e.g., NAD<sup>+</sup>, NADP<sup>+</sup>, CoA.
- Most of the co-enzymes are made up of water soluble vitamins B and C, e.g., thiamine, riboflavin, nicotinamide, pyridoxine, etc.
- Prosthetic groups** are non protein organic co-factors firmly attached to apoenzymes and take part in group transfer reactions, e.g., heme, biotin, pyridoxal phosphate.
- Inorganic co-factors** include ions of a variety of minerals, e.g., calcium, iron, copper, zinc, nickel, molybdenum etc. They usually function as activators by forming one or more coordination bonds with both the substrate and active site of enzyme.

**Table:** Differences between apoenzyme and coenzyme

|       | Apoenzyme                                                 | Coenzyme                                                                                                              |
|-------|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| (i)   | It is protein part of the holoenzyme or conjugate enzyme. | Coenzyme is the nonprotein organic group which gets attached to the apoenzyme to form holoenzyme or conjugate enzyme. |
| (ii)  | It is large in size.                                      | It is small in size.                                                                                                  |
| (iii) | An apoenzyme is specific for an enzyme.                   | A coenzyme can function as a cofactor for a number of enzymes carrying out that particular type of reaction.          |
| (iv)  | It takes part only in catalytic activity of the enzyme.   | It helps in removing a product of chemical reaction besides bringing contact between the substrate and the enzyme.    |
| (v)   | Apoenzyme does not help in group transfer.                | Coenzyme takes part in group transfer.                                                                                |
| (vi)  | Apoenzyme is thermolabile.                                | Coenzyme is heat stable.                                                                                              |

- Active site** of enzyme is the small portion of enzyme that takes part in catalysing biochemical reaction by attracting and holding particular substrate molecule by its specific charge, size or shape.
- Active site consists of a few amino acids and their side groups which are brought together in a particular fashion due to secondary and tertiary folding of a protein molecule and its association with the cofactor, if any. An enzyme may have more than one active site.
- The molecule or biochemical acted upon by an enzyme is known as **substrate** and if more than one biochemical are involved in a reaction, they are called **reactants**. The chemicals formed after the completion of reaction are called **products**.

**Table:** Some coenzymes that serve as transient carriers of functional groups

| Coenzyme                                                | Examples of chemical groups transferred | Dietary precursor in mammals         |
|---------------------------------------------------------|-----------------------------------------|--------------------------------------|
| Biocytin                                                | CO <sub>2</sub>                         | Biotin                               |
| Co-enzyme A                                             | Acyl groups                             | Pantothenic acid and other compounds |
| 5' - Deoxyadenosylcobalamin (coenzyme B <sub>12</sub> ) | H atoms and acyl groups                 | Vitamin B <sub>12</sub>              |
| Flavin adenine dinucleotide                             | Electrons                               | Riboflavin (vitamin B <sub>2</sub> ) |
| Lipoate                                                 | Electrons and acyl groups               | Not required in diet                 |

|                                   |                               |                             |
|-----------------------------------|-------------------------------|-----------------------------|
| Nicotinamide adenine dinucleotide | Hydride ion ( $\text{:H}^-$ ) | Nicotinic acid (niacin)     |
| Pyridoxal phosphate               | Amino groups                  | Pyridoxine (vitamin $B_6$ ) |
| Tetrahydrofolate                  | One-carbon groups             | Folate                      |
| Thiamine pyrophosphate            | Aldehydes                     | Thiamine (vitamin $B_1$ )   |

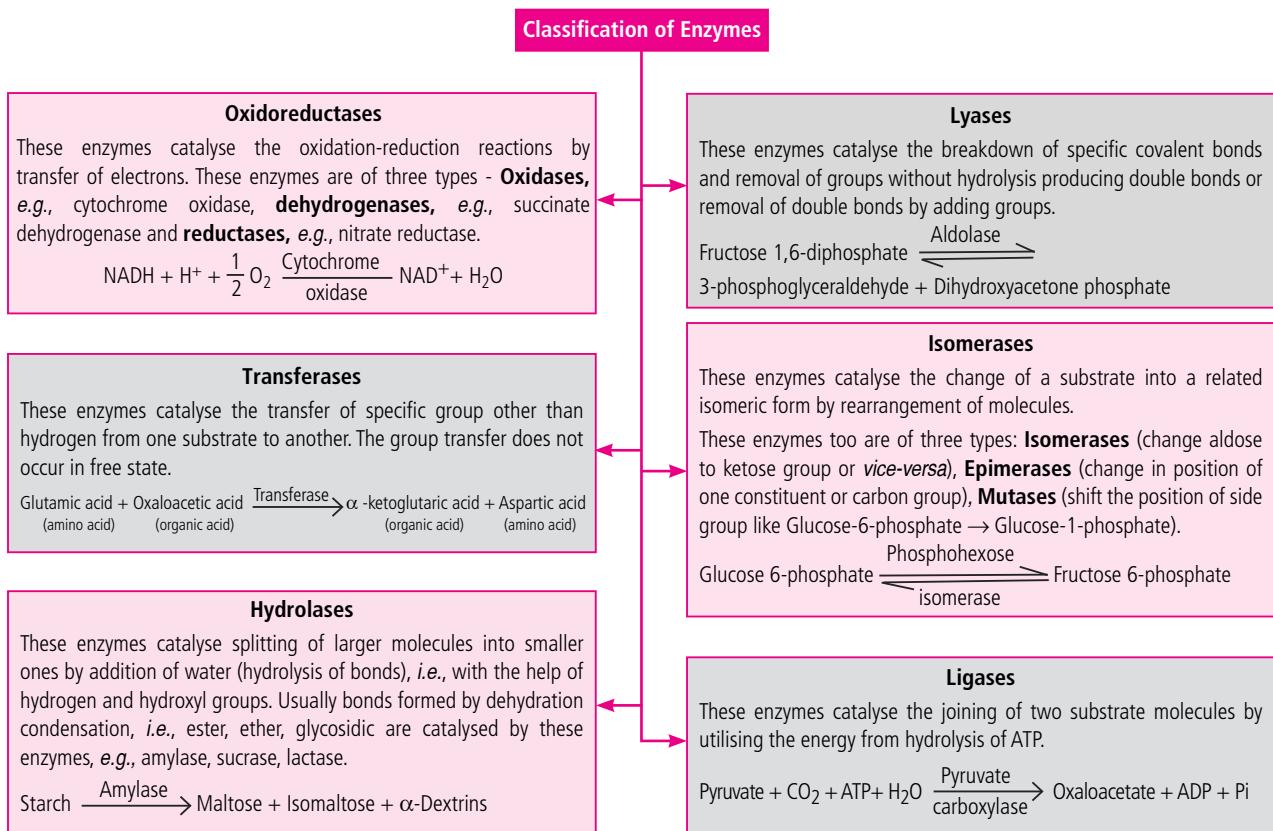
**Table:** Some inorganic ions that serve as cofactors for enzymes

| Ions                                 | Enzymes                                                              |
|--------------------------------------|----------------------------------------------------------------------|
| $\text{Cu}^{2+}$                     | Cytochrome oxidase                                                   |
| $\text{Fe}^{2+}$ or $\text{Fe}^{3+}$ | Cytochrome oxidase, catalase, peroxidase                             |
| $\text{K}^+$                         | Pyruvate kinase                                                      |
| $\text{Mg}^{2+}$                     | Hexokinase, glucose 6-phosphatase, pyruvate kinase                   |
| $\text{Mn}^{2+}$                     | Arginase, ribonucleotide reductase                                   |
| Mo                                   | Dinitrogenase                                                        |
| $\text{Ni}^{2+}$                     | Urease                                                               |
| Se                                   | Glutathione peroxidase                                               |
| $\text{Zn}^{2+}$                     | Carbonic anhydrase, alcohol dehydrogenase, carboxypeptidases A and B |



## Classification of Enzymes

- According to modern system of enzyme classification, introduced by **International Union of Biochemistry and Molecular Biology (IUBMB)** in 1961, enzymes are classified into six classes, based on the type of reaction catalysed.



## Characteristics of Enzymes

|                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Proteinaceous nature</b><br>Enzymes are usually globular proteins except two RNA enzymes.                                                                                                                                                                                          | <b>Colloidal nature</b><br>Enzymes are hydrophilic and form hydrosol in free state.                                                                                                                                                                                                                                                                 |
| <b>Efficiency</b><br>The efficiency of enzyme depends upon the number of active sites present over an enzyme. The number of substrate molecules changed per minute by an enzyme is called <b>turn over number</b> . The higher the turn over number, the more efficient an enzyme is. | <b>Reversibility</b><br>Almost all enzymatic reactions are reversible. However, reversibility is dependent upon energy requirements, availability of reactants, concentration of end products and pH.                                                                                                                                               |
| <b>Enzyme specificity</b><br>Enzymes are highly specific in their action. Different enzymes act on same substrate but give rise to different products. Similarly, an enzyme may act on different substrates to produce different end products.                                        | <b>Thermolabile</b><br>Enzymes are heat sensitive or thermolabile and operate between 25-35°C (optimum temperature range). They become inactive at freezing temperatures and denature at 50-55°C.                                                                                                                                                   |
| <b>Chain of reactions</b><br>Enzymatic reactions are not isolated, they occur in quick succession or a team of enzymes (complex) work together to perform multistep reactions.                                                                                                        | <b>Enzyme-substrate complex</b><br>The active sites of enzymes have crevices or conformations that fit in the substrates in a complementary fashion forming a complex known as enzyme substrate complex. The latter are changed into products. As soon as the products are released, the active sites become free to perform another catalytic act. |

## MECHANISM OF ENZYME ACTION

- The mechanism of enzyme action can be studied under two steps :

### Mechanism of Enzyme Action

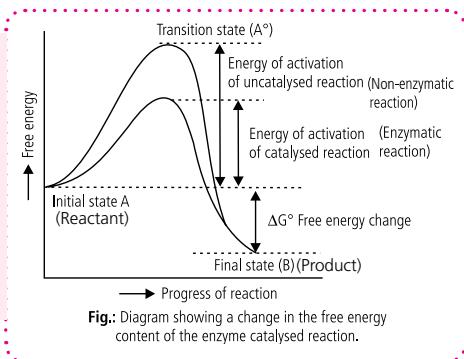
#### Lowering of Activation Energy

Most of the chemical reactions have an energy barrier separating the reactants and products.

Therefore an external supply of energy is needed for the start of chemical reaction. This energy is called **activation energy** which is quite high for the non-catalysed reactions and is lowered by the enzyme. The activation energy increases the kinetic energy of the system and brings about forceful collisions between the reactants. Enzyme lowers activation energy of a reaction by : taking the reactants out of solution state (desolvation), establishing weak bonds between reactants and enzymes, bringing reactant molecules, close to one another in the region of active sites and developing strain in reactants bonds by electrophilic and nucleophilic attack.

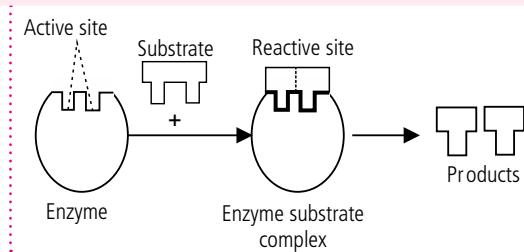
#### Formation of Enzyme-Substrate Complex

All enzymes have a specific three-dimensional structure and a part of it is known as **active site** into which substrate fits to proceed chemical reactions. The point where substrate is bound on the active site is known as the **substrate binding site**. The first step in an enzymatic reaction is that the enzyme forms a temporary association with its substrate called **enzyme substrate complex** (E – S complex). Following two models have been proposed to explain the formation of E – S complex.



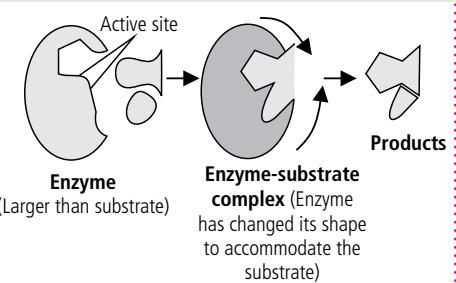
#### Lock and key hypothesis

**Emil Fischer** (1894) proposed that as a particular lock can be opened by only a particular key, similarly a substrate of specific shape fits into a specific active site on the enzyme surface. This suggests that both enzyme and substrate molecules have specific geometrical shapes and form an enzyme substrate (ES) complex. This also explains the **specificity** of enzyme action.



#### Induced fit hypothesis

**Koshland** (1959) proposed that the active sites of an enzyme are not rigid. When the substrate binds to an enzyme, it may induce conformational change in enzyme molecule in such a way that it is fit for the substrate-enzyme interaction.



**Table: Differences between lock and key and induced fit theories**

|       | <b>Lock and key theory</b>                                                          | <b>Induced fit theory</b>                                                                           |
|-------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| (i)   | Active site is a single entity.                                                     | Active site is made of two components.                                                              |
| (ii)  | There is no separate catalytic group.                                               | A separate catalytic group is visualised.                                                           |
| (iii) | Active site is static.                                                              | In contact with substratum, the buttressing group undergoes conformational change.                  |
| (iv)  | Development of transition state is not considered.                                  | It considers the development of transition state before the reactants undergo change.               |
| (v)   | It does not visualise the weakening of substrate bonds.                             | Catalytic group is believed to weaken the substrate bonds by nucleophilic and electrophilic attack. |
| (vi)  | It does not explain the mechanism of non-activity in case of competitive inhibitor. | It gives a mechanism for non-action over competitive inhibitor.                                     |

#### Temperature

An enzyme is active within a narrow range of temperature. The temperature at which an enzyme shows its highest activity is called **optimum temperature**. The optimum temperature for most of the enzymes is between 25°C - 35°C. Temperature above and below this range affects the enzyme activity. High temperature above 50°C destroy enzymes by causing their denaturation and very low temperature preserves the enzymes in the inactive state.

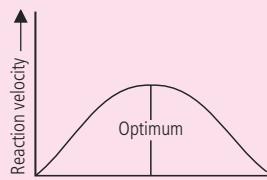


Fig.: Relation between temperature and enzyme controlled reaction velocity

#### Enzyme concentration

The rate of enzymatic reaction increases with the increase in enzyme concentration upto a point called **saturation point**. Above this limit, there is little effect on enzyme activity.

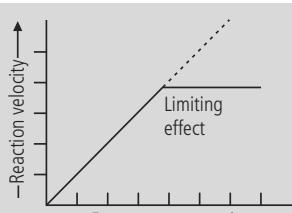


Fig.: Effect of enzyme concentration on the rate of biochemical reaction

### Factors Affecting Enzyme Activity

#### pH

Enzymes work at their own optimum pH. A rise or fall in pH reduces enzyme activity by changing the degree of ionisation of its side chains. Most of the intracellular enzymes function near neutral pH with the exception of several digestive enzymes that are active either at acidic or alkaline pH range.

#### Substrate concentration

Initially the rate of enzymatic reaction increases with the increase in substrate concentration. In beginning, the velocity of reaction is high but later it does not increase progressively with the increase in substrate concentration. It happens because enzyme molecules get fully saturated and no active site is left free to bind additional substrate.

#### Activators and poisons

Some chemical substances or molecules increase activity of enzymes such as co-factors, e.g., K<sup>+</sup>, Mn<sup>2+</sup> etc. On the other hand, salts of heavy metals and compounds such as cyanides, azides, iodoacetate destroy tertiary structure of enzymes thus affecting enzyme activity.

### Michaelis-Menten Equation

- Michaelis-Menten equation mathematically illustrates the relationship between initial reaction velocity and substrate concentration.
- Here, the Km (Michaelis Menten constant) is a mathematical derivative which indicates the substrate concentration at which the chemical reaction catalysed by an enzyme attains half its maximum velocity.
- Km indicates affinity of the enzyme for its substrate. A high Km indicates low affinity while a low Km indicates strong affinity.
- The Km value generally lies between 10<sup>-1</sup> to 10<sup>-6</sup> M.
- K<sub>m</sub>, the Michaelis-Menten constant (or Brig's and Haldane's constant), is given by the formula  $K_m = \frac{k_2 + k_3}{k_1}$ , here k<sub>1</sub>, k<sub>2</sub> and k<sub>3</sub> represent the velocity constants for the respective reactions as shown below.

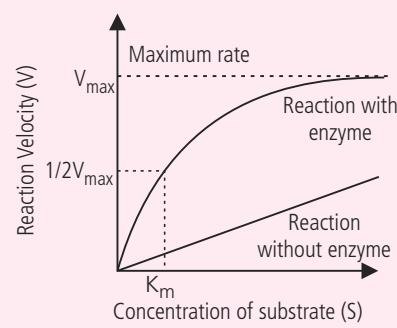
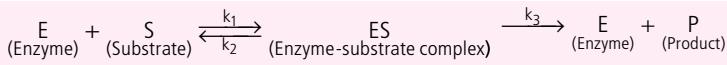


Fig.: Effect of substrate concentration on reaction velocity with or without enzyme.



The Michaelis-Menten equation obtained after suitable algebraic manipulation is  $V = \frac{V_{\max}[S]}{K_m + [S]}$  where  $V$  = Measured velocity,  $V_{\max}$  = Maximum velocity,  $S$  = Substrate concentration,  $K_m$  = Michaelis-Menten constant.

## INHIBITION OF ENZYME ACTION

- The reduction or cessation of enzyme activity due to presence of certain adverse conditions or chemicals is called enzyme inhibition.

### Enzyme Inhibition

#### On the basis of nature of inhibition

##### Reversible inhibition

- Temporary inhibition that can be overcome by withdrawal of inhibition.
- It occurs due to blocking of active site or binding to linkages required for maintenance of active site.
- It is characterised by rapid dissociation of enzyme inhibitor complex.
- Dilution and dialysis reduces or eliminates the effect of reversible inhibition.

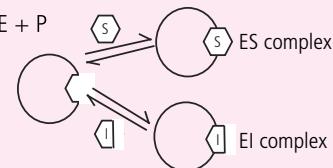
##### Irreversible inhibition

- Permanent inhibition of enzyme due to the change or destruction in conformation of enzyme.
- It occurs due to covalent binding of heavy metals or other inhibitors with the enzymes, resulting in their inactivation.

#### On the basis of causes of inhibition

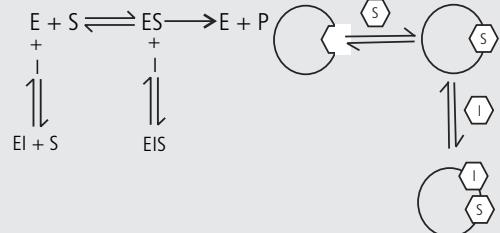
##### Competitive Inhibition

- The inhibitor ( $I$ ) closely resembles the real substrate ( $S$ ), and is regarded as a **substrate analogue**. The inhibitor competes with substrate and binds at the active site of the enzyme, but does not undergo any catalysis. As long as the competitive inhibitor holds the active site, the enzyme is not available for the substrate to bind.
- Competitive inhibition is usually reversible.
- The classical example of competitive inhibition is enzyme **succinate dehydrogenase** with succinic acid as its substrate. Malonate, oxaloacetate are its inhibitor which resemble succinic acid.



##### Non-Competitive Inhibition

- The inhibitor binds at a site other than the active site on the enzyme surface. This binding impairs the enzyme function. The inhibitor has no structural resemblance with the substrate. It does not interfere with the enzyme-substrate binding but the catalysis is prevented, possibly due to a distortion in the enzyme conformation.
- Non-competitive inhibition is usually irreversible because it cannot be overcome by increasing substrate concentration.
- The inhibitor ( $I$ ) generally binds with the enzyme as well as the ES complex.
- Common example of non-competitive inhibition is inhibition of respiratory enzyme cytochrome oxidase by cyanide that combines with its metallic ions. It has no structural similarity with the substrate of the enzyme cytochrome  $c$ .



##### Uncompetitive inhibition

- A rarely encountered inhibition called uncompetitive inhibition is also known where inhibitor binds only to the ES complex.
- Uncompetitive inhibition cannot be overcome as the ESI complex cannot form product.

##### Allosteric inhibition (Feedback inhibition)

- It is a type of reversible inhibition found in allosteric enzymes. The inhibitor is non-competitive and is usually a low molecular weight intermediate or product of a metabolic pathway having a chain of reactions involving a number of enzymes. It is, therefore, also called end product or **feed back inhibition**.
- The inhibitor is also called **modulator**. Modulator is a substance that attaches with an allosteric enzyme at a site other than catalytic one but influences the latter, either inhibiting or activating the same.
- An example of feed back or allosteric inhibition is stoppage of activity of enzyme **hexokinase** (glucokinase) by **glucose-6-phosphate**, the product of reaction catalysed by it.

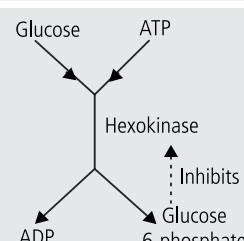


Fig.: Feedback or allosteric inhibition of hexokinase.

**Table: Differences between competitive inhibition and allosteric inhibition**

|       | <b>Competitive Inhibition</b>                                                | <b>Allosteric Inhibition</b>                                                                |
|-------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| (i)   | The inhibitor binds to the active site of enzyme.                            | The inhibitor attaches to an area other than the active site.                               |
| (ii)  | It does not change conformation of enzymes.                                  | Conformation of enzyme is changed.                                                          |
| (iii) | The active site is swamped by inhibitor.                                     | Conformation of active site is changed so that substrate cannot combine with it.            |
| (iv)  | The inhibitor resembles the substrate in its broad structure.                | The inhibitor has no structural similarity with the substrate.                              |
| (v)   | The inhibitor is not connected by metabolic pathway catalysed by the enzyme. | Inhibitor is a product or intermediate of the metabolic pathway connected with that enzyme. |
| (vi)  | It does not have a regulatory function.                                      | It has a regulatory function as it stops the excess formation of a product.                 |

## Significance of Enzymes

### Biological Importance

Enzymes are highly regulated by activation and repression of genes, allowing some enzymes to be functional or non-functional as per requirement.

Operate under favourable conditions, enabling the organism to live under favourable environment only.

Mediates thousands of chemical reactions occurring inside living cells.

### Economic Importance

Various enzymes have been isolated for their wide uses and commercial purposes.

#### Alcoholic beverages

Enzyme complex zymase obtained from yeast is used in brewing or fermentation of alcoholic drinks.

#### Detergents

Amylases are used as detergents for machine, dishwashing to remove resistant starch residues. Lipases are used to assist in removal of fatty and oily stains.

#### Baby foods

Enzyme trypsin is used to partially predigest baby foods.

#### Digestive aids

Several enzymes such as diastase are prescribed to patients with deficient digestive juices.

#### Cheese

Enzymes such as rennet and lactase are employed in preparation of cheese and to impart consistency and flavour to it.

#### Diagnostics

ELISA (Enzyme linked immunosorbent assay) is an enzyme based technology used for detection of diseases such as AIDS.

## METABOLITES

- Metabolites are biomolecules or organic compounds that are constantly utilised (catabolism) or formed (anabolism) in various metabolic reactions occurring inside the cells.
- Plants and microbes produce several organic compounds that may be required for their basic metabolic process while at the same time they also synthesise compounds that do not participate in metabolic pathways.
- On this basis, metabolites are of two types :

### Types of Metabolites

#### Primary metabolites

Some of the organic compounds like carbohydrates, fats, proteins, nucleic acids, etc., are required for basic metabolic processes and are directly involved in normal growth, development and reproduction. These organic compounds are called primary metabolites.

#### Secondary metabolites

Many plants, fungi and microbes of certain genera synthesise a number of organic compounds which are not involved in primary metabolism (photosynthesis, respiration, protein and lipid metabolism) and seem to have no direct function in growth and development of plants. These compounds are called secondary metabolites e.g., gum, resin, rubber etc.

#### Isoprenoids or terpenes

e.g., rubber, steroids, carotenoids.

#### 'N' containing compounds

e.g., alkaloids, glycosides, glucosinolates

#### Phenolic compounds

e.g., tannins, flavonoids, lignin etc.

### Role of Secondary Metabolites

- Some of them attract animals for pollination and seed dispersal.
- They act as agents of plant-plant competition.
- They help plants in defense against herbivores and pathogens.
- They are also used in making drugs, flavours, gums, resins, insecticides etc.

**Table: Some secondary metabolites**

|        |                      |                                 |
|--------|----------------------|---------------------------------|
| (i)    | Pigments             | Carotenoids, anthocyanins, etc. |
| (ii)   | Alkaloids            | Morphine, codeine, etc.         |
| (iii)  | Terpenoides          | Monoterpene, diterpenes etc.    |
| (iv)   | Essential oils       | Lemon grass oil, etc.           |
| (v)    | Toxins               | Abrin, ricin                    |
| (vi)   | Lectins              | Concanavalin A                  |
| (vii)  | Drugs                | Vinblastin, curcumin, etc.      |
| (viii) | Polymeric substances | Rubber, gums, cellulose         |

**Table: Differences between primary and secondary metabolites**

|       | Primary metabolites                                                                   | Secondary metabolites                                                                    |
|-------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| (i)   | These are biomolecules required for basic metabolic processes.                        | These are derivatives of primary metabolites which are not involved in basic.            |
| (ii)  | These are produced in generous quantities and can easily be extracted from the plant. | These are produced in small quantities and their extraction from the plant is difficult. |
| (iii) | These are found throughout the plant kingdom.                                         | Particular secondary metabolites are found in one plant species or families and not all. |
| (iv)  | These are part of the basic molecular structure of the cell.                          | These are not part of the basic molecular structure of the cell.                         |
| (v)   | They are highly useful to plant.                                                      | They have limited role in plant.                                                         |
| (vi)  | They are found from the beginning of plant life.                                      | They are found at particular stages of development.                                      |

# **SPEED PRACTICE**

1. Study the given table and identify A, B, C and D.

| Class (Enzymes) | Type of reaction catalysed            |
|-----------------|---------------------------------------|
| <b>A</b>        | Transfer of electrons                 |
| Transferases    | <b>B</b>                              |
| <b>C</b>        | Transfer of functional group to water |
| Isomerases      | <b>D</b>                              |

|     | <b>A</b>         | <b>B</b>                 | <b>C</b>         | <b>D</b>                     |
|-----|------------------|--------------------------|------------------|------------------------------|
| (a) | Ligases          | Transfer of hydride ion  | Oxido-reductases | Transfer of H atom           |
| (b) | Hydrolases       | Hydrolysis reaction      | Lyases           | Transfer of ion              |
| (c) | Oxido-reductases | Group transfer reactions | Hydrolases       | Intramolecular rearrangement |
| (d) | Lyases           | Transfer of H atom       | Ligases          | Transfer of electron         |

2. Match column I with column II and select the correct option from the given codes.

- | Column I                           | Column II       |
|------------------------------------|-----------------|
| A. Catalase                        | (i) $Zn^{2+}$   |
| B. Salivary amylase                | (ii) $Cu^{2+}$  |
| C. Carboxypeptidase                | (iii) $Fe^{2+}$ |
| D. Cytochrome oxidase              | (iv) $Cl^-$     |
| (a) A-(iv), B-(iii), C-(ii), D-(i) |                 |
| (b) A-(iii), B-(iv), C-(i), D-(ii) |                 |
| (c) A-(iii), B-(ii), C-(i), D-(iv) |                 |
| (d) A-(i), B-(ii), C-(iii), D-(iv) |                 |
3. A low  $K_m$  indicates
- (a) low affinity of the enzyme for its substrate
  - (b) high affinity of the enzyme for its substrate
  - (c) substrate concentration decreases at which chemical reaction attains maximal velocity
  - (d) negligible affinity of the enzyme for its substrate.

# CONCEPT MAP

# TRANSCRIPTION

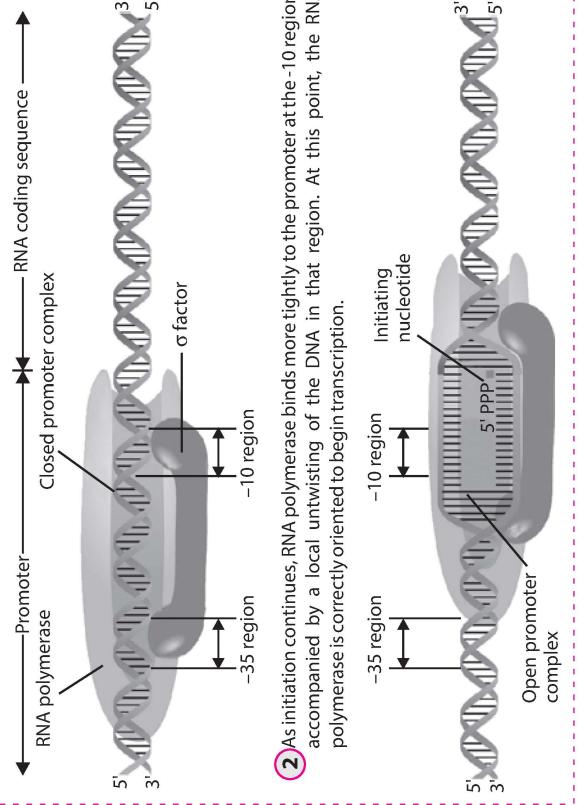
Transcription is the process of copying of genetic information from template strand of DNA to an RNA molecule. Template strand refers to DNA strand that directs synthesis of RNA and have  $3' \rightarrow 5'$  polarity. The other strand having  $5' \rightarrow 3'$  polarity is called antisense strand. RNA synthesis occurs in  $5' \rightarrow 3'$  direction and requires an enzyme complex called RNA polymerase and other initiation and termination proteins.

## TRANSCRIPTION UNIT

Refers to the sequence of nucleotides in DNA that codes for an RNA molecule along with other sequences necessary for transcription.

### IN PROKARYOTES

- Transcription takes place in cytoplasm.
- Structural genes** are **polycistronic** i.e., encodes for more than one polypeptide.
- Promoters** include (i)  $-10$  sequence "is TATAAT; called "Pribnow box".
- (ii)  $-35$  sequence "is TTGACA, called "recognition sequence".
- Only one type of RNA polymerase is involved, represented by  $(\alpha\beta\beta'\omega)\sigma$ .



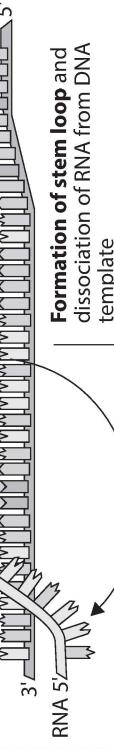
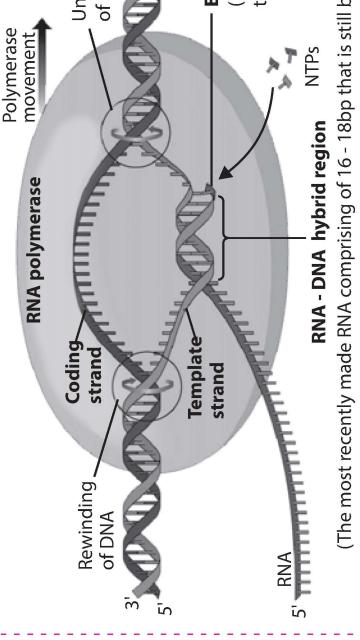
### MECHANISM OF TRANSCRIPTION

#### Initiation

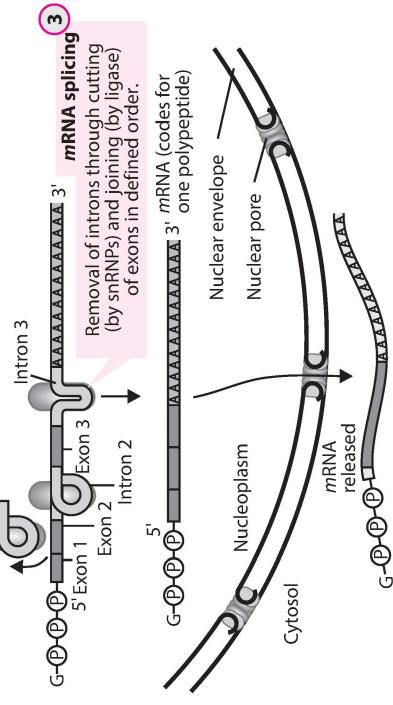
Just before initiation, RNA polymerase and accessory proteins bind to a DNA molecule upstream of the initiation point. The DNA is unwound to separate and expose the strand to be transcribed. Then, the RNA polymerase complex binds to promoter sequence, which initiates transcription. Polymerase begins to synthesise a strand of RNA complementary to one side of the DNA strand, moving into the coding sequence portion of the gene being transcribed. The enzyme and the factors involved are different in both eukaryotes and prokaryotes.

#### Elongation

During elongation, a lengthening RNA molecule is synthesised by DNA polymerase as it reads the DNA triplet code on the template strand. The DNA polymerase will continue reading the template until it reaches a sequence that provides a signal indicating that transcribed region is at an end. Another RNA polymerase can attach to the promoter to begin synthesising another RNA before the first one is finished.



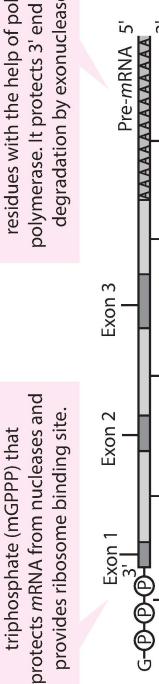
- Termination** may or may not require rho ( $\rho$ ) factor.
- mRNA do not undergo any processing and may undergo translation before the completion of transcription i.e., coupled as both the processes takes place in cytosol and in  $5' \rightarrow 3'$  direction.
- Most prokaryotic mRNAs terminate with the sequence 5'-UUUUUA-3', which allows nascent transcript to form **hairpin loop** that disrupts the RNA-DNA hybrid as well as the interaction between DNA and polymerase resulting in dissociation and termination of transcription of RNA molecule.



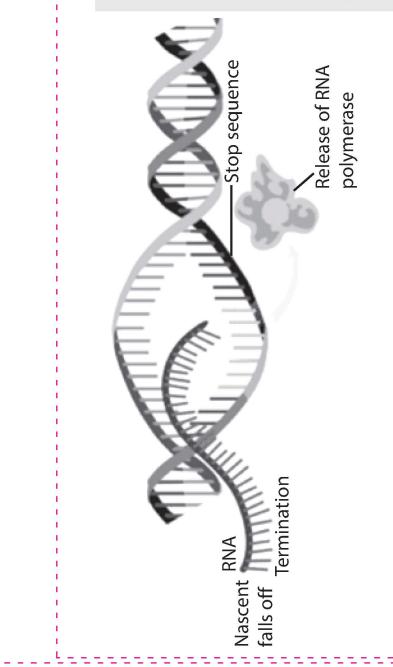
### Post Transcriptional Modifications of hnRNA

#### Tailing

Addition of 200-300 polyadenylate residues with the help of poly A polymerase. It protects 3' end from degradation by exonucleases.



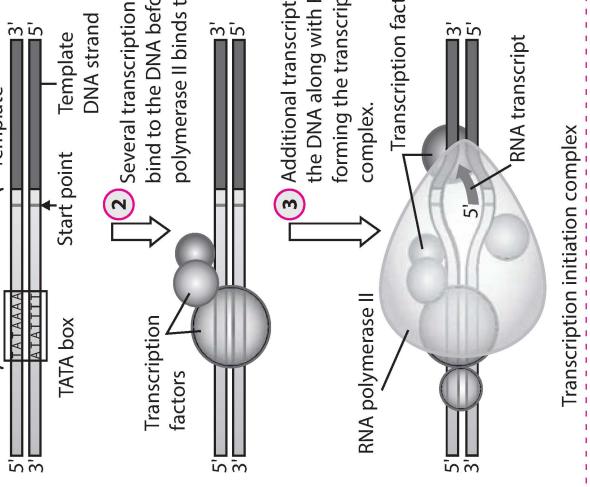
**Termination** - Coupled transcription - translation is not possible in eukaryotes, as transcription products i.e., RNA pass from nucleus to cytoplasm for translation. The nascent RNA i.e., hnRNA or primary transcript undergoes modifications to form functional mRNA.



Termination of transcription is triggered when the RNA polymerase encounters a particular DNA sequence, causing the polymerase to lose affinity for the DNA template. At this point, RNA polymerase disengages from the DNA and the RNA molecule is released for translation or post-transcriptional processing.

### IN EUKARYOTES

- An eukaryotic promoter includes a TATA box and CAAT box.



### STRUCTURAL GENES

(RNA-coding sequence)

(Termination sequence)

3' - Non-template strand

5' - Template strand

Transcription termination site

Downstream of gene

### Promoter

(Binding site for RNA polymerase)

+1

5' -

DNA

3'

Transcription initiation site

Upstream of gene

### Terminator

(Termination sequence)

3'

Non-template strand

5' - Template strand

Transcription termination site

Downstream of gene

- 4.** Fumarase catalyses conversion of fumarate to malate at pH 6.2. What will be the effect on this reaction if the pH is increased to 7.5?  
 (a) Krebs' cycle will stop.  
 (b) Fumarate will change directly to oxaloacetate.  
 (c) Fumarate will convert to succinate.  
 (d) Malate will convert to fumarate.
- 5.** Refer to the given list of secondary metabolites and select the correct option.  
 (i) Concanavalin A      (ii) Vinblastin  
 (iii) Morphine      (iv) Ricin  
 (v) Carotenoid      (vi) Anthocyanin  
 (vii) Codeine      (viii) Abrin  
 (ix) Curcumin
- | <b>Pigments</b> | <b>Alkaloids</b> | <b>Toxins</b> | <b>Lectin(s)</b> | <b>Drug(s)</b> |
|-----------------|------------------|---------------|------------------|----------------|
| (a) (v), (vi)   | (iii), (vii)     | (iv), (viii)  | (i)              | (ii), (ix)     |
| (b) (i), (vi)   | (ii), (v)        | (vii)         | (iii), (ix)      | (iv), (viii)   |
| (c) (v), (vi)   | (iii), (vii)     | (i), (viii)   | (iv), (ii)       | (ix)           |
| (d) (iii), (vi) | (v), (i)         | (vii), (viii) | (iv), (ii)       | (ix)           |
- 6.** Consider the following statements and select the correct option.  
 I. All the enzymes are proteinaceous in nature.  
 II. The enzymatic reactions may be reversible or irreversible.  
 III. Enzymes denature at both low and high temperatures.  
 IV. All enzymes are active at optimum pH of 7.0.  
 (a) I and III      (b) II only  
 (c) IV only      (d) II and IV
- 7.** In induced fit theory,  
 (a) the active site is a single entity  
 (b) there is no separate catalytic group  
 (c) the active site is static  
 (d) the development of transition state before the reactants changes.
- 8.** Di-isopropyl fluorophosphate (DFP), is a nerve gas that prevents impulse transfer by combining with amino acid serine of acetylcholine esterase. It is an example of  
 (a) competitive inhibition  
 (b) non-competitive inhibition  
 (c) protein denaturation  
 (d) allosteric inhibition.
- 9.** During an enzymatic reaction, the activation energy  
 (a) decreases to increase the kinetic energy of system  
 (b) increases to decrease the kinetic energy of system  
 (c) required is higher in case of exothermic reactions  
 (d) all of these.

- 10.** Read the following statements and fill up the blanks with correct options.  
 (i) The complete conjugate enzyme consists of a protein portion called \_\_\_\_\_.  
 (ii) \_\_\_\_\_ is a non-protein cofactor which is loosely bound to an apoenzyme.  
 (iii) \_\_\_\_\_ enzyme is used for removing blood clots inside blood vessels.
- | <b>(i)</b>     | <b>(ii)</b>      | <b>(iii)</b>  |
|----------------|------------------|---------------|
| (a) holoenzyme | Prosthetic group | Trypsin       |
| (b) coenzyme   | Apoenzyme        | Diastase      |
| (c) apoenzyme  | Coenzyme         | Streptokinase |
| (d) apoenzyme  | Holoenzyme       | Trypsin       |
- 11.** Read the following statements and select the incorrect ones.  
 I. Proenzyme is the active precursor of an enzyme.  
 II. Enzymes are mostly produced in the zymogen state.  
 III. The enzymes become reactive only at their optimum temperature.  
 IV. An enzyme catalyses specific reaction of a single or only a few substrates.  
 (a) I and II      (b) III and IV  
 (c) I and III      (d) I, II and III
- 12.** Which of the following is not a function of secondary metabolite?  
 (a) Acts as agents of competition between plants  
 (b) Helps in defense against herbivores  
 (c) Used in degumming of silk  
 (d) Attract animals for pollination and seed dispersal
- 13.** An enzyme such as alcohol dehydrogenase occurs in multiple molecular forms with similar substrate activity. Such enzymes are called  
 (a) allosteric enzymes      (b) isozymes  
 (c) holoenzymes      (d) proenzyme.
- 14.** Read the following statements regarding enzyme inhibition and select the incorrect ones.  
 I. In allosteric inhibition, the inhibitor attaches to active site.  
 II. Competitive inhibition changes the conformation of enzyme.  
 III. In competitive inhibition, the product of the metabolic pathway itself acts as inhibitor.  
 IV. Allosteric inhibition has a regulatory function as it stops the excess formation of a product.  
 (a) I, II and III      (b) I and IV  
 (c) III and IV      (d) II, III and IV

- 15.** Michaelis Menten constant is a mathematical derivative that indicates the
- concentration of products formed at the end of enzymatic reaction
  - substrate concentration at which the reaction catalysed by an enzyme attains half of its maximum velocity
  - substrate concentration at which the reaction catalysed by an enzyme attains its maximum velocity
  - rate of increase in velocity of enzyme reaction due to increase in substrate concentration.
- 16.** Select the incorrectly matched pair for the type of enzyme inhibition and their respective inhibitors involved.
- Competitive inhibition - Sulpha drugs
  - Non-competitive inhibition - Cyanide
  - Allosteric inhibition - Iodoacetamide
  - Irreversible inhibition - Iodoacetic acid
- 17.** Select the correct statement regarding allosteric enzymes.
- These are molecular variants of a single enzyme showing same active site for binding of various substrates.
  - These are enzymes having separate sites for binding of various modulators that may alter the conformation of active site.
  - Allosteric activator binds to the active site so as to make it active in absence of substrate.
  - Lactate dehydrogenase is an example of allosteric enzyme.
- 18.** The role of a coenzyme during enzymatic reaction is to
- pick up product of the reaction
  - transfer the product picked up to another reactant
  - bring substrate in contact with the enzyme
  - all of these.
- 19.** Select the correctly matched pair.
- Amylase - Preparation of cheese
  - Protease - Added in baby foods
  - Pectinase - Preparation of green coffee
  - Lipase - Softening of meat
- 20.** The turn over number of an enzyme refers to
- number of substrate molecules changed per minute by an enzyme
  - the efficiency of enzyme in terms of number of active sites present over it
  - increase in rate of reaction
  - both (a) and (b).



## EARTH IS ON BRINK OF SIXTH MASS EXTINCTION

Scientists say 25% of all mammals and 13% of birds are at risk as humans corner resources

Humans are bringing about the sixth mass extinction of life on Earth, according to scientist writing in a special edition of the leading journal Nature. Mammals, birds and amphibians are currently becoming extinct at rates comparable to the previous five mass extinctions that occurred across the past 500 million years when "cataclysmic forces", such as massive meteorite strikes and super volcano explosions, wiped out vast swathes of life, including the dinosaurs.

The growing human population which has increased by 130 percent in the last 50 years and is set to rise to more than 10 billion by 2060 and our increasing demand for resources as we become wealthier, ramping up the pressure on the natural world. Tens of thousands of species, including 25 percent of all mammals and 13 percent of birds, are now threatened with extinction because of over-hunting, poaching, pollution, loss of habitat, the arrival of invasive species and other human-caused problems.

But the researchers said it was not "inevitable" that this process would continue. There is still time for humans to turn the situation around by protecting habitats, changing our diets to less land-intensive food and taking other forms of conservation.

In one of a series of papers in Nature, a team of international scientists wrote:

"There is overwhelming evidence that habitat loss and fragmentation, over-exploitation of biological resources, pollution, species invasions and climate change have increased rates of global species extinctions to levels that are much higher than those observed in the fossil records." This loss of biodiversity could "substantially diminish the benefits that people derive from nature", they warned.

In order to preserve such "ecosystem services", policies should be designed to "secure the valuable and often irreplaceable benefits of biodiversity for future generations, even under conditions of rapid global change" the paper added.

Another paper painted a bleak picture of humans' long history of wiping out other animals. Human-influenced extinctions began when modern humans moved out of Africa it said. Successive waves of extinctions in Australia (50,000 years ago), North America and South America (10,000-11,000 years ago) and Europe (3,000-12,000 years ago) were driven largely by a combination of hunting by humans and natural climate change. By 3,000 years ago, Earth had lost half of all terrestrial mammalian megafauna species and 15 percent of all bird species.

The researchers said that since 1500 AD, human destruction of wildlife had accelerated. It said urgent action was needed to ensure that sufficient habitats will remain to preserve the viability of species in the long term and to guarantee that such habitats are well managed.

Courtesy : The Times of India

# MPP-4

## MONTHLY Practice Problems

Class XI

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

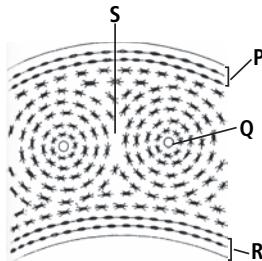
- Structural Organisation in Animals
- Cell : The Unit of Life



Total Marks : 160

Duration : 40 Min.

- The epithelium present in the descending limb of loop of Henle is
  - simple cuboidal epithelium
  - simple columnar epithelium
  - simple ciliated epithelium
  - simple squamous epithelium.
- Study the given diagram showing transverse section of mammalian bone and select the incorrect option regarding P, Q, R and S.



- P forms an envelope around bone and contains osteoblasts which produce new bone material.
- Q represents Haversian canals in bone matrix and are interconnected by Volkmann's canals.
- R comprises of inactive bone cells called osteocytes and white fibrous tissue.
- S represents canaliculi, which connects osteocyte with another.
- Identify the tissue from the given functions.
  - Collagen fibres are present in rows between many parallel bundles of fibres.
  - Presence of this tissue at joints between skull bones makes them immovable.
  - Loose connective tissue
  - Dense regular connective tissue
  - Dense irregular connective tissue
  - Hyaline cartilage

- Bidder's canal is found in
  - kidney of mammal
  - testes of frog
  - kidney of frog
  - ovary of mammal.
- In a sodium potassium exchange pump, when one ATP is hydrolysed, the number of  $\text{Na}^+$  ions pumped outward and  $\text{K}^+$  ions pumped inward, respectively are
  - two, three
  - one, two
  - three, two
  - two, one.
- Complete the following table by correctly identifying A, B and C.

|       | Connective tissue                 | Location             | Function                                     |
|-------|-----------------------------------|----------------------|----------------------------------------------|
| (i)   | Yellow elastic connective tissues | A                    | Provides strength and elasticity             |
| (ii)  | B                                 | Rings of trachea     | Forms embryonic skeleton in bony vertebrates |
| (iii) | White fibrous cartilage           | Intervertebral discs | C                                            |

|     | A                      | B                   | C                                       |
|-----|------------------------|---------------------|-----------------------------------------|
| (a) | Walls of blood vessels | Hyaline cartilage   | Acts as a cushion and provides strength |
| (b) | Periosteum of bone     | Hyaline cartilage   | Provides articulation                   |
| (c) | Cornea of the eyeball  | Calcified cartilage | Allows stretching of pubic symphysis    |
| (d) | Nasal septum           | Calcified cartilage | Provides flexibility to organs          |

- 7.** Select the incorrect statement with reference to cockroach.
- Ecdysone secreted by prothoracic glands controls moulting of body wall of the nymph.
  - The atrial part of a spiracle possesses a valve and bristly plate to filter out dust particles.
  - The secretion of uricose glands form the outermost layer of spermatophore.
  - Anal styles are present in the 9<sup>th</sup> sternum of male cockroach only.

- 8.** Read the given statements and select the correct option.

**Statement A :** In the nymph of cockroach, neotinin is secreted by a paired structure called corpora allata.

**Statement B :** Neotinin regulates the development and functioning of reproductive organs.

- Both statements A and B are correct and B is the correct explanation of A.
- Both statements A and B are correct but B is not the correct explanation of A.
- Statement A is correct but statement B is incorrect.
- Both statements A and B are incorrect.

- 9.** Bone resorption is brought about by

- osteocytes
- osteoblasts
- osteoclasts
- osteoprogenitor cells.

- 10.** The ovaries in a female cockroach are located in the segments

- 3<sup>rd</sup> to 5<sup>th</sup>
- 2<sup>nd</sup> to 6<sup>th</sup>
- 6<sup>th</sup> to 8<sup>th</sup>
- 4<sup>th</sup> to 8<sup>th</sup>.

- 11.** Identify the correct statements with reference to the ultrastructure of nucleus.

- Perinuclear space separates the two membranes of the nuclear envelope.
  - Some proteins present in nucleoplasm are essential for spindle formation.
  - The lightly stained condensed fibrous part of chromatin is called heterochromatin.
  - Nucleolus is the main site for the development of ribosomal RNAs.
- I and II
  - II and IV
  - I, II and IV
  - III only

- 12.** The cell organelle which takes part in the storage and synthesis of lipids is

- peroxisome
- glyoxysome
- aleuroplast
- sphaerosome.

- 13.** Cell membrane was discovered by (i) in year (ii). Most recent fluid mosaic model of biomembrane was given by (iii).

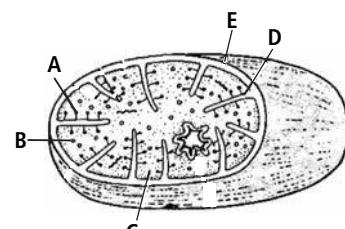
- | (i)                   | (ii) | (iii)               |
|-----------------------|------|---------------------|
| (a) Plowe             | 1855 | Danielli and Davson |
| (b) Schwann           | 1838 | Singer and Nicolson |
| (c) Plowe             | 1831 | David Robuston      |
| (d) Nageli and Cramer | 1844 | Singer and Nicolson |

- 14.** Select the correct set of differences among the following types of membrane transport.

|       | <b>Pinocytosis</b>                                                 | <b>Phagocytosis</b>                                              |
|-------|--------------------------------------------------------------------|------------------------------------------------------------------|
| (i)   | Bulk intake of fluid materials by a cell.                          | Intake of solid material from outside to the inside of the cell. |
| (ii)  | Large vesicles are formed.                                         | Small vesicles are formed.                                       |
| (iii) | Receptor pits are present on membrane for receiving the materials. | Receptor pits are absent.                                        |

- (i) and (iii)
- (ii) only
- (i) and (ii)
- (i), (ii) and (iii)

- 15.** Study the diagram of a mitochondrion given below and select the option that correctly identifies the labelled parts A-E.



| A           | B            | C             | D             | E             |
|-------------|--------------|---------------|---------------|---------------|
| (a) Oxsome  | 70S ribosome | Matrix        | Crista        | Outer chamber |
| (b) Vesicle | 80S ribosome | Inner chamber | Crista        | Outer chamber |
| (c) Oxsome  | 70S ribosome | Crista        | Inner chamber | Matrix        |
| (d) Vesicle | 80S ribosome | Crista        | Matrix        | Outer chamber |

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- 16.** Which of the following is not the similarity between mitochondria and chloroplast?
- Both produce ATP.
  - Both possess double membrane envelope.
  - Both convert light energy into chemical energy.
  - Both contain naked DNA.

- 17.** Match column I with column II and select the correct option from the codes given below.

| <b>Column I</b>                           | <b>Column II</b>                  |
|-------------------------------------------|-----------------------------------|
| A. Elaioplasts                            | (i) Endosperm cells of castor     |
| B. Aleuroplasts                           | (ii) Plastids of red algae        |
| C. Chromoplasts                           | (iii) Synthesis of membrane lipid |
| D. Chloroplasts                           | (iv) Colourless plastids          |
| E. Rhodoplasts                            | (v) Starch storage                |
| (a) A-(iv), B-(i), C-(v), D-(iii), E-(ii) |                                   |
| (b) A-(ii), B-(iii), C-(v), D-(iv), E-(i) |                                   |
| (c) A-(iv), B-(i), C-(iii), D-(v), E-(ii) |                                   |
| (d) A-(iii), B-(ii), C-(iv), D-(v), E-(i) |                                   |

- 18.** Refer to the given table showing differences between single-unit and multi-unit smooth muscles.

|       | <b>Single-unit smooth muscles</b>                                 | <b>Multi-unit smooth muscles</b>                                           |
|-------|-------------------------------------------------------------------|----------------------------------------------------------------------------|
| (i)   | Composed of muscle fibres not so closely joined together.         | Composed of muscle fibres closely joined together.                         |
| (ii)  | All the fibres contract simultaneously as a single unit.          | All the fibres contract independently as separate units.                   |
| (iii) | Found in the walls of gastrointestinal tract and urinary bladder. | Found in the walls of the large blood vessels and iris muscles in the eye. |

Which of the above cited differences is/are not correct?

- (i) only
- (i) and (ii)
- (iii) only
- (ii) and (iii)

- 19.** Which of the following features does not belong to fluid mosaic model of biomembrane system?
- $\alpha$ -protein molecules are attached by electrostatic forces to phospholipid bilayer.
  - Proteins are held in their position by both polar and non-polar side chains.
  - Proteins provide the structural and functional specificity to the membrane.
  - Tunnel proteins are integral proteins that form channels for passage of water.

- 20.** The larger subunit of 70S ribosome is
- 60S
  - 50S
  - 40S
  - 30S.

- 21.** Softening of ripe fruits is caused due to partial solubilisation of pectic compounds present in
- primary cell wall
  - middle lamella
  - cell membrane
  - secondary cell wall.

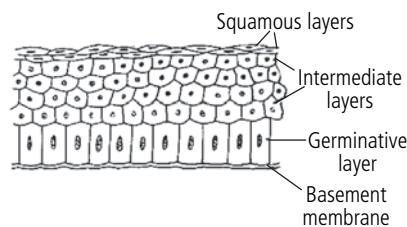
- 22.** Read the given statements and select the correct option.

**Statement A :** Lysosomes contain enzymes called acid hydrolases in the form of crystalline or semi-crystalline granules.

**Statement B :** Digestive enzymes present in lysosomes require a pH of 3-4 for proper functioning.

- Both statements A and B are correct and B is the correct explanation of A.
- Both statements A and B are correct but B is not the correct explanation of A.
- Statement A is correct but statement B is incorrect.
- Both statements A and B are incorrect.

- 23.** Which of the following options is matched incorrectly regarding the epithelium shown in the given figure?



- It represents non-keratinised stratified squamous epithelium.
- It lines the buccal cavity, vagina, cornea of eye, etc.
- It provides well protection against abrasions and contains dead superficial cells.
- It is permeable to water.

## Spellathon

- Make as many biological terms as possible using the given letters. Each word should contain the letter given in circle.
- Minimum 4 letter word should be made.
- In making a word, a letter can be used as many times as it appears in the box.
- Make at least 1 seven letter word.



Send your response at editor@mtg.in or post to us with complete address by 25<sup>th</sup> of every month to win exciting prizes. Winners' name will be published in next issue.

**24.** Complete the following table by identifying X, Y and Z from the given options.

|       | Chromosome type | Position of centromere |
|-------|-----------------|------------------------|
| (i)   | Acrocentric     | X                      |
| (ii)  | Y               | Sub-median             |
| (iii) | Telocentric     | Z                      |

- | X                     | Y               | Z          |
|-----------------------|-----------------|------------|
| (a) Sub-terminal      | Sub-metacentric | Terminal   |
| (b) Inner to telomere | Metacentric     | Terminal   |
| (c) Sub-terminal      | Metacentric     | Median     |
| (d) Terminal          | Sub-metacentric | Sub-median |

**25.** The component of the cell associated with synthesis of sterols and steroid hormones in the interstitial cells of testis and ovary is

- (a) smooth endoplasmic reticulum
- (b) rough endoplasmic reticulum
- (c) Golgi vesicle
- (d) mitochondrion.

**26.** Select the mismatched pair from the given options.

- (a) Cardiac muscle fibres - Branched fibres
- (b) Microfilaments - Actin
- (c) Apocrine glands - Goblet cells
- (d) Polyteny chromosomes - Salivary chromosomes

**27.** Nephrostome occurs in earthworm's

- (a) septal nephridia
- (b) integumentary nephridia
- (c) pharyngeal and septal nephridia
- (d) pharyngeal and integumentary nephridia.

**28.** Which option is correct with reference to the parts marked A, B and C in the given figure of section of flagellum?

- (a) A is a microtubule made of protein dynein.
  - (b) A and B are interconnected by a linker called spoke.
  - (c) C is made up of protein hexin.
  - (d) Part C is made up of 11 protofilaments.
- 

**29.** Consider the following statements.

- I. Golgi apparatus in plant cell consists of distinct units called dictyosomes.
- II. Glyoxysomes are absent in plant cells but present in animal cells.
- III. Specialised vacuoles in plant cells are analogous to lysosomes in animal cells.
- IV. Absence of cell wall in animal cell results in its bursting in hypertonic solution.

Of the above statements

- (a) II and III are correct
- (b) I and IV are correct
- (c) I, II and IV are correct
- (d) I and III are correct.

**30.** Match column I with column II and select the correct option.

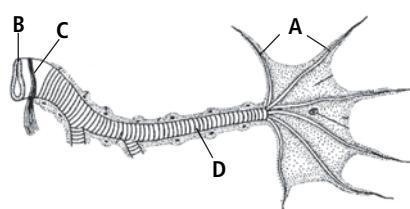
| Column I                        | Column II                          |
|---------------------------------|------------------------------------|
| A. Pseudo-stratified epithelium | (i) Subcutaneous tissue around eye |
| B. Adipose tissue               | (ii) Sternal parts of ribs         |
| C. Hyaline cartilage            | (iii) Nephrons of kidneys          |
| D. Smooth muscle tissue         | (iv) Olfactory mucosa              |
| E. Ciliated cuboidal epithelium | (v) Blood vessels                  |

(a) A-(iv), B-(i), C-(ii), D-(v), E-(iii)  
 (b) A-(iii), B-(i), C-(ii), D-(v), E-(iv)  
 (c) A-(i), B-(iii), C-(ii), D-(iv), E-(v)  
 (d) A-(iv), B-(iii), C-(i), D-(ii), E-(v)

**31.** Identify the correct option on the basis of type of flagellation in bacteria.

- (a) Lophotrichous - Tuft of flagella at one end
- (b) Cephalotrichous - Number of flagella distributed all over the surface
- (c) Amphitrichous - Flagellum at each of the two ends
- (d) Atrichous - Single flagella present at one end

**32.** Refer to the given figure of trachea and tracheoles in a cockroach. Identify the parts labelled as A – D.



- | A                  | B         | C              | D             |
|--------------------|-----------|----------------|---------------|
| (a) Tracheoles     | Spiracle  | Atrial muscle  | Trachea       |
| (b) Tracheae       | Atrium    | Tracheoles     | Atrial muscle |
| (c) Spiracles      | Tracheole | Trachea        | Atrium        |
| (d) Atrial muscles | Spiracle  | Tracheole cell | Atrial muscle |

**33.** Cell wall of \_\_\_\_\_ contains long chain fatty acids of mycolic acid.

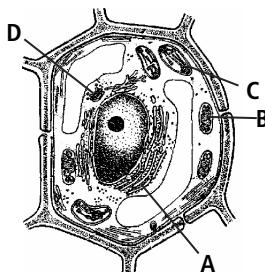
- (a) *Bacillus subtilis*
- (b) *E. coli*
- (c) *Streptococcus*
- (d) *Mycobacterium*

## ANSWERS

## WHO AM I ...

- |                              |        |
|------------------------------|--------|
| 1. Arbor vitae               | Pg. 15 |
| 2. Iris                      | Pg. 25 |
| 3. Non-competitive inhibitor | Pg. 40 |

- 34.** Study the given diagram of a typical plant cell and identify the option that correctly corresponds with the function of labelled parts A-D.



- (a) A-Site for synthesis of glycoproteins.
- (b) B-Synthesis of acrosome found at the tip of animal sperms.
- (c) C-Coupling factors found in the matrix and thylakoids are responsible for ATP synthesis.
- (d) D-Concentrating and packaging of the secretory substances inside a soluble protein coat.

- 35.** Read the given statements and select the option stating which ones are true (T) and which ones are false (F).
- (i) Non-striated muscle fibres have nerve supply from autonomic neural system.
  - (ii) Presence of Balbiani rings is a characteristic feature of lampbrush chromosomes.
  - (iii) Cell wall of cork cells contains a special fatty substance called suberin.
  - (iv) In cockroach, anus lies in the 8<sup>th</sup> segment just below the tergum.

- | <b>(i)</b> | <b>(ii)</b> | <b>(iii)</b> | <b>(iv)</b> |
|------------|-------------|--------------|-------------|
| (a) T      | T           | T            | F           |
| (b) T      | F           | T            | T           |
| (c) T      | T           | F            | F           |
| (d) T      | F           | T            | F           |

- 36.** Which of the following statements is incorrect?
- (a) In cockroach, the auditory sensillae are located on the anal cerci.
  - (b) Gram -ve bacteria are more resistant to antibiotics than Gram +ve bacteria.
  - (c) Nucleoproteins are synthesised and stored in the nucleolus.
  - (d) Mast cells produce serotonin that acts as a vasoconstrictor.

- 37.** A frog has
- (a) eyes but no lids
  - (b) jaws but no teeth
  - (c) hands but no fingers
  - (d) ears but no pinnae.

- 38.** Match the column I containing various part of earthworm with column II showing its body segments.

| <b>Column I</b>                    | <b>Column II</b>                                 |
|------------------------------------|--------------------------------------------------|
| p. Typhlosole                      | (i) 4 <sup>th</sup> -6 <sup>th</sup> segments    |
| q. Stomach                         | (ii) 9 <sup>th</sup> -14 <sup>th</sup> segments  |
| r. Pharyngeal nephridia            | (iii) 6 <sup>th</sup> -9 <sup>th</sup> segments  |
| s. Spermathecae                    | (iv) 26 <sup>th</sup> -35 <sup>th</sup> segments |
| (a) p-(ii), q-(iv), r-(iii), s-(i) |                                                  |
| (b) p-(iv), q-(ii), r-(i), s-(iii) |                                                  |
| (c) p-(i), q-(ii), r-(iv), s-(iii) |                                                  |
| (d) p-(iv), q-(iii), r-(i), s-(ii) |                                                  |

- 39.** Consider the following statements and select the option with correct set of statements.

- (i) Oligodendrocytes are found in the central nervous system and have a function similar to Schwann cells.
  - (ii) Microglial cells engulf microbes and debris in the nervous tissue.
  - (iii) Ependymal cells play an important role in maintenance of the blood brain barrier.
  - (iv) The movement of astrocytes processes is responsible for flow of cerebrospinal fluid.
- (a) (i) and (iii) only
  - (b) (ii), (iii) and (iv) only
  - (c) (i) and (ii) only
  - (d) (ii) and (iv) only

- 40.** Which option is correctly matched with its function?

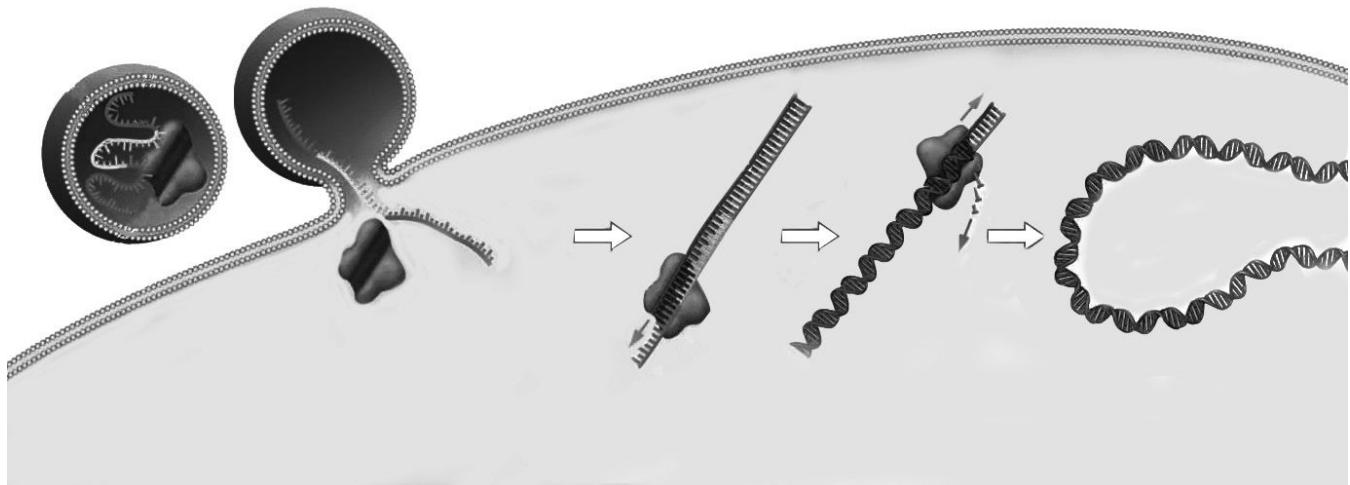
- |                     |                                                   |
|---------------------|---------------------------------------------------|
| (a) Desmosome       | - Increases surface area of contact between cells |
| (b) Zonula adherens | - Facilitates chemical exchange between cells     |
| (c) Tight junction  | - Checks flow of material between the cells       |
| (d) Gap junction    | - Joins epithelial cells with basement membrane   |

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## SELF CHECK

### Check your score! If your score is

|                 |                          |                                                            |
|-----------------|--------------------------|------------------------------------------------------------|
| <b>&gt; 90%</b> | <b>EXCELLENT WORK !</b>  | You are well prepared to take the challenge of final exam. |
| <b>90-75%</b>   | <b>GOOD WORK !</b>       | You can score good in the final exam.                      |
| <b>74-60%</b>   | <b>SATISFACTORY !</b>    | You need to score more next time.                          |
| <b>&lt; 60%</b> | <b>NOT SATISFACTORY!</b> | Revise thoroughly and strengthen your concepts.            |



# NEET ESSENTIAL

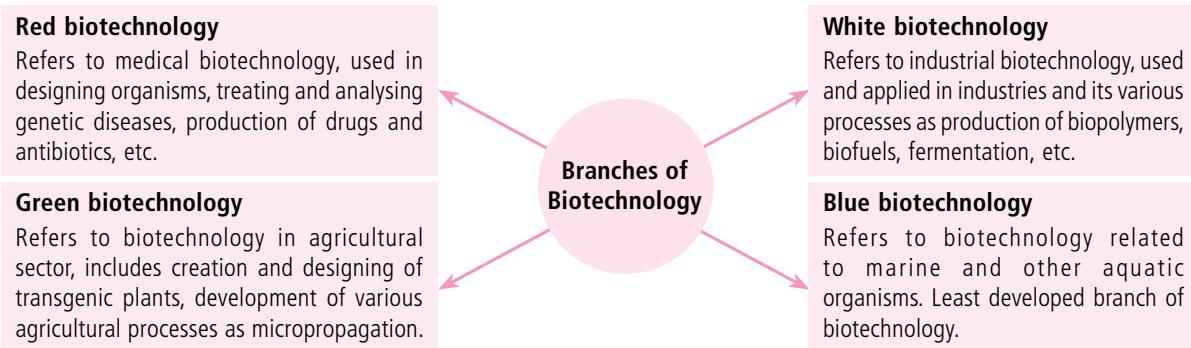
The syllabus for NEET is very vast which impedes students from acquiring indepth knowledge and covering the entire syllabus at the same time. An essential topic for NEET is therefore presented here to enable students grasp the topic, analyse the type of questions and SCORE HIGH.

## APPLICATIONS OF BIOTECHNOLOGY

Biotechnology is the use of living systems and organisms to develop or make useful products. It harnesses cellular and biomolecular processes to develop technologies and products that help to improve our health and lives.

Modern biotechnology provides breakthrough solutions and technologies to combat debilitating and rare diseases, reduce our environmental foot-prints, support use of less and cleaner energy, contribute safer and more efficient industrial manufacturing processes and improve areas of food production and health.

The diverse applications of biotechnology in various fields have led to emergence of different branches of biotechnology.



## APPLICATIONS IN AGRICULTURE

Despite the increase in food production through green revolution, purpose is not served. Increasing population and new challenges in agricultural sector, seek new solutions to overcome these problems.

One such solution is production of genetically modified (GM) crops.

**Genetically modified organisms refer to organisms that have been genetically manipulated or modified. They can be plants, animals or even microbes.**

Genetically modified crops contain and express one or more useful, desirable foreign genes. Such genes incorporated into the genome of organisms are called **transgenes** and the plants expressing the products of transgenes are called **transgenic plants**.

### Production of Transgenic plants using Ti Plasmid

The vector used to introduce new genes into plant cells is most often a plasmid from soil bacterium *Agrobacterium tumefaciens*. Since the plasmid possesses genes that transfer the DNA from plasmid and gets integrated into host (plant genome), it is called natural genetic engineer. The plasmid induces tumors in broad leaf plants such as tomato, tobacco, soyabean, etc., hence is also referred to as **tumor inducing plasmid (Ti plasmid)**.

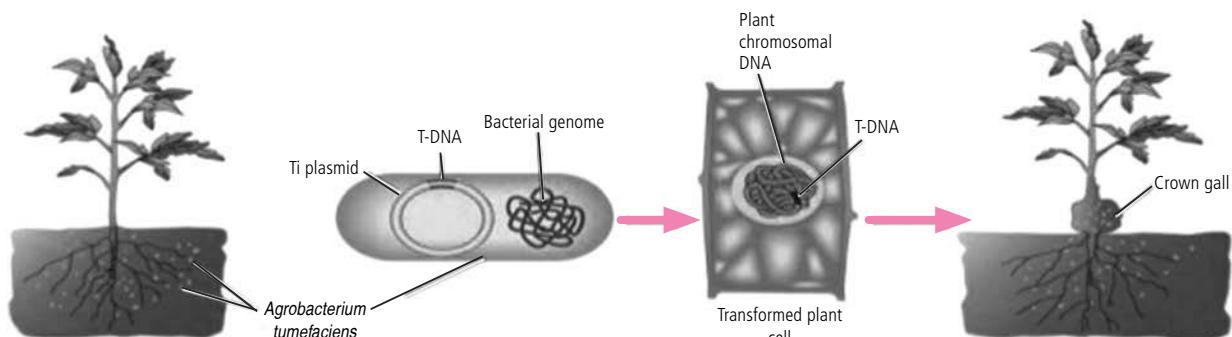


Fig. : *A. tumefaciens* as natural genetic engineer

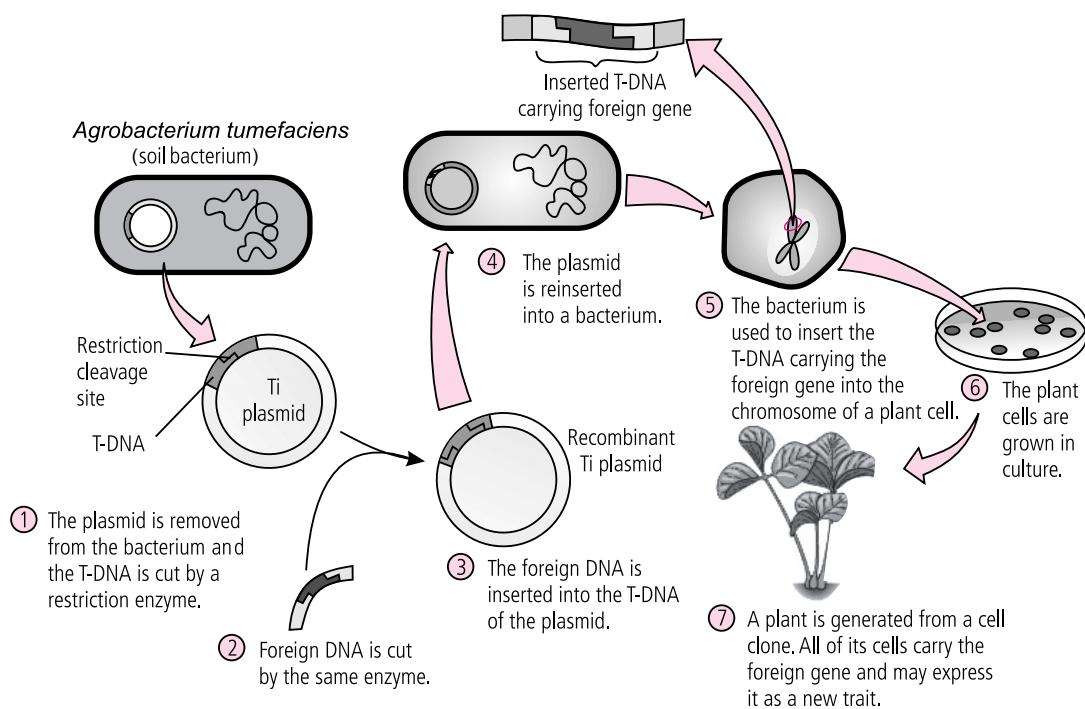


Fig.: Production of transgenic plants using Ti plasmid

The transgenic plants are produced for variety of purposes such as they carry desirable traits for disease resistance, insect resistance and herbicide resistance and improved food quality. Some of them are discussed here.

## Insect Resistance in Transgenic Plants

- Soil bacterium *Bacillus thuringiensis* produces proteins that kill certain insects like lepidopterans (tobacco budworm, army worm), coleopterans and dipterans (flies, mosquitoes).
- Bacteria produces protein crystals containing inactive toxin (protoxins). Hence, these toxins do not harm the bacteria, but kill insects when they ingest plant parts expressing them. Alkaline pH of alimentary canal of insect, solubilises the crystal and converts inactive protoxins into active toxins.
- Through genetic engineering, these Bt toxin genes were isolated and incorporated into several crop plants as tobacco, cotton, corn, etc.
- The choice of gene depends upon the crop and its target pest, as most of the toxins are pest or insect group specific.
- Cry genes**: In cotton, *cry I Ac* and *cry II Ab* provide resistance against cotton bollworms. In corn *cry I Ab* provides resistance against corn borer.

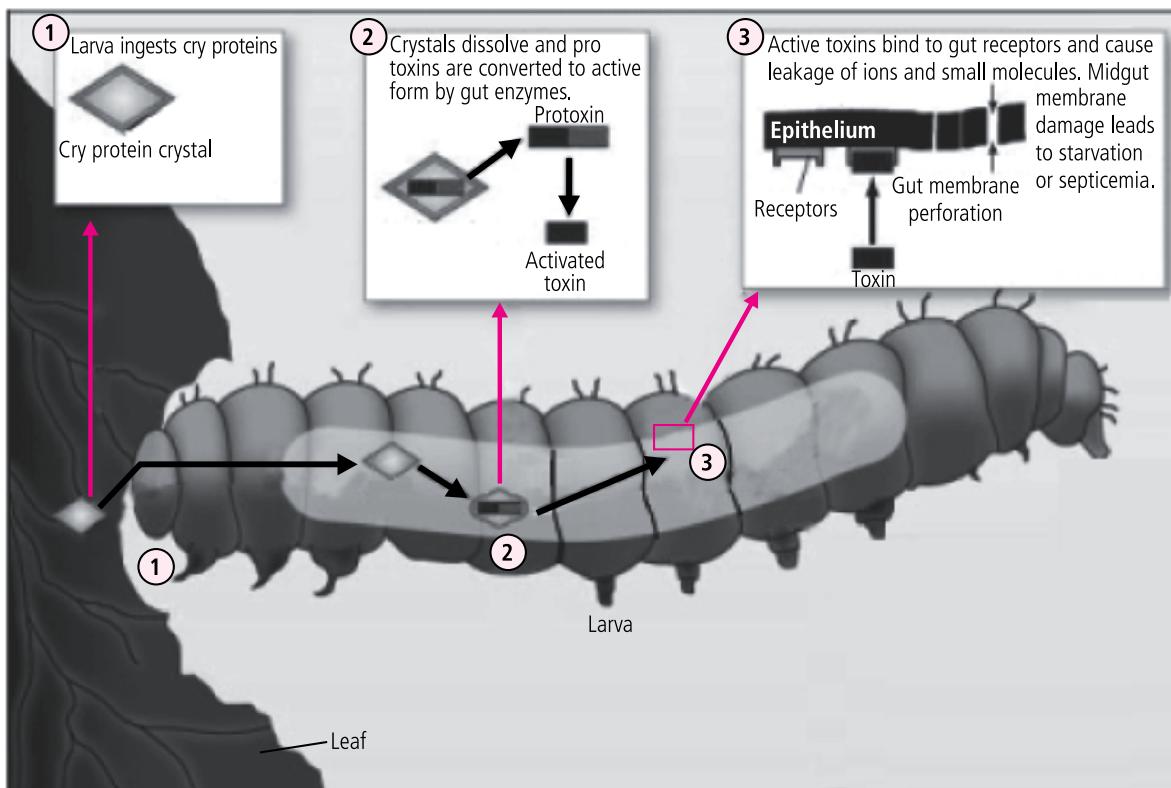


Fig.: Mode of action of Bt toxins in insect gut

## Pest Resistance in Transgenic Plants

- Many nematodes living as parasites in plants, affect their productivity e.g., *Meloidogyne incognita* infects the roots of tobacco plants and greatly reduces its yield.
- To prevent this infection and make plant pest resistant, a novel strategy based on the process of RNA interference is adopted.
- RNA interference (RNAi)** is the phenomenon of inhibiting activity of a gene by synthesis of RNA molecules complementary to mRNA.
- Using *Agrobacterium* vectors, nematode specific genes are introduced into host plant and it produces both **sense** and **antisense RNA**. The complementary strand of mRNA does not contain sequences that can be translated to produce a functional protein hence called **antisense RNA**.
- The antisense RNA and mRNA molecules anneal to form duplex RNA molecules, which block translation of mRNA of affected gene.

- Different steps involved in making tobacco plant resistant to nematode are as follows :
  - Double-stranded RNAs are processed into approximately 21-23 nucleotide RNAs. An RNase enzyme, called **Dicer**, cuts the dsRNA molecules (from a virus, transposon or through transformation) into **small interfering RNAs (siRNAs)**.
  - Each siRNA forms an **RNA-induced silencing complex (RISC)** with **ribonucleases** (distinct from Dicer).
  - The siRNA unwinds and RISC is activated.
  - The activated RISC targets complementary *mRNA* molecules. The siRNA strands act as guide for RISCs to identify and cut the *mRNA*. This destroys the *mRNA*.
  - When *mRNA* of the parasite is destroyed, no proteins are synthesised that results in the death of the parasite (nematode).
  - As the transgenic plant expresses antisense RNA, *mRNA* of nematode gets silenced and its infestation in the tobacco plant fails thus these transgenic plants get protected from the parasite.

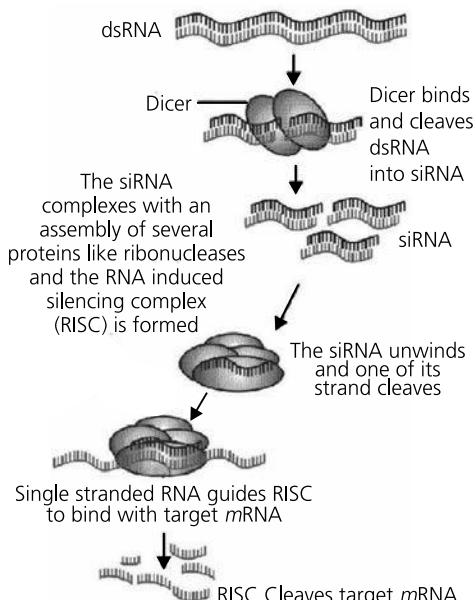


Fig.: Process of RNA interference

## Herbicide Resistance in Transgenic Plants

- Transgenic plants resistant to certain biodegradable herbicides have been successfully developed through genetic engineering.
- Herbicides like glyphosate is a broad spectrum herbicide that inhibits the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). This enzyme is involved in aromatic acid biosynthesis in plants. Thus, the glyphosate kills plant by making its cells deficient of aromatic amino acids which disrupts their protein synthesis.

**Table :** Transgenes for herbicide resistance and the mechanisms of their action

| Transgene                         | Source organism                                         | Confers resistance to the herbicide | Mechanism of action/Remarks                                                                          |
|-----------------------------------|---------------------------------------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------|
| <i>aroA</i>                       | <i>Agrobacterium</i> sp. strain CP4                     | Glyphosate/ Roundup                 | Encodes 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) enzyme that is insensitive to glyphosate |
| <i>bar</i>                        | <i>Streptomyces hygroscopicus</i>                       | Bialaphos/Basta/Glufosinate         | Acetylation of phosphinothricin (enzyme phosphinothricin acetyl transferase)                         |
| <i>bxn</i>                        | <i>Klebsiella ozaene</i>                                | Bromoxynil                          | Converts the herbicide into 3, 5-dibromo-4-hydroxy benzoic acid                                      |
| <i>gax</i>                        | <i>Achromobacter</i> sp. strain LBAA                    | Glyphosate/ Roundup                 | Detoxifies glyphosate by oxidising it into amino ethylphosphonic acid and glyoxylate                 |
| <i>Hra, csr1-1, C3 and ahas3r</i> | <i>Arabidopsis thaliana, N. tabacum, yeast, E. coli</i> | Sulfonylureas and imidazolinones    | Encode acetolactate synthase (ALS) enzyme that is insensitive to the herbicides                      |

## Transgenic Plant to Reduce Post-Harvest Losses

- Post-harvest and overripening losses have been reduced by introducing genes which prevent deterioration of harvested products.
- The tomato variety '**Flavr Savr**' presents an example where expression of a native tomato gene, coding for the enzyme **polygalacturonase** has been blocked.
- This enzyme promotes fruit softening by degrading pectin. Non-availability of this enzyme makes fruits of transgenic tomato variety remain fresh and retain their flavour for much longer than do the fruits of normal tomato varieties. Additionally, these fruits have superior taste and increased total soluble solids.

## Transgenic Nutritionally Enhanced Plants

- Certain crops are genetically modified to enhance the nutritional value of the food they produce e.g., vitamin A enriched rice.
- **Prof. Ingo Potrykus** and **Peter Beyer** produced genetically engineered rice by introducing three genes associated with synthesis of carotene.
- It is a transgenic variety of rice (*Oryza sativa*) which contains good quantities of  **$\beta$ -carotene (provitamin A)** - inactive state of vitamin A). Since the grains (seeds) of the rice are yellow in colour due to  $\beta$ -carotene, the rice is commonly called **golden rice**.

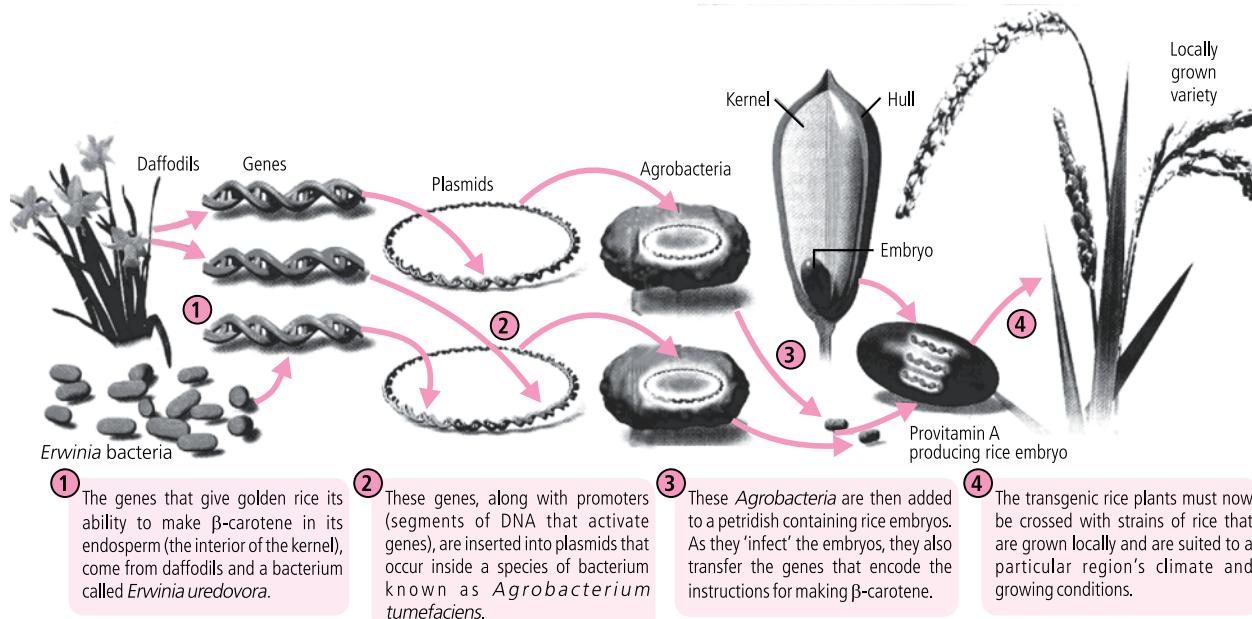


Fig.: Steps involved in production of golden rice

## Transgenic Plants Producing Various Biochemicals

- Plants are the chief source of carbohydrates, e.g., starch, sugar, lipids, proteins and a variety of unique biochemicals.
- Transgenes have been shown to introduce novel branches in the biosynthetic pathways of plants and thereby, to generate valuable products or to produce new valuable proteins.
- **Hirudin (the first commercial biochemical)** is a protein that stops blood clotting. The gene encoding hirudin was chemically synthesised. This gene was then transferred into *Brassica napus*, where hirudin accumulates in seeds. The hirudin is then extracted and purified to be used as medicine.

## Disadvantages of GM Crops

- GM crops can cause unintended harm to other organisms. A laboratory study on high mortality rate in Monarch butterfly caterpillars that feed on pollen of Bt corn seemed to support the view point. Monarch caterpillars feed on milkweed plants that might have pollens of Bt corn blown by wind onto it.
- Use of GM crops can reduce the effectiveness of the pesticides as insects can become resistant to Bt or other crops that have been genetically modified to produce their own pesticides.
- Another concern is that crop plants engineered for herbicide tolerance and weeds can cross-breed, resulting in the transfer of the herbicide resistant genes from the crops into the weeds. These "superweeds" would then be herbicide tolerant as well.
- Moreover, GM food can lead to allergies, they can harm bacteria of the alimentary canal, etc.

## APPLICATIONS IN MEDICINE

- The recombinant DNA technology has made great impact in the area of healthcare by mass production of safe and more effective therapeutic drugs.

- Now about 30 recombinant therapeutics have been approved for human use, all over the world. In India, 12 of these are presently being marketed.
- Several of the recombinant proteins, used for treatment of diabetes mellitus (e.g., insulin), dwarfism (e.g., human growth hormone [hGH]), cancer (e.g., interferons, interleukins, granulocyte macrophage colony stimulating factor), thrombosis (e.g., streptokinase) and AIDS (e.g., interferons, granulocyte macrophage colony stimulating factor) has been produced.

## Production of Genetically Engineered Insulin

- Insulin** is made of 51 amino acids, arranged in two short polypeptide chains : chain A with 21 amino acids and chain B with 30 amino acids, that are linked together by disulphide bridges. In humans, insulin is synthesised as a pro-hormone which contains an extra stretch called the C-peptide with 33 amino acids. This C-peptide is not present in the mature insulin, as it is removed during its maturation.
- The main challenge for production of insulin using rDNA techniques was getting insulin assembled into a mature form.
- In 1983, **Eli Lilly** an American company prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E.coli* to produce insulin chains.
- Chains A and B were produced separately, extracted and combined by creating disulfide bonds to form human insulin (**Humulin**).

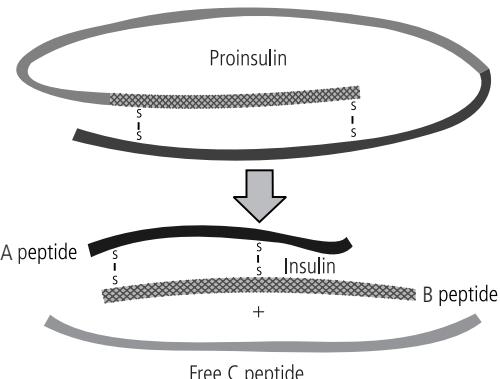


Fig.: Maturation of pro-insulin into insulin

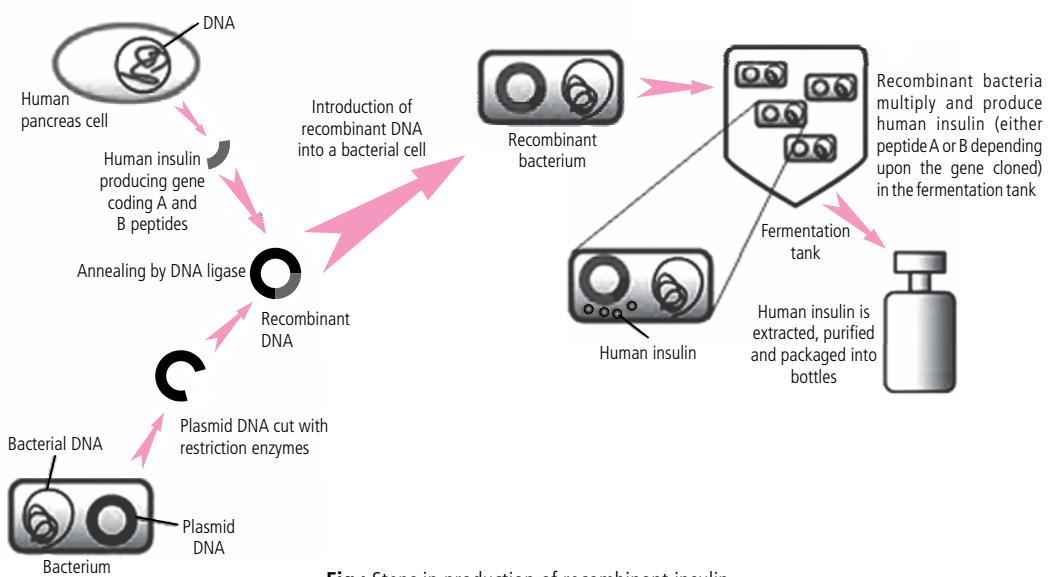


Fig.: Steps in production of recombinant insulin

## Production of Human Growth Hormone

Growth of human body is regulated by human growth hormones (hGH), **Somatotropin**. Secretion of somatotropin is regulated by somatotropin releasing hormone and somatostatin or growth inhibiting hormone.

**Somatostatin** is the first human protein to be produced in *E.coli*. It is only 14 amino acids long. The gene for somatostatin was chemically synthesised and expressed as a fusion protein with lac ZX sequence of  $\beta$ -galactosidase.

However, the production of somatotropin, being 191 amino acids long, presented a more difficult problem. Therefore, a combination of artificial gene synthesis and complementary (cDNA) DNA cloning was done.

## Production of Bovine Growth Hormone

Engineered *E.coli* produce bovine somatotropin or bovine growth hormone (bGH). This hormone, when injected into cows, raises milk production as well as beef output. The engineered *E.coli* produce the enzyme cellulase, which hydrolyses cellulose and enables animals to utilise the entire feed.

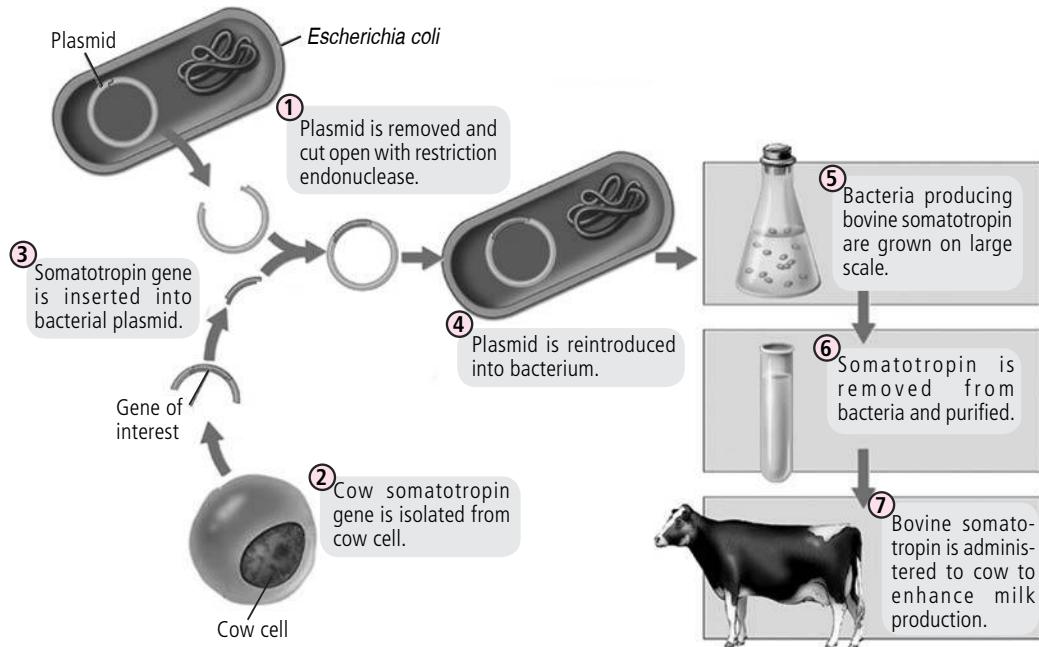


Fig.: Bovine somatotropin production

## Production of Recombinant Vaccines

- Conventional vaccines consist of attenuated or inactivated pathogens while the gene encoding a critical antigen in a pathogen has been isolated and expressed in bacterial or animal cells to produce recombinant proteins. These proteins are used as a vaccine and such vaccines are called **recombinant vaccines**.
- But usually the entire protein molecule is not necessary for an effective immunisation since the antigenic property is ordinarily localised in a small part of protein molecules. Therefore, either a constituent polypeptide (in case of heteromultimeric proteins) or a small part of a polypeptide may be used as a vaccine, such vaccines are known as **subunit vaccines**.
- Subunit vaccines are produced using recombinant DNA technology for cloning and expressing the appropriate DNA sequences encoding antigenic polypeptides as its segments in suitable hosts.
- Recombinant vaccines are produced through bacterial fermentation or in animal cell cultures that makes their cost prohibitively high, thus, preventing their wide use e.g., the oral cholera vaccine consisting of recombinant cholera-toxin B subunit.

## DNA Vaccines

- DNA vaccines are composed of a small, circular piece of DNA, called a DNA plasmid that contain genes which code for proteins of a pathogen. When the vaccine is injected into the host, the inner machinery of the host cells 'reads' the DNA, converts it into proteins from the pathogen. Recognising that the protein is foreign, the cells display them on their surface to alert the body's immune system— both helper T-cells, which spur the production of antibodies and killer T-cells. This triggers a range of immune responses and therefore, DNA vaccines induce wider range of immune responses.

## Production of Interferons

- Interferons (IFNs) are members of a large group of proteins called **cytokines**, which affect a wide range of target cells and tissues by binding to specific receptors present on the surface of their target cells. Interferons are proteins produced by the infected cells in response to viral infections. They diffuse to neighbouring cells and trigger a reaction that neutralises the particular virus and prevent viral infections.

**FIND  
MORE  
FREE  
MAGAZINES**

**FREEMAGS.CC**

- Until recently the only source of interferons was human white blood cells or **virus infected human cells** grown in tissue culture.
- Production of human interferon by cloning of genes in colon bacilli was started in 1980 by two American scientists **Gilbert** and **Weissmann**.
- The interferons (particularly IFN- $\alpha$ ) are used on a significant scale for the treatment of hepatitis-B. Interferons are also being tested for the treatment of cancer and other **viral diseases** including AIDS.

## Production of Monoclonal Antibodies

- Monoclonal antibody is a specific antibody produced from a normally short lived antigen-activated B-cell that has been immortalised by hybridising it with a myeloma cell, by hybrid cell culture technique, known as **hybridoma technology**.
- In this technique the antigen (against whom the antibodies are required) is injected in rat or mouse.
- After sometime B-lymphocytes from spleen of an animal are isolated and mixed with the myeloma cells (isolated from cancer cells of bone marrow).
- Antibodies producing B-lymphocytes and myeloma cells fuse together to form **hybridoma cells**.
- These hybrid cells retain the ability of the B-cells to secrete antibody and the ability of myeloma cell to grow indefinitely.
- The hybridoma cells in culture conditions produce specific and pure (monoclonal) antibodies rapidly.
- These are isolated and purified to be used in the cure of diseases.
- The advantage of monoclonal antibody is that it is derived from a single cell and comprises a uniform breed of antibody, specific for a single antigen site (epitope).**
- In 1984, **Kohler** and **Milstein** shared the Nobel Prize in Physiology or Medicine for the development of the monoclonal antibody technique.

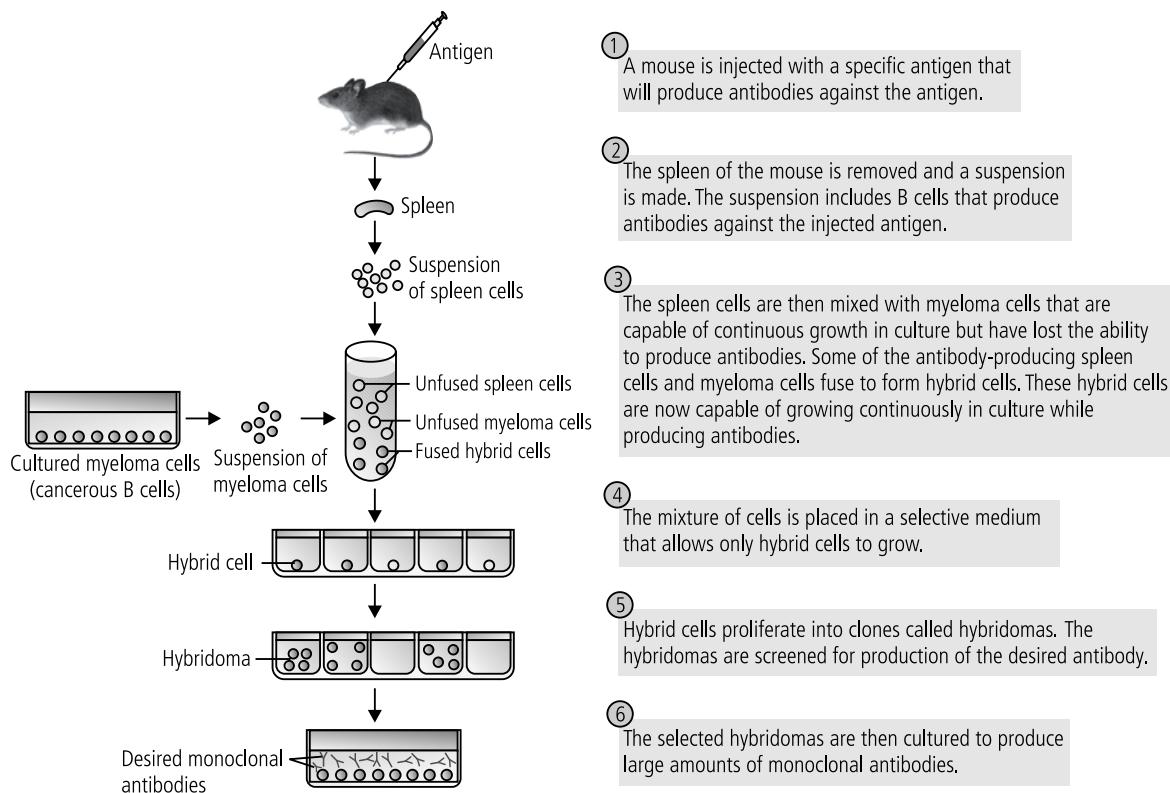


Fig.: Production of monoclonal antibodies

## Gene Therapy

- This technique is based on the fact that cells of the body manufacture substances under the guidance of DNA. Thus, by manipulating the DNA structures, it is possible to control various diseases.

- It is a collection of methods that allows correction of a gene defect that has been diagnosed in a child/embryo.
- Correction of a genetic defect involves delivery of a normal gene into the individual or embryo to take over the function of and compensate for the **non-functional gene**.

### Types of gene therapy

#### Germ line gene therapy

Involves modification of germ cells *i.e.*, sperms or eggs by introduction of functional genes, which are usually integrated into their genomes. This mode of therapy is inheritable and is highly effective in counteracting the genetic disorders.

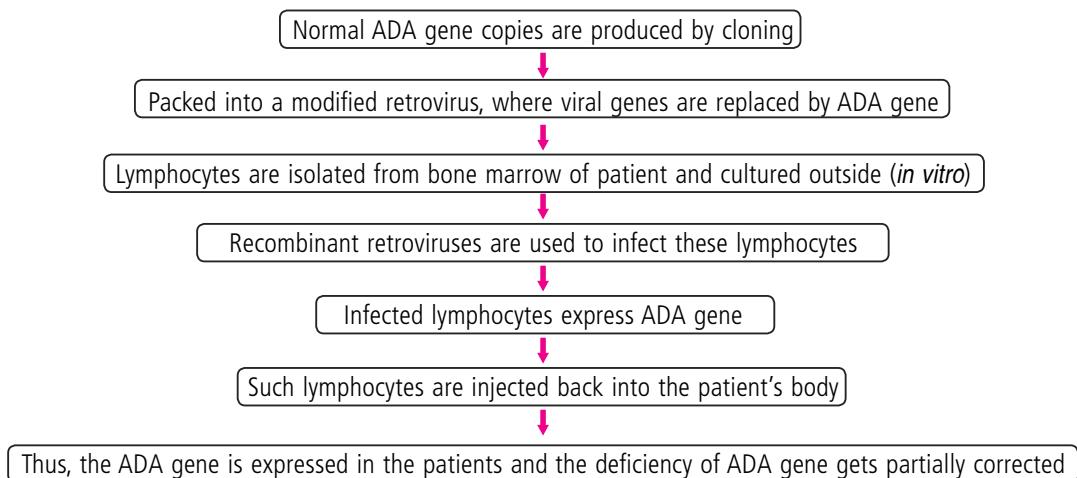
#### Somatic cell gene therapy

Involves modification of somatic cells by introduction of concerned gene. This is not heritable. The expression of gene in the body cells however relieves or eliminates symptoms of the disorder temporarily.

### Gene therapy for treating SCID

The first gene therapy trials began in 1990 with the treatment of a 4 years old girl, Ashanti DeSilva, who had a genetic disorder called **severe combined immunodeficiency (SCID)**. SCID is caused by a mutation in the gene encoding the enzyme **adenosine deaminase (ADA)**. This enzyme is very important for the immune system to function. Because these patients do not have functional T- lymphocytes, they cannot provide immune responses against invading pathogens.

- As a first step towards gene therapy, lymphocytes are extracted from the bone marrow of the patient and are grown in a culture outside the body. A **functional ADA cDNA** (using a retroviral vector) is then introduced into these lymphocytes, which are reinjected to the patient's bone marrow.



**Flow Chart :** Steps of gene therapy for the treatment of SCID

- The drawback of this therapy is that these cells are mortal, hence the patient requires periodic infusion of such genetically engineered lymphocytes. However, if the therapy is done into cells at early embryonic stages, the ADA deficiency can be permanently cured.

### Molecular Diagnosis of Diseases

- Early diagnosis and understanding the symptoms are very important for effective treatment of disease but early detection is not possible using conventional methods.
- **PCR, ELISA** are some of the biotechniques that serve the purpose of early diagnosis.
- PCR can detect mutation even in very low amounts of DNA, as it amplifies DNA by making billions of copies of a DNA segment in few hours. It is a good technique to detect mutations and identify genetic disorders, especially in detecting HIV in AIDS patients, mutated genes in cancer patients and other genetic disorders.
- **Enzyme linked immunosorbent assay (ELISA)** : ELISA is based on the principle of **antigen - antibody interaction**. Infection by pathogen can be detected by the presence of antigens such as proteins, glycoproteins, etc., or by detecting the antibodies synthesised against the pathogen.

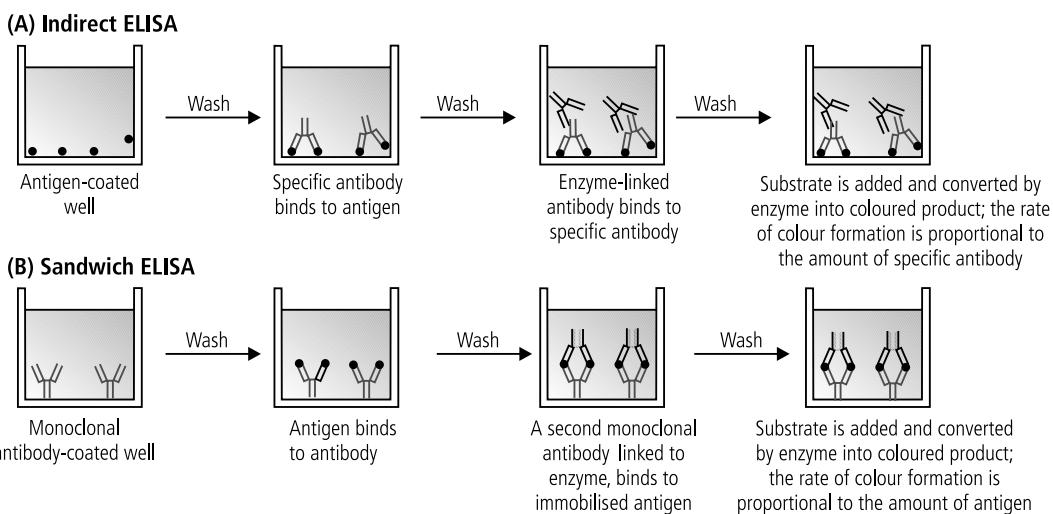


Fig.: Process involved in indirect ELISA and sandwich ELISA

## APPLICATIONS IN INDUSTRY

- The exploitation of microorganisms for industrial production of useful products began as early as 1875 with the production of alcohol.
- At present, several chemicals, such as lactic acid (1881), amylase (1884), glycerine (1914), citric acid (1923), gluconic acid (1928), acetic acid, acetone, butanol, a variety of enzymes, vitamins, amino acids and all the antibiotics are produced using microorganisms.

## Production of Enzymes

- In 1874, **Christian Hansen** prepared pure enzyme by extracting 'rennet' from the calf's stomach.
- The bulk of industrial enzymes are prepared almost exclusively from **Gram positive bacteria** and **fungi**.
- Enzymes are purified by precipitation and filtration to remove undesirable metabolites and particulate matter and to improve stability and standardise activity.
- Different types of specific enzymes used in rDNA technology are lysing enzymes, restriction enzymes, DNA ligases, etc.

Table : Some common industrial enzymes, their sources and uses

| Enzyme              | Source                                                                                         | Principal use                                                                      |
|---------------------|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| $\alpha$ - Amylase  | <i>Aspergillus oryzae</i> , <i>Bacillus amyloliquefaciens</i><br><i>Bacillus licheniformis</i> | Production of alcohol, preparation of glucose syrup                                |
| Cellulase           | <i>Aspergillus</i> sp., <i>Trichoderma koningii</i>                                            | Alcohol and glucose production                                                     |
| $\beta$ -Glucanase  | <i>Bacillus subtilis</i> , <i>Aspergillus niger</i>                                            | $\beta$ -Glucan hydrolysis in brewing                                              |
| Glucoamylase        | <i>Aspergillus niger</i> , <i>Bacillus amyloliquifaciens</i>                                   | Glucose syrup production from liquefied starch                                     |
| Glucose isomerase   | <i>Anthrobacters</i> , <i>Bacillus</i> sp.                                                     | Isomerisation of glucose into high fructose syrups                                 |
| Lactase             | <i>Saccharomyces fragilis</i> ,<br><i>Kluyveromyces marxianus</i>                              | Hydrolysis of lactose<br>Removal of lactose from whey                              |
| Lipase              | <i>Aspergillus</i> sp., <i>Candida lipolytica</i>                                              | Cheese and butter preparation, flavour modification                                |
| Pectinase           | <i>Aspergillus niger</i>                                                                       | Extraction and clarification of fruit juices                                       |
| Penicillin amidase  | <i>Bacillus megatherium</i> , <i>Escherichia coli</i>                                          | Synthesis of 6-aminopenicillanic acid for manufacture of semisynthetic antibiotics |
| Protease (alkaline) | <i>Bacillus licheniformis</i>                                                                  | Detergent and leather industries                                                   |

|                    |                                           |                                           |
|--------------------|-------------------------------------------|-------------------------------------------|
| Protease (neutral) | <i>Bacillus amyloliquefaciens</i>         | Fish and meat tenderiser                  |
| Protease (acid)    | <i>Aspergillus niger</i>                  | Digestive aid, substitute for calf rennet |
| Pullulanase        | <i>Klebsiella pneumoniae</i>              | Starch hydrolysis                         |
| Streptokinase      | Hemolytic bacterium, <i>Streptococcus</i> | Lysis of blood clots                      |

### Production of Antibiotics

- The term **antibiotics** may be defined as a chemical substance produced by some microorganisms that in small concentration can kill or inhibit the growth of other harmful microorganisms without affecting the host.
- Antibiotics function either as **bactericides** (killing bacteria) or **bacteriostatic** (inhibiting growth of bacteria).
- Suitable strain of microorganism is cultivated on a sterilised nutrient medium provided with optimum pH, aeration, temperature, antifoaming agent and antibiotic precursor.
- When sufficient antibiotic has diffused into medium, the microorganisms are separated and the antibiotic is extracted from medium by precipitation, absorption or solvent. It is purified, concentrated and bioassayed before packing.
- The production of newer antibiotics is a never ending process because microbes continuously become resistant to older antibiotics. *S. griseus* produces more than 41 antibiotics while *Bacillus subtilis* can give about 60 antibiotics.

### Production of Food and Drinks

- Some of the oldest biotechnology procedures are concerned with the manufacture of various foods and drinks.
- Yeast fermentation** or alcoholic fermentation are carried out to produce bread, brewing or malting of sugars from barley grain to obtain beer and production of other alcoholic drinks such as wine, brandy, rum, whisky, etc., by distillation.
- Microbial fermentation** involves large scale fermentation of various microbes capable of producing specific vitamins. These vitamins are essential for normal health and complete growth of organisms.

### Industrial Biotechnology

#### Recovery of metals

Various microbes are employed to recover valuable metals from low grade ores and from dilute solutions. This process is called as **microbial ore leaching**, e.g., *Thiobacillus ferrooxidans* induces leaching of copper as copper sulphates from ores.

#### Biotransformation

It is the process by which organic compounds are transformed into other recoverable products by the use of enzymes present in microbes, plants or animal cells, e.g., biotransformation is used to produce several antibiotics and steroids.



#### Production of biocontrol agents

The microorganisms used to control insects, pests, pathogens and even weeds are considered biocontrol agents. Such wide strains of bacteria and fungi are developed on large scale in fermenters.

#### Production of biofertilisers

Microorganisms used to enhance availability of nutrients, viz., nitrogen and phosphorus are produced and made available commercially, e.g., *Rhizobium*, *Azotobacter*, *Azospirillum*, blue green algae.

#### Metabolite production

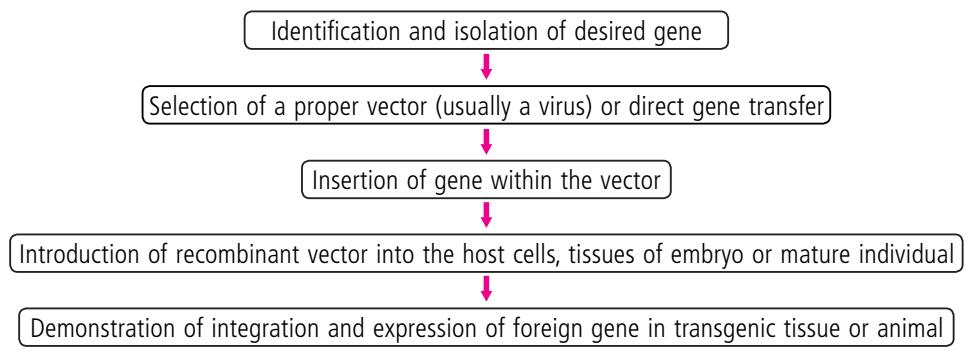
Various metabolites such as acetone, alcohol, antibiotics, enzymes, organic acids, etc., are produced using variety of microorganisms concerned.

### TRANSGENIC ANIMALS

- A transgenic animal contains a foreign gene in its genome introduced by one or the other technique of **transfection**.

## Production of Transgenic Animals

- The **foreign genes** are inserted into the genome of the animal using recombinant DNA technology.



## Applications of Transgenic Animals

### Production of biological products

Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product. Such as human protein ( $\alpha$ -1-antitrypsin) to treat emphysema, human alpha lactalbumin, etc.

### Production of clones

Clones of animals with desirable traits can be produced.

### Replacement of defective parts

Defective parts can be replaced with freshly grown parts from own cells or transgenic animals.

### Study of physiology and development

Transgenic animals are developed to study how genes are regulated and how they affect normal functions of body and its development, e.g., study of factors involved in growth.

### Testing vaccine safety

Before being used on humans, transgenic mice are used to test safety of newly developed vaccines, e.g., transgenic mice was used to test safety of polio vaccine.

### Study of diseases

Transgenic animals act as models for study and understanding of causes and possible treatments of disease in concern, e.g., cancer, cystic fibrosis, Alzheimer's disease.

## Examples of Transgenic Animals

### Transgenic cattle

- The only successful transfection technique in cattle is **microinjection of fertilised ova**, which may either be recovered surgically or may be obtained from ovaries extracted from slaughtered cows and cultured *in vitro*.
- The chief objectives** of transgenic cattle production are as follows:
  - increased milk or meat production
  - molecular farming
  - improved properties and proportions of casein in milk.
  - regulate content of lactose and butterfat in milk
  - enhanced resistance to viral and bacterial pathogens.
- The name of first transgenic cow is Rosie.

## Transgenic mice

- Mouse is the most preferred mammal for studies on gene transfer.
- Favourable features of mice as a suitable model are:
  - short oestrous cycle and gestation period
  - relatively short generation time
  - production of several offsprings per pregnancy (*i.e.*, litter)
  - convenient *in vitro* fertilisation
  - successful culture of embryos *in vitro* at least for a period of time
  - production and maintenance of ES (embryonic stem) cell lines
  - availability of a diverse array of genetic stocks, etc.
- As a result, the techniques of gene transfer and transgenic production have been developed using mice as models.

### Ethical Issues

The main bioethical concerns pertaining to biotechnology are briefly mentioned as follows:

Introduction of a transgene from one species into another species violates the '**integrity of species**'.

Biotechnology may pose unforeseen risks to the environment, including risk to biodiversity.  
Thus, it could **disturb the existing ecological balance**.

Transfer of human genes into animals (*and vice-versa*) **dilutes the concept of 'humanness'**.

**Use of animals** in biotechnology causes great suffering to them.

Scientists cannot rule out the possibility of other **biological damage**. It can accidentally create new infectious agents.

When animals are used for production of pharmaceutical proteins, they are virtually reduced to the **status of a 'factory'**.

It is disrespectful to living beings and only exploits them for the **benefit of human beings**.

## Role of biotechnology in Environment

Biotechnology is applied for processes to protect and restore the quality of environment. It is used to detect, prevent and remediate the emission of pollutants into the environment in a number of ways. It also makes a significant contribution to sustainable development.

Some important applications are aimed at:

- processes that make optimal use of natural resources by recycling biomass, recovering energy and minimising waste generation
- use of biotechnological techniques for bioremediation of land and water, waste treatment, soil conservation, reforestation, land rehabilitation, etc.,
- biodegradation of xenobiotic compounds.

### Bioremediation

**Bioremediation** refers to the process of removal or detoxification of pollutants from contaminated sites, with the use of biological organisms as bacteria, fungi or plants. Certain bacterial, fungal and algal species capable of accumulating some toxic inorganic contaminants are developed in the laboratory and introduced at the site. **Phytoremediation** on the other hand is use of green plants and their associated microorganisms, soil amendments to remove both organic and inorganic contaminants.

## GENETICALLY ENGINEERED MICROBES (GEMS)

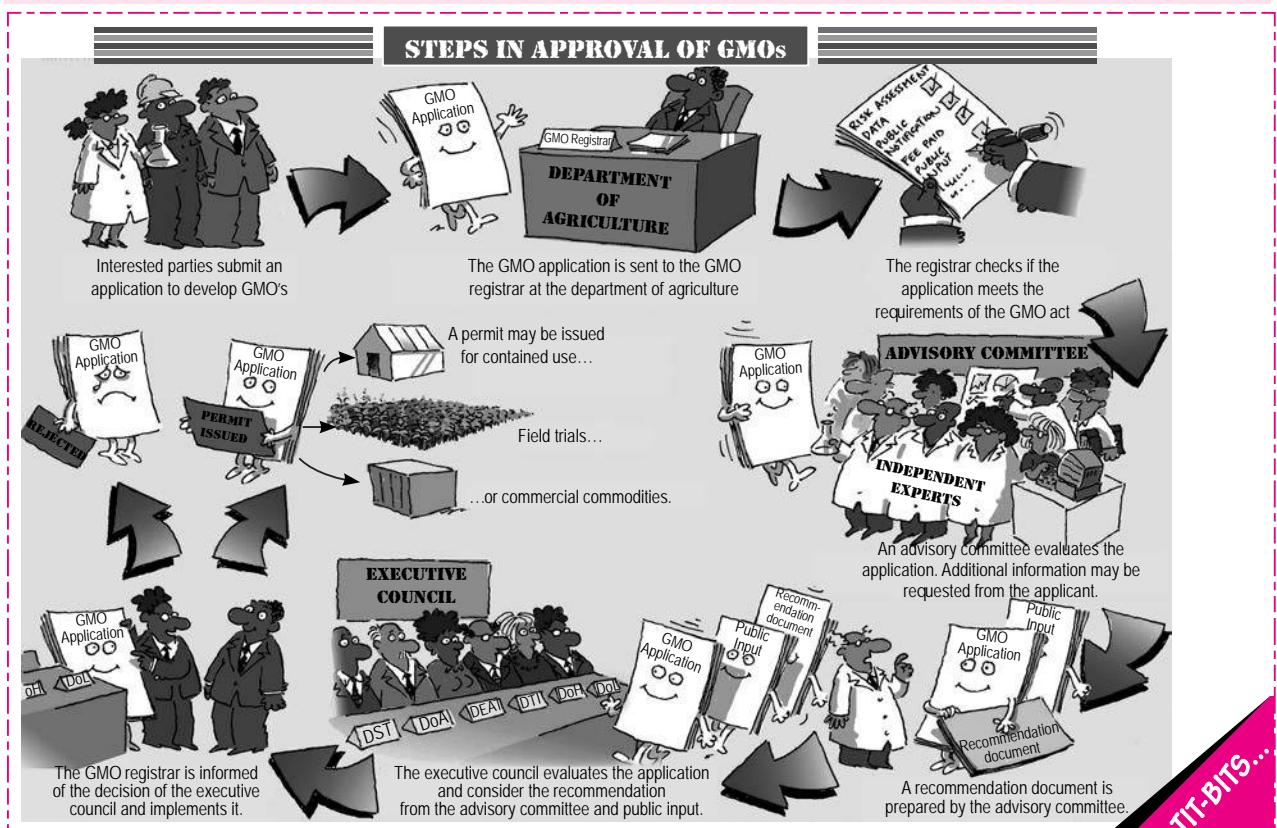
The microorganism in which a gene or genes have been introduced by r-DNA technology are referred to as genetically engineered microbes. Such microbes are developed to fulfil specific needs and perform functions such as :

- Producing pharmaceutically useful proteins
- Protection of crops from insects (e.g., *Clavibacter* containing *cry* gene), fungal diseases (e.g., *Pseudomonas* expressing chitinase gene from *Serratia*), frost damage (e.g., *ice* mutants of *Pseudomonas fluorescens*, since *ice* gene regulates ice crystal formation at low temperatures), etc.
- Enhancing nitrogen fixation by amplification of *nif* genes in *R. meliloti*.

### ***Pseudomonas putida*- A superbug**

This genetically engineered bacteria was developed by using plasmids from four species of oil eating bacteria and joined to form recombinant plasmid and introduced into the bacteria. This plasmid conferred the ability to digest the four types of petro-chemical products i.e., octane, xylene, camphor and naphthalene.

Hence, it is called a **superbug** or oil eating bug. It is a potent solution to the problem of soil petro pollution or oil spilling in sea.



# **POWER EXERCISE**

## **New MCQs**

1. During the formation of recombinant insulin, maturation of proinsulin into insulin is processed by
  - adding C-peptide to proinsulin
  - adding B-peptide to proinsulin
  - removal of C-peptide from proinsulin
  - removal of A-peptide from proinsulin.
2. The genetically modified crop of golden rice is a variety showing
  - insect resistance
  - herbicide resistance
  - golden coloured grains with large size
  - adequate quantities of provitamin A.

Exam Section

- 1.** Which kind of therapy was given in 1990 to a four-year-old girl with adenosine deaminase (ADA) deficiency?  
(a) Gene therapy      (b) Chemotherapy  
(c) Immunotherapy      (d) Radiation therapy  
*(NEET Phase-II 2016)*

**2.** Which part of the tobacco plant is infected by *Meloidogyne incognita*?  
(a) Stem      (b) Root  
(c) Flower      (d) Leaf  
*(NEET Phase-I 2016)*

**3.** Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of  
(a) omega 3      (b) vitamin A  
(c) vitamin B      (d) vitamin C.  
*(AIPMT 2015)*

- 4.** The introduction of T-DNA into plants involves  
 (a) exposing the plants to cold for a brief period  
 (b) allowing the plant roots to stand in water  
 (c) infection of the plant by *Agrobacterium tumefaciens*  
 (d) altering the pH of the soil, then heat-shocking the plants. *(AIPMT 2015)*
- 5.** Which organism is used to transfer T-DNA?  
 (a) *Streptomyces hygroscopicus*  
 (b) *Agrobacterium tumefaciens*  
 (c) *Salmonella typhi*  
 (d) *Escherichia coli* *(AIIMS 2015)*
- 6.** An example of gene therapy is  
 (a) production of injectable hepatitis B vaccine  
 (b) production of vaccines in food crops like potatoes which can be eaten  
 (c) introduction of gene for adenosine deaminase in persons suffering from severe combined immuno deficiency (SCID)  
 (d) production of test tube babies by artificial insemination and implantation of fertilised eggs. *(AIIMS 2015)*
- 7.** Select the wrong statement.  
 (a) Human insulin is being commercially produced from a transgenic species of *Escherichia coli*.  
 (b) The genetically modified *Bacillus thuringiensis* is used as biopesticide on the commercial scale.  
 (c) Human protein, alpha-1-antitrypsin is used to treat emphysema.  
 (d) The first transgenic cow, Rosie, produced alpha lactalbumin enriched milk.  
 (e) Bt toxin gene *cry* IAc controls the corn borer. *(Kerala PMT 2015)*
- 8.** The microbial biocontrol agent for butterfly caterpillar is  
 (a) *Bacillus thuringiensis* (b) *Saccharomyces*  
 (c) *Lactobacillus* (d) Cyanobacteria  
 (e) *Staphylococcus*. *(Kerala PMT 2015)*
- 9.** A dicotyledonous plant forms crown gall when  
 (a) *Agrobacterium tumefaciens* comes in contact with the plant  
 (b) *Agrobacterium rhizogenes* comes in contact with the plant  
 (c) a specific part of DNA from the Ti plasmid gets integrated with the plant chromosome  
 (d) a specific part of DNA from the Ri plasmid gets integrated with the plant chromosome. *(WB JEE 2015)*
- 10.** Genetic engineered male sterile crop plants may be produced by inserting  
 (a) Bt toxin gene (b) barnase gene  
 (c) lectin gene (d) chitinase gene. *(AMU 2015)*
- 11.** A transgenic food crop which may help in solving the problem of night blindness in developing countries is  
 (a) Golden rice (b) Flavr-Savr tomatoes  
 (c) Starlink maize (d) Bt soybean. *(J & K 2015)*
- 12.** The hybridoma cell concept was introduced by  
 (a) Kohler and Milstein  
 (b) Schleiden and Schwann  
 (c) Karry Mullis  
 (d) J. Ingenhousz. *(UP CPMT 2015)*
- 13.** The first human hormone produced by recombinant DNA technology is  
 (a) insulin (b) estrogen  
 (c) thyroxin (d) progesterone. *(AIPMT 2014)*
- 14.** Which of the following genes do not occur naturally in living organisms?  
 (a) *Bt* genes (b) RNAi genes  
 (c) *cry* genes (d) Endogenous cytoplasmic defense genes *(AIIMS 2014)*
- 15.** RNA interference which is employed in making tobacco plant resistant to *Meloidogyne incognita* is essentially involved in  
 (a) preventing the process of replication of DNA  
 (b) preventing the process of translation of mRNA  
 (c) preventing the process of splicing of hnRNA  
 (d) preventing the process of transcription. *(Karnataka CET 2014)*

### Assertion & Reason

The following questions consist of two statements each : assertion (A) and reason (R). To answer these questions, mark the correct alternative as directed below :

- (a) If both A and R are true and R is the correct explanation of A.
- (b) If both A and R are true but R is not the correct explanation of A.
- (c) If A is true but R is false.
- (d) If both A and R are false.

**1. Assertion :** GM crops pose risk of causing toxicity and allergic reaction in humans.

**Reason :** The transgenes in commercial crops can endanger native species.

**2. Assertion :** Transgenic tobacco plant is resistant to nematode *Meloidogyne incognita*.

**Reason :** *Agrobacterium* vectors deliver nematode specific genes into the host tobacco plant.

- 3. Assertion :** Transgenic animals are used to produce useful biological products such as  $\alpha$ -1 antitrypsin to treat emphysema.  
**Reason :** Transgenic animals are not safe for the production and consumption of biological products for human use.
- 4. Assertion :** Human insulin cannot be synthesised using bacterial cells.  
**Reason :** Bacterial genes possess introns.
- 5. Assertion :** The recombinant vaccines consist of critical antigen expressed by the gene in bacteria or other microbes.  
**Reason :** The sub-unit vaccines are small part of the polypeptide, constituting the entire vaccine, that are effective against immunisation.

### Short Answer Type Questions

- Fill in the blanks.
  - The shelf life of transgenic tomato is prolonged due to non-availability of \_\_\_\_\_ enzyme.
  - Introduction of genes into somatic cells to correct the defective gene is called \_\_\_\_\_.
  - All the decisions regarding the validity and safety of introducing genetically modified organisms are done by organisations as \_\_\_\_\_.
- Write a short note on RNA interference which confers resistance against nematodes in tobacco plant.
- Discuss some of the ethical issues concerned with the use and production of transgenic animals.
- Illustrate the steps in the production of human insulin using a prokaryotic cell with the help of a diagram.

### ANSWER KEY

#### New MCQ

- |         |         |         |         |         |
|---------|---------|---------|---------|---------|
| 1. (c)  | 2. (d)  | 3. (b)  | 4. (b)  | 5. (c)  |
| 6. (c)  | 7. (c)  | 8. (b)  | 9. (c)  | 10. (d) |
| 11. (d) | 12. (c) | 13. (c) | 14. (d) | 15. (a) |

#### Exam Section

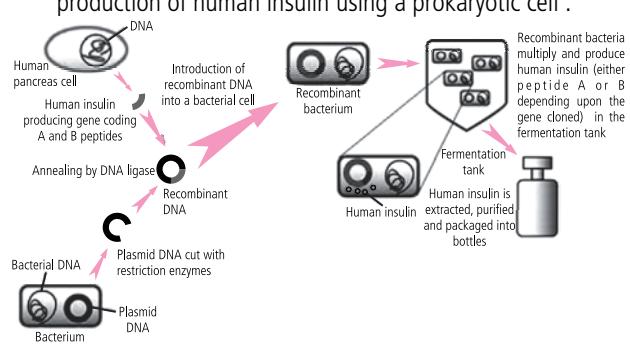
- |         |         |         |         |         |
|---------|---------|---------|---------|---------|
| 1. (a)  | 2. (b)  | 3. (b)  | 4. (c)  | 5. (b)  |
| 6. (c)  | 7. (e)  | 8. (a)  | 9. (c)  | 10. (b) |
| 11. (a) | 12. (a) | 13. (a) | 14. (d) | 15. (b) |

#### Assertion & Reason

- |        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 1. (b) | 2. (a) | 3. (c) | 4. (d) | 5. (b) |
|--------|--------|--------|--------|--------|

### Short Answer Type Questions

- (i) polygalacturonase      (ii) somatic cell gene therapy  
                                   (iii) Genetic Engineering Approval Committee (GEAC)
- RNA interference is the phenomenon of inhibiting activity of a gene by synthesis of RNA molecules complementary to mRNA. The complementary strand of mRNA does not contain sequences that can be translated to produce a functional protein hence called antisense RNA. The antisense RNA and mRNA molecules anneal to form duplex RNA molecules, which block translation of mRNA of affected gene.  
     The specific genes of nematode are transferred to the host tobacco plant using *Agrobacterium* vectors. Introduction of this DNA produces both sense and antisense RNA in host cells. The two RNAs being complementary to each other forms a dsRNA and thus gets silenced as the protein is not synthesised. In this way, the tobacco plant becomes resistant to nematode infection.
- The major bioethical concerns regarding the use and production of transgenic animals are :
  - Introduction of a transgene from one species into another species violates the 'integrity of species'.
  - Biotechnology may pose unforeseen risks to the environment, including risk to biodiversity. Thus, it could disturb the existing ecological balance.
  - Transfer of human genes into animals (and *vice-versa*) dilutes the concept of 'humanness'.
  - Use of animals in biotechnology causes great suffering to them.
  - Scientists cannot rule out the possibility of other biological damage. It can accidentally create new infectious agents.
  - When animals are used for production of pharmaceutical proteins, they are virtually reduced to the status of a 'factory'.
  - It is disrespectful to living beings and only exploits them for the benefit of human beings.
- The given diagram illustrates the steps involved in the production of human insulin using a prokaryotic cell :



# NCERT Xtract

New

## Questions for NEET

### Principles of Inheritance and Variation

1. Which of the following cannot be inferred from Mendel's dihybrid cross?
  - (a) Two new combinations of traits, different from parental types appear
  - (b) Plants with four different phenotypes were produced in  $F_2$  generation
  - (c) In  $F_2$  generation, the factors for the two characters assort independently
  - (d) Single trait may be controlled by more than two alleles of a gene
2. Consider the following statements regarding the chromosomal theory of inheritance and select the correct ones.
  - I. Chromosomes as well as genes occur in pairs in diploid cells.
  - II. The two alleles of a gene pair are located on homologous sites of heterologous chromosomes.
  - III. Chromosomes are carriers of Mendelian factors which segregate and assort independently during meiosis at the time of gamete formation.
  - IV. Pairing and separation of chromosomes during meiosis leads to segregation of a pair of unit factors.
  - (a) I, II and IV
  - (b) II and III
  - (c) I, III and IV
  - (d) All of these
3. Which of the following represents the phenomenon of incomplete linkage?
  - (a) Separation of two genes present on the same chromosome due to crossing over.
  - (b) Inheritance of genes in a way that one gene suppresses the expression of other genes.
  - (c) Expression of heterozygous phenotype is intermediate to phenotype of both the parents.
  - (d) Genes located on same chromosome always get inherited and expressed together.
4. Select the correct statement regarding the phenomenon of co-dominance.
  - (a) In offsprings, the effect of one of the two alleles is more prominent.
  - (b) The effect in hybrid is a fine mixture of expression of two alleles.
  - (c) The alleles show quantitative effect.
  - (d) The expressed phenotype is a combination of two phenotypes and their alleles.
5. Select the correct statements regarding sex determination.
  - I. In grasshoppers, the females are homogametic (XX) while, males are heterogametic carrying X and Y chromosomes.
  - II. In pigeon, the females are heterogametic (ZW) while the males are homogametic (ZZ).
  - III. In butterflies, the females are homogametic (ZZ) while the males are heterogametic with odd sex chromosome (ZO).
  - IV. In *Drosophila*, the females are homogametic (XX) and males are heterogametic (XY).
  - (a) I, II and III
  - (b) II, III and IV
  - (c) II and IV
  - (d) I, II, III and IV
6. Read the following statements and select the incorrect ones regarding crossing over.
  - I. In single crossing over between two non-sister chromatids of homologous chromosome pair, two parental types and two recombinant types are formed.
  - II. Crossing over occurs at zygotene stage of prophase I, at four strand stage.
  - III. Complementary crossing over forms two cross-over and two non-cross over chromatids.
  - IV. Genes located closely on chromosome have more chances of forming recombinants.
  - (a) I, III and IV
  - (b) I, II and III
  - (c) II, III and IV
  - (d) I and II

- 7.** Though Mendel had published his results and conclusions in 1865, yet his work was unnoticed for so many years till 1900. The reason for this was mainly because
- he used statistical methods and mathematical logic for analysing his experiments
  - he failed to reproduce the same results with Hawkweed
  - concept of stable, unblending, discrete units for various traits did not find acceptance
  - all of these.
- 8.** When two pure line short horned cattle for red (RR) and white (WW) were cross bred, the individuals of  $F_1$  generation were neither red nor white but were roan coloured. This change in hair colour of cattle is due to the phenomenon of
- co-dominance
  - pleiotropy
  - incomplete dominance
  - dominance.
- 9.** Suppose if the recombination frequency between genes present on same chromosome, 'q' and 'r' is 13%, 'p' and 'r' is 2%, 'q' and 's' is 4%, 'q' and 'p' is 15% and 'r' and 's' is 17%. Based on these frequencies, identify the correct sequence of genes on the chromosome.
- p, q, r and s
  - p, r, q and s
  - r, p, q and s
  - s, q, p and r
- 10.** The genotype of a hybrid plant obtained from a cross can be determined by crossing the plant with
- pure dominant plant at  $F_2$  generation
  - pure recessive parent at  $F_2$  generation
  - heterozygous dominant parent at  $F_1$  generation
  - pure recessive parent at  $F_1$  generation.
- 11.** The presence of an extra X chromosome in genome of a human male indicates
- Turner's syndrome
  - Down syndrome
  - Klinefelter's syndrome
  - metamales.
- 12.** According to the chromosomal theory of linkage proposed by Morgan and Castle the incorrect statement is
- linked genes lie in a linear sequence in chromosome
  - linked genes may occur on same chromosome
  - linked genes have a tendency to maintain parental combination of genes
  - the strength of linkage between genes is directly proportional to distance between them.
- 13.** Read the following statements and choose the incorrect one.
- Recessive allele is influenced in the presence of dominant allele.
  - In  $F_2$  generation, of a Mendelian monohybrid cross, the tall and dwarf traits were identical to their parental types and shows blending inheritance.
  - Large sampling size of Mendelian experiments gave greater credibility to the data collected.
  - Multiple alleles can be found only after study of populations.
- 14.** If the factors responsible for pod shape and pod colour in a pea plant, studied by Mendel to understand inheritance of two genes were located closely on same chromosome, then which of the following would not have been explained?
- Law of dominance
  - Law of segregation
  - Law of independent assortment
  - Both (b) and (c)
- 15.** If the mother is heterozygous for disease haemophilia and father suffers from the disease, then what would be the probability of their son being haemophiliac?
- 100%
  - 50%
  - 25%
  - 75%
- 16.** Identify the incorrectly described statements regarding sex linked inheritance.
- Sex linked traits are inherited together and determined by genes present on sex chromosomes.
  - Sex influenced traits are autosomal traits expressed in response to sex hormones in a particular sex only.
  - Sex limited traits are expressed as a result of by-products of sex hormones and not due to expression of gene.
  - Haemophilia and colourblindness are sex linked diseases in humans.
- II and IV
  - I and III
  - II and III
  - III and IV
- 17.** Which of the following is correct for the progenies showing incomplete dominance?
- $F_1$  is similar to the dominant parent.
  - There is no mixing of the effect of the two alleles.
  - The genotypic ratio is similar to phenotypic ratio.
  - All of these
- 18.** When pureline plant with violet flowers is crossed with pureline plant having white flowers, then all plants of  $F_1$  generation bears violet flowers. What would be the proportion of plants with white flowers in generation produced by selfing of  $F_1$  plants?
- $\frac{1}{4}$
  - $\frac{1}{2}$
  - $\frac{1}{3}$
  - $\frac{3}{4}$
- 19.** A condition in which two different alleles of a gene are present in a single diploid cell of an individual is called
- homozygous
  - heterozygous
  - hemizygous
  - dihybrid.
- 20.** Which of the following best explains the mechanism of inheritance with respect to Mendel's law of segregation and independent assortment?
- A trait or character is inherited independent of the other character.

- (b) The expression of one trait is modified in the presence of other trait.  
 (c) A trait is always inherited in combination with the other.  
 (d) All of these
- 21.** Select the correctly matched pair.  
 (a) Sickle cell anaemia - X chromosome  
 (b) Haemophilia - Y chromosome  
 (c) Down syndrome - 21<sup>st</sup> chromosome  
 (d) Colourblindness - 7<sup>th</sup> chromosome
- 22.** Read the given statements and select the correct option.  
**Statement A :** Y-linked disorders are rare.  
**Statement B :** Y chromosome do not contain many genes and these disorders are inherited from father to son.  
 (a) Both statements A and B are true and B is the correct explanation of A.  
 (b) Both statements A and B are true but B is not the correct explanation of A.  
 (c) Statement A is true but statement B is false.  
 (d) Both statements A and B are false.
- 23.** If the child has blood group O, then which of the following would not be the blood groups of parents?  
 (a) A and B (b) A and A  
 (c) AB and B (d) B and O
- 24.** How many Barr bodies will be observed in an individual with genotype 44+XXX?  
 (a) 3 (b) 2  
 (c) 1 (d) 4
- 25.** Read the following statements and select the correct ones.  
 I. Linkage chromosome maps depict the exact physical distance amongst genes.  
 II. The sequence of genes in a chromosome can be determined by chromosome maps.  
 III. Frequency of linkage increases with the increase in the distance but decreases with increase in age.  
 IV. Chromosome maps can predict the result of breeding experiments.  
 (a) I and III (b) III and IV  
 (c) II and IV (d) I, II, III and IV
- 26.** The phenomenon, in which an allele of one gene suppresses the activity of an allele of another gene, is known as  
 (a) epistasis (b) dominance  
 (c) suppression (d) inactivation.
- 27.** Consider the following three cases with respect to sex determination in *Drosophila* and select the correct option.
- |                      |                      |                        |
|----------------------|----------------------|------------------------|
| P. $\frac{X}{A} = 1$ | Q. $\frac{X}{A} > 1$ | R. $\frac{X}{A} = 0.5$ |
| <b>P</b>             | <b>Q</b>             | <b>R</b>               |
| (a) Female           | Metafemale           | Male                   |
| (b) Male             | Female               | Metafemale             |
| (c) Female           | Male                 | Intersex               |
| (d) Metafemale       | Female               | Male                   |
- 28.** Consider the following statements regarding Punnett square and select the correct option.  
 I. Punnett square was developed by a British geneticist, R.C. Punnett.  
 II. It is a mathematical equation to calculate the probability of all possible genotypes of offspring in a genetic cross.  
 III. Punnett squares may act as standard tools used by genetic counsellors to determine the appearance of a genetic disease in the progenies.  
 IV. Punnett square can be used to study only monohybrid crosses.  
 V. Punnett square can be effectively used to understand the independent segregation of the two pairs of genes during meiosis.  
 (a) I and IV (b) II and V  
 (c) I, III and V (d) All of these
- 29.** Which cross helps to increase useful traits in a population?  
 (a) Back cross (b) Reciprocal cross  
 (c) Test cross (d) All of these
- 30.** If a normal man marries a woman, carrier for colourblindness then what are the chances of their child being colourblind?  
 (a) 25% (b) 50% (c) 75% (d) 33%
- 31.** Match the column I with column II and III and select the correct option.
- | <b>Column I</b>        | <b>Column II</b>                          | <b>Column III</b>                                |
|------------------------|-------------------------------------------|--------------------------------------------------|
| A. Albinism            | (p) Decreased synthesis of globin chain   | (i) Autosomal, recessive genetic disorder        |
| B. Thalassemia         | (q) Absence of homogenetic oxidase enzyme | (ii) Urine turns black on exposure to air        |
| C. Sickle cell anaemia | (r) Absence of enzyme tyrosinase          | (iii) Replacement of glutamic acid with valine   |
| D. Alkaptonuria        | (s) Homozygous recessive genes            | (iv) Adequate haemoglobin not generated in blood |
- (a) A-(q)-(iii), B-(p)-(iv), C-(r)-(ii), D-(s)-(i)  
 (b) A-(r)-(i), B-(p)-(iv), C-(s)-(iii), D-(q)-(ii)  
 (c) A-(p)-(i), B-(r)-(iv), C-(q)-(iii), D-(s)-(ii)  
 (d) A-(r)-(i), B-(q)-(iv), C-(s)-(ii), D-(p)-(iii)
- 32.** Which of the given statements best explains the Mendel's law of segregation?  
 (a) Only one allele of a pair expresses itself in a hybrid and prevents expression of the other allele.  
 (b) Alleles of a pair separate from each other during gamete formation.  
 (c) Alleles of two pairs get randomly rearranged in offspring during fertilisation.  
 (d) Both (b) and (c).

- 33.** Read the given statements and select the correct option.  
**Statement A :** According to Bridges, in *Drosophila*, both Y-chromosome and autosomes are responsible for fertility and sex determination in males.  
**Statement B :** In *Drosophila*, autosomes are responsible for feminine characteristics.
- Both statements A and B are true and B is the correct explanation of A.
  - Both statements A and B are true but B is not the correct explanation of A.
  - Statement A is true but statement B is false.
  - Both statements A and B are false.

- 34.** Select the incorrectly matched pair.

- |                          |           |
|--------------------------|-----------|
| (a) Monohybrid cross     | - 3:1     |
| (b) Dihybrid cross       | - 9:3:3:1 |
| (c) Incomplete dominance | - 1:2:1   |
| (d) Test cross           | - 1:3:1   |

- 35.** Consider the following statements regarding chromosomal aberrations and select the incorrect ones.
- Chromosomal aberrations refers to changes in number and arrangement of genes in the chromosomes.
  - Aneuploidy refers to the condition in an individual where the genome comprises of extra or fewer chromosomes than its normal number.
  - Heteroploidy occurs due to non-disjunction of chromosomes of homologous pair.
  - Nullisomy is a type of hyperploidy in which one chromosome is devoid of its homologue.
- II and III
  - IV only
  - II only
  - I, III and IV

- 36.** Barr body in humans refers to

- heterochromatin in both male and female cells
- Y chromosomes in somatic cells of male
- inactive X chromosome in somatic cells of female
- euchromatin in female cells only.

- 37.** A female shows certain characteristics as

- Short stature and narrow hips
- Undeveloped ovaries and breasts

- III. Absence of menstruation

- IV. Cardiovascular abnormalities

These traits indicate that the female suffers from

- Down syndrome
- Turner's syndrome
- Klinefelter's syndrome
- thalassemia.

- 38.** The hologenic type of inheritance refers to transfer of traits from

- father to son
- father to grandson through his daughter
- mother to daughter
- mother to granddaughter through her son.

- 39.** Select the correct statement regarding nondisjunction of chromosomes.

- Nondisjunction refers to failure of synapsed homologous chromosomes to separate during metaphase I of meiosis.
- Nondisjunction was first discovered by Morgan in XX chromosomes in *Drosophila*.
- The initial nonseparation of synapsed chromosomes that occurs in meiocytes is called secondary nondisjunction.
- White eyed female when crossed with red eyed males produced a number of abnormal flies, i.e., XXY, XXX, YYY due to secondary nondisjunction.

- 40.** From the given features, identify the type of cross being performed.

- The cross is both sided in which female of one type is crossed with male of the second type and *vice versa*.
  - It allows to study inheritance of two or more traits.
  - It can differentiate between nuclear and cytoplasmic inheritance as well as sex linked and autosomal inheritance.
- Test cross
  - Monohybrid cross
  - Reciprocal cross
  - Back cross



## HIGHER ORDER THINKING SKILLS QUESTIONS (HOTS)

- 41.** From the given pattern of gene inheritance for a particular trait, identify the type of gene associated with it.
- Trait appears more often in males as compared to females.
  - Trait rarely appears in both father and son.
  - Females when homozygous for such trait, passes it to all her sons.

- IV. Females show traits only if their father and mother both possess it.

- Autosomal recessive
- Sex-linked recessive
- Autosomal dominant
- Sex-linked dominant

- 42.** In maize, coloured endosperm (C) is dominant over colourless (c) and full endosperm (S) is dominant over shrunken (s). When a dihybrid of F<sub>1</sub> generation was test

crossed, it resulted in four phenotypes in given percentages.

Coloured and full - 48%

Coloured and shrunken - 5%

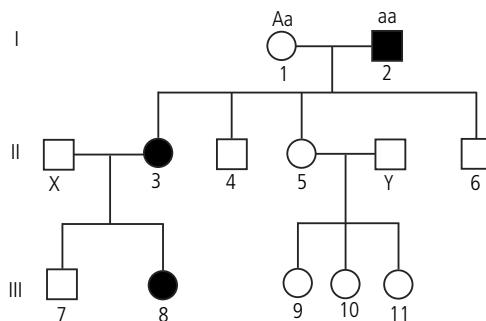
Colourless and full - 7%

Colourless and shrunken - 48%

Based on the above data, the distance between the two non-allelic genes is deduced to be

- (a) 48 units (b) 11 units  
(c) 7 units (d) 5 units.

- 43.** Consider the given pedigree analysis of the family members (comprising three generations) for the trait fused ear lobe. This autosomal recessive trait appears in the progeny only when its homozygous recessive (aa).



Based on the above facts, identify the correct genotype of individuals X and Y.

| X      | Y  |
|--------|----|
| (a) Aa | aa |
| (b) Aa | AA |
| (c) AA | Aa |
| (d) aa | Aa |

- 44.** In a monohybrid cross between pea plants homozygous for the gene of starch synthesis, i.e., BB and bb 'B' being dominant allele produces large and round starch grains seeds while 'b' results in smaller and round starch grains seeds. The resulting heterozygotes produce intermediate type of seed grains. This is a case of  
(a) co-dominance (b) incomplete dominance  
(c) pleiotropism (d) multiple allelism.

- 45.** A child with abnormal characteristics was diagnosed with a genetic disorder. On analysis of his genotype showed - 45+XY chromosomes.

The genetic disorder in concern can be identified as  
(a) Turner's syndrome (b) Down syndrome  
(c) Klinefelter's syndrome (d) Patau's syndrome.

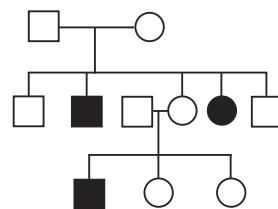
- 46.** A dwarf pea plant was treated with gibberellin and thus became tall. This treated pea plant was then crossed with a homozygous tall pea plant. The results in F<sub>2</sub> generation are expected to be  
(a) all tall  
(b) 50% tall and 50% dwarf

- (c) tall and dwarf in 3:1 ratio

- (d) all dwarf.

- 47.** The linkage map of a chromosome of *Drosophila* has 45 linkage groups, with yellow body (y) gene at one end and bobbed hair (b) gene at its other end. The recombination frequency between these two genes 'y' and 'b' will be  
(a) 45% (b) ≤ 50% (c) ≥ 50% (d) 100%.

- 48.** Consider the given pedigree analysis for a disease and identify the type of disease.



- (a) Sex linked recessive  
(b) Autosomal recessive  
(c) Autosomal dominant  
(d) Sex linked dominant

- 49.** A geneticist infers that the two alleles for coat colour in cattle show incomplete dominance. The best method to obtain evidence in support of his hypothesis is performing  
(a) a test cross of homozygous recessive cattle to unknown genotype  
(b) selfing of F<sub>1</sub> cattle to obtain 1:2:1 ratio  
(c) a cross with true breeding cattle of different colour to obtain an intermediate phenotype in the F<sub>1</sub>  
(d) a reciprocal cross where the sex of cattle of each coat colour is reversed.

- 50.** A colourblind woman, marries a normal man. What proportion of his sons and daughters will be colourblind?

| Sons     | Daughters |
|----------|-----------|
| (a) 50%  | 50%       |
| (b) 100% | -         |
| (c) 75%  | 25%       |
| (d) 25%  | 25%       |

### ANSWER KEY

- |         |         |         |         |         |
|---------|---------|---------|---------|---------|
| 1. (d)  | 2. (c)  | 3. (a)  | 4. (d)  | 5. (c)  |
| 6. (c)  | 7. (d)  | 8. (a)  | 9. (b)  | 10. (b) |
| 11. (c) | 12. (d) | 13. (b) | 14. (c) | 15. (b) |
| 16. (c) | 17. (c) | 18. (a) | 19. (b) | 20. (a) |
| 21. (c) | 22. (a) | 23. (c) | 24. (b) | 25. (c) |
| 26. (a) | 27. (a) | 28. (c) | 29. (a) | 30. (a) |
| 31. (b) | 32. (b) | 33. (d) | 34. (d) | 35. (b) |
| 36. (c) | 37. (b) | 38. (c) | 39. (d) | 40. (c) |
| 41. (b) | 42. (b) | 43. (b) | 44. (b) | 45. (b) |
| 46. (c) | 47. (b) | 48. (b) | 49. (c) | 50. (b) |



# MPP-4

# MONTHLY Practice Problems

Class XII

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

- Evolution
- Human Health and Disease

Total Marks : 160

1. Select the incorrectly matched pair of organisms and their description.
  - (a) *Neopalina* – Connecting link between annelida and arthropoda
  - (b) *Archaeopteryx* – Missing link between birds and reptiles
  - (c) *Seymouria* – Missing link between amphibians and reptiles
  - (d) *Ornithorhynchus* – Connecting link between reptiles and mammals
2. Identify the option that correctly indicates the sequence in which the organisms first evolved on earth.
  - I. Aerobic photoautotrophs
  - II. Anaerobic chemoheterotrophs
  - III. Anaerobic photoautotrophs
  - IV. Anaerobic chemoautotrophs
  - (a) II → I → IV → III
  - (b) I → III → IV → II
  - (c) IV → II → I → III
  - (d) II → IV → III → I
3. Read the following statements regarding humoral immunity and select the incorrect one.
  - (a) It does not provide immunity against cancer.
  - (b) Antibodies that circulate in the blood and lymph form its main component.
  - (c) It defends the body against all kinds of pathogens.
  - (d) It does not get activated following an organ transplant in a patient.
4. Refer to the given table showing stages in life cycle of *Plasmodium* and select the correct option for A, B and C.

| Host                      | Stage       | Site  |
|---------------------------|-------------|-------|
| <i>Anopheles</i> mosquito | Ookinete    | A     |
| Man                       | B           | Liver |
| Man                       | Gametocytes | C     |

Time Taken : 40 Min.

- | A                   | B           | C     |
|---------------------|-------------|-------|
| (a) Stomach         | Merozoites  | RBCs  |
| (b) Salivary glands | Merozoites  | Liver |
| (c) Salivary glands | Sporozoites | RBCs  |
| (d) Stomach         | Sporozoites | RBCs  |
5. The theory which states that life reached earth from some unknown part of the universe in the form of spores is known as (i). It was proposed by (ii).
    - (i) cosmozoic theory
    - (ii) Georges Cuvier
    - (a) biogenesis theory
    - (b) Preyer
    - (c) theory of Panspermia
    - (d) Richter
  6. The type of speciation found in flightless grasshoppers, occurring at the edge of parent species range is called
    - (a) sympatric speciation
    - (b) parapatric speciation
    - (c) quantum speciation
    - (d) allopatric speciation.
  7. The type of immunity obtained by administration of anti-tetanus serum to a recipient is called
    - (a) artificial active immunity
    - (b) natural passive immunity
    - (c) natural active immunity
    - (d) artificial passive immunity.
  8. Select the mismatched pair.
    - (a) Kala-azar – *Glossina palpalis*
    - (b) Elephantiasis – *Culex* mosquito
    - (c) Bubonic plague – Rat flea
    - (d) Malaria – *Anopheles* mosquito
  9. Which of the following statements about Stanley Miller and Urey's experiment are correct?
    - I. The mixture used for the experiment contained CH<sub>4</sub>, H<sub>2</sub>, NH<sub>3</sub> and water vapour.

- 10.** Match column I with column II and select the correct option from the codes given below.

| <b>Column I</b>          | <b>Column II</b>               |
|--------------------------|--------------------------------|
| A. Age of fishes         | (i) Carboniferous Period       |
| B. Origin of mammals     | (ii) Devonian Period           |
| C. Age of herbs          | (iii) Jurassic Period          |
| D. Age of amphibians     | (iv) Triassic Period           |
| E. Origin of angiosperms | (v) Quaternary Period          |
| (a) A-(ii)      B-(i)    | C-(iii)      D-(iv)      E-(v) |
| (b) A-(iii)      B-(ii)  | C-(i)      D-(iv)      E-(v)   |
| (c) A-(ii)      B-(iv)   | C-(v)      D-(i)      E-(iii)  |
| (d) A-(i)      B-(ii)    | C-(iv)      D-(v)      E-(iii) |

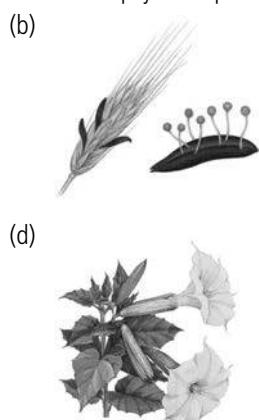
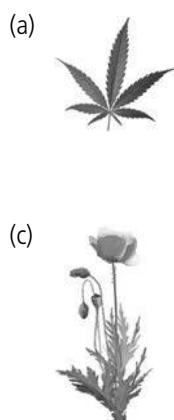
11. Refer to the given table showing differences between allopatric speciation and sympatric speciation.

| <b>Allopatric speciation</b> |                                                        | <b>Sympatric speciation</b>                              |
|------------------------------|--------------------------------------------------------|----------------------------------------------------------|
| (i)                          | It occurs in an isolated population.                   | It occurs from a segment within a population.            |
| (ii)                         | The barrier is ecological and genetic.                 | The barrier is physical.                                 |
| (iii)                        | There are chances of breakdown of isolating mechanism. | Chances of breakdown of isolating mechanism are rare.    |
| (iv)                         | Speciation is rapid.                                   | Speciation is slow.                                      |
| (v)                          | Barriers to interspecific crossings are fewer.         | Barriers to interspecific crossings are more pronounced. |

Which of the above cited differences are not correct?

- (a) (i), (iii) and (iv)      (b) (ii), (iii) and (v)  
 (c) (ii) and (iv)      (d) (i) and (iv)

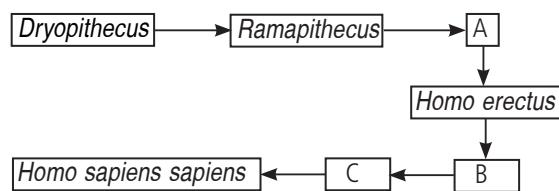
- 12.** Which of the following is a source for psychotropic drug?



13. Which one of the following statements is incorrect?

  - (a) The biogenetic law stating 'Ontogeny repeats phylogeny' was given by Von Baer.
  - (b) Auricular muscles in human beings are vestigial.
  - (c) Tooth buds and gill clefts found in bird embryos are temporary embryonic structures.
  - (d) Spiny and scaly anteaters show adaptive convergence.

- 14.** Given flow chart shows the chronological order of evolution of human from early to recent. Identify the missing links A, B and C from options given below



- (a) A – *Homo habilis*, B – *Australopithecus*,  
C – Cro-magnon man
  - (b) A – *Australopithecus*, B – Neanderthal man,  
C – *Homo habilis*
  - (c) A – *Homo habilis*, B – Cro-magnon man,  
C – *Homo sapiens fossilis*
  - (d) A – *Australopithecus*, B – Neanderthal man  
C – Cro-magnon man

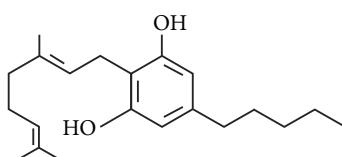
15. Mohit was suffering from high fever, pain in stomach and eyes, rashes on the body, bleeding from nose, frequent vomiting and excessive thirst. A blood test suggested by his doctor diagnosed him with



- 16.** Consider the following statements about antibodies and select the correct option stating which ones are true (T) and which ones are false (F).

- (i) All immunoglobulins are antibodies but all antibodies are not immunoglobulins.
  - (ii) IgA is abundant in colostrum and is passed on to the newborn baby to impart active immunity.
  - (iii) IgG and IgM participate in complement activation.
  - (iv) Antigen-antibody complex is formed by binding of specific antigen to  $F_{ab}$  part in the variable region of the antibody.

- |     | (i) | (ii) | (iii) | (iv) |
|-----|-----|------|-------|------|
| (a) | T   | F    | T     | F    |
| (b) | F   | F    | T     | T    |
| (c) | T   | T    | F     | F    |
| (d) | F   | F    | T     | F    |

- 17.** Read the following postulates regarding a theory of evolution and identify the scientist who gave them.
- Discontinuous variations are the raw material of evolution.
  - Accumulation of variations produce a new species.
  - Evolution is a discontinuous process.
- (a) Hugo de Vries      (b) Alfred Wallace  
 (c) Lamarck              (d) Darwin
- 18.** The mouthparts of some insects such as mosquitoes and butterflies are example of \_\_\_\_\_ organs which results from \_\_\_\_\_ evolution.
- (a) analogous, divergent  
 (b) homologous, divergent  
 (c) homologous, convergent  
 (d) analogous, convergent
- 19.** Select the correct statements for the drug having the following molecular structure.
- 
- I. It is obtained from *Cannabis*.  
 II. It causes hallucinations and affects the cerebrum along with sense organs.  
 III. Even slight excess of this drug can cause death.  
 (a) I and III      (b) I and II  
 (c) I, II and III      (d) II and III
- 20.** Select the correct statement regarding cell-mediated immune system.
- (a) The cell mediated immunity involves production of both B-cells and T-cells of immune system.  
 (b) The effector functions of cell mediated immunity involves cytolysis and lymphokine production.  
 (c) Its regulatory functions include increased production of antibodies.  
 (d) All of these
- 21.** Select the mismatched pair.
- (a) Alcoholism – Mallory Weiss Syndrome, Pancreatitis  
 (b) Toxoid – Tetanus vaccine, Diphtheria vaccine  
 (c) Homologous organs – Thorn of *Bougainvillea*, Tendril of *Cucurbita*.  
 (d) Connecting link – *Seymouria*, *Ichthyostega*
- 22.** According to Oparin's hypothesis, the earliest non-living structures that led to the formation of living cells were called
- (a) microspheres      (b) proteinoids  
 (c) coacervates      (d) stromatolites.
- 23.** Darwin's theory of natural selection could not explain
- vestigial organs
  - discontinuous variations
  - differential reproduction
  - speciation
  - over specialisation of certain organs.
- (a) (i), (ii) and (iii)      (b) (ii), (iii) and (iv)  
 (c) (i), (ii), (iii) and (v)      (d) (i), (ii) and (v)
- 24.** Given below are the different barriers that belong to non-specific immunity. Select the option that correctly segregates them under physical and physiological barriers respectively.
- |                            |                      |
|----------------------------|----------------------|
| (i) Mucous membranes       | (ii) Sebum           |
| (iii) Vaginal secretions   | (iv) Lysozyme        |
| (v) Cerumen                | (vi) Stratum corneum |
| (vii) Cilia of the pharynx | (viii) Bile          |
- |                             |                                |
|-----------------------------|--------------------------------|
| <b>Physical</b>             | <b>Physiological</b>           |
| (a) (i), (ii), (iii), (vii) | (iv), (v), (vi), (viii)        |
| (b) (i), (vi), (vii)        | (ii), (iii), (iv), (v), (viii) |
| (c) (iii), (v), (vi)        | (i), (ii), (iv), (vii), (viii) |
| (d) (ii), (iii), (v), (vi)  | (i), (iv), (vii), (viii)       |
- 25.** Hardy-Weinberg principle is applicable to a population only under conditions when there is
- (a) a gene flow in the population  
 (b) elimination of certain alleles in a population  
 (c) absence of mutations in genes or chromosomes of the population  
 (d) variations in the gene frequencies over several generations of the concerned population.
- 26.** Identify the correct pair of carcinomas.
- (a) Osteoma and adenocarcinoma  
 (b) Lipoma and melanoma  
 (c) Glioma and osteoma  
 (d) Melanoma and adenocarcinoma
- 27.** Select the option that correctly fills any four blanks in the given paragraph.
- The primary lymphoid organs are bone marrow and \_\_\_\_\_. The \_\_\_\_\_ mature in the bone marrow and migrate to secondary lymphoid organs via blood and \_\_\_\_\_. Here they undergo proliferation and \_\_\_\_\_. T-lymphocytes help B-lymphocytes to produce \_\_\_\_\_ which regulate \_\_\_\_\_. immunity.
- (a) (i) thymus, (ii) lymph, (iii) differentiation, (iv) humoral  
 (b) (i) spleen, (ii) B-lymphocytes, (iv) activation, (v) immunoglobulins  
 (c) (i) thymus, (ii) interstitial fluid, (iv) perforins, (vi) humoral  
 (d) (i) lymph nodes, (ii) T-lymphocytes, (v) antibodies, (vi) cellular

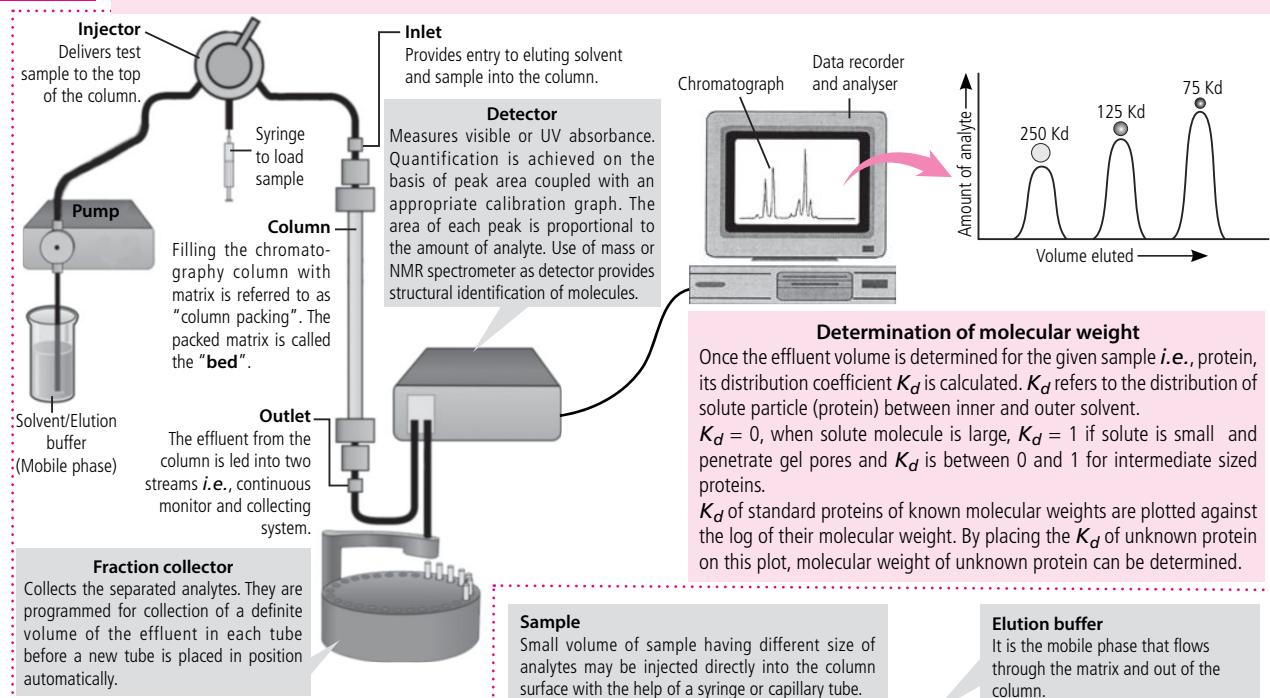
- 28.** Select the incorrectly described species.
- Monotypic – A species without any distinct variety.
  - Sibling species – Two species that are morphologically almost identical and can interbreed freely.
  - Allopatric species – A species occurring in an exclusive geographical area.
  - Allochronic species – Species that do not belong to the same time periods.
- 29.** Read the given statements and select the correct option.
- Statement A :** Chronic alcoholism can lead to cirrhosis.
- Statement B :** Continuous intake of alcohol leads to hepatocyte destruction and collagen deposition in liver.
- Both statements A and B are correct and B is the correct explanation of A.
  - Both statements A and B are correct but B is not the correct explanation of A.
  - Statement A is correct but B is incorrect.
  - Both statements A and B are incorrect.
- 30.** Which one of the following correctly describes the transmission and symptoms of the respective diseases?
- | Disease          | Transmission      | Symptoms                                             |
|------------------|-------------------|------------------------------------------------------|
| (a) Influenza    | Droplet infection | Sore throat, sneezing, headache                      |
| (b) Yellow fever | Rat flea          | Severe pain in joints, yellowing of skin, chilliness |
| (c) Cholera      | Sputum of patient | Frequent white stool and vomiting                    |
| (d) Botulism     | Wound infection   | Double vision, vomiting, blood and mucus in stool    |
- 31.** Read the given statements and select the incorrect one.
- Balancing selection favours average sized individuals while eliminates small sized individuals.
  - During progressive selection, the population changes towards one particular direction.
  - Diversifying selection is opposite of stabilising selection and is rare in nature.
  - Progressive selection maintains a mean value from generation to generation.
- 32.** A normal *Citrus* leaf shows jointed winged petiole where the lamina is separated from wing petiole by means of a constriction. But at times, the leaf may show two additional lateral leaflets, thus making the leaf trifoliate. This describes the phenomenon of
- retrogressive metamorphosis
  - atavism
  - progressive metamorphosis
  - divergent evolution.
- 33.** Of the below mentioned functions, which of these are performed by complement proteins?
- Cytolysis
  - Inflammation
  - Phagocytosis
  - All of these
- 34.** Consider the following statements and select the correct option stating which ones are true (T) and which ones are false (F).
- Marsupials of Australia follow the same biogeographical evolutionary trend as Darwin's finches.
  - The considerable change in allele frequency that is more marked in small populations is called genetic drift.
  - Major histocompatibility complex responsible for lymphocyte recognition are encoded by genes present on chromosome 8.
  - Benign tumours are cancerous and show metastasis.
- | (i)   | (ii) | (iii) | (iv) |
|-------|------|-------|------|
| (a) T | F    | F     | T    |
| (b) T | T    | T     | F    |
| (c) T | T    | F     | F    |
| (d) F | F    | T     | F    |
- 35.** Read the following statements regarding autoimmunity and select the correct ones.
- Autoimmunity is the property of immune system wherein it fails to recognise 'self' and 'non-self' cells leading to malfunction of its system.
  - During autoimmune disorder, the C-reactive proteins, an important component of immune system decreases significantly.
  - Autoimmunity may also get triggered by decreased helper T-cell and increased suppressor T-cell functions.
  - Autoimmune disorders are more common in women than in men.
- I and IV
  - II and IV
  - I and III
  - II and III
- 36.** Genetic drift can be best explained as
- sum total of all genes and alleles in a population
  - addition of new alleles to local gene pool of host population
  - drastic change in allele frequency when population size is very small
  - change in gene frequency due to repeated mating for certain selected traits.

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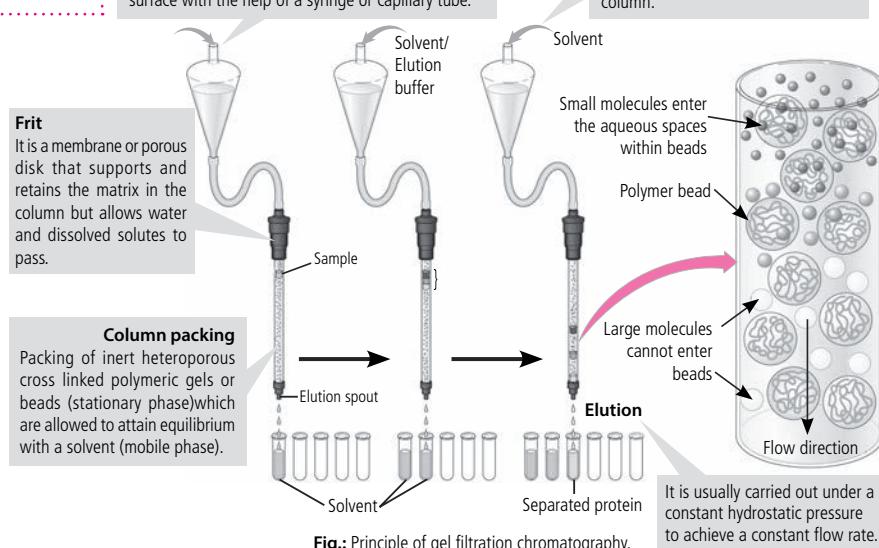
# Gel Filtration Chromatography

Chromatography is a biophysical technique that is used for the separation, identification, and purification of the components in a mixture for qualitative and quantitative analysis. Biomolecules can be purified based on their size and shape, total charge, hydrophobic groups present on the surface, and binding capacity with the stationary phase. There are two basic techniques of chromatography based on type of stationary bed: plane chromatography and column chromatography. Column chromatography is one of the most common methods of protein purification. It may be of various types viz., adsorption, partition, ion exchange, affinity, gel filtration. Gel filtration or molecular/size exclusion or molecular sieve chromatography is a type of column chromatography that separates molecules on the basis of their molecular size.

The basic components of column chromatography are **stationary phase**; composed of either a solid phase or a layer of a liquid adsorbed on the surface of a solid support. It is chosen according to the analytes to be separated and **mobile phase**; composed of liquid components that complement the stationary phase and maintains constant rate of flow into the column. The general setup of gel filtration chromatography is described below.



**Principle**  
When a sample having molecules of different size is placed on the top of such an equilibrated column, the larger molecules pass through the interstitial spaces between the beads. This is because the pores of the gel have a smaller diameter than what is needed for the large molecules to enter. Large molecules, therefore, move down the column with little resistance and will come first in the effluent. The small molecules, however, can enter the pores and are thereby effectively removed from the stream of the eluting solvent. These molecules are thus retarded and will then pass through the column at slower rate, hence appear latter in effluent. Thus, a sample passing through a gel filtration column will separate based on molecular size: the big ones will elute first, middle sized proteins will elute in the middle and the smallest ones will elute last.

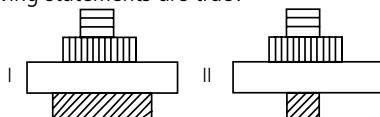


# BIOLOGY

## OLYMPIAD PROBLEMS

1. A few statements regarding the sexual and asexual modes of reproduction in plants are given.
- In sexual reproduction, progeny are genetically different from each other.
  - In asexual mode of reproduction, progeny are genetically identical to each other but different from the parent.
  - Sexual reproduction is more conducive for driving evolution.
  - A minor change in the habitat may adversely affect all offspring derived by asexual reproduction.
  - A bisexual plant grown in isolation is always incapable of sexual reproduction.
- Which of these statements are correct?
- (i), (iii) and (iv)
  - (i), (ii) and (v)
  - (iii), (iv) and (v)
  - (ii), (iii) and (iv)
- (INBO 2017)

2. Two ecological pyramids are drawn below. If 'I' represents aquatic and 'II' represents terrestrial ecosystem, which of the following statements are true?



- Pyramid 'I' is based on biomass.
  - Pyramid 'II' is based on numbers.
  - The unshaded box in pyramid 'I' represents zooplankton and in pyramid 'II' it represents insects.
  - Neither 'I' nor 'II' can be based on energy.
- (ii) and (iii) only
  - (i) and (iii) only
  - (i), (ii) and (iv) only
  - (i), (ii), (iii) and (iv)
- (INBO 2016)

3. The support staff in a Zoology lab mixed up the description charts of the following organisms.

X : Rotifer Y : Sea anemone Z : Spider

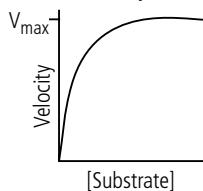
Description charts:

- Coelomate with segmented body.
- Pseudocoelomate with alimentary canal and head having ciliated crown.
- Diploblastic with gastrovascular cavity.

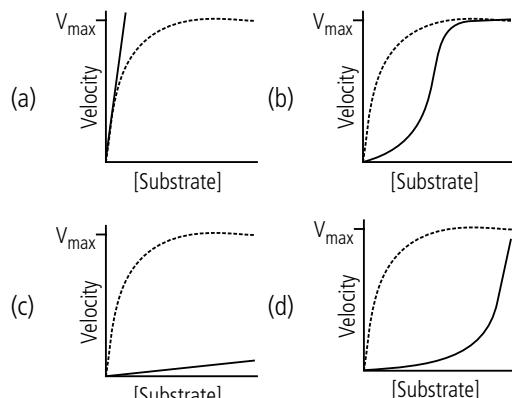
Description charts that match X, Y and Z respectively are:

- I, II and III
  - II, III and I
  - III, I and II
  - I, III and II
- (NSEB 2015-16)

4. A typical graph obtained for an enzyme catalysed reaction that takes place in a human body is shown below.

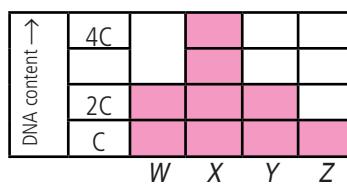


Which of the following correctly represents the same reaction in which no enzyme is used? Broken line represents the enzyme catalysed reaction for comparison.



(INBO 2015)

5. The amount of DNA present per cell during a nuclear division is represented as a bar diagram below.



What phase are represented by X and Y?

- X-Prophase I, Y-S phase
  - X-Prophase I, Y-Prophase II
  - X-Metaphase II, Y-Prophase II
  - X-Anaphase II, Y-Telophase I
- (NSEB 2014-15)

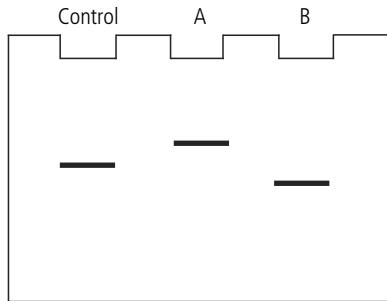
6. When treated with proteases, the extract of which of the endocrine glands would lose its hormonal influence?

- Ovary
  - Pineal gland
  - Pituitary gland
  - Adrenal cortex
- (INBO 2014)

7. Water potential ( $\psi$ ) plays important role in water absorption and conduction from soil to leaf. Under which condition the process will go on smoothly?

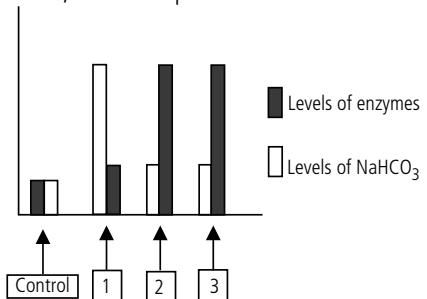
- (a)  $\psi_{\text{atmosphere}} < \psi_{\text{leaf}} < \psi_{\text{root}} < \psi_{\text{soil}}$
  - (b)  $\psi_{\text{atmosphere}} > \psi_{\text{leaf}} > \psi_{\text{root}} > \psi_{\text{soil}}$
  - (c)  $\psi_{\text{atmosphere}} = \psi_{\text{leaf}} = \psi_{\text{root}} = \psi_{\text{soil}}$
  - (d)  $\psi_{\text{atmosphere}} < \psi_{\text{leaf}} = \psi_{\text{root}} > \psi_{\text{soil}}$
- (NSEB 2013-14)

8. A short fragment of DNA was analysed for various mutations. When comparison between normal and mutated types was done, following gel pattern was observed for two individuals A and B. Most probable type of mutation in these individuals is



- (a) deletion in A and inversion in B.
  - (b) deletion in A and duplication in B.
  - (c) inversion in A and deletion in B.
  - (d) duplication in A and deletion in B.
- (NSEB 2013 - 14)

9. Effect of some compounds (present in partially digested food) on pancreatic secretion is depicted in the bar graph. Compounds 1, 2 and 3 represent



- (a) 1. Acid      2. Fat      3. Salt
  - (b) 1. Salt      2. Peptone      3. Fat
  - (c) 1. Acid      2. Fat      3. Peptone
  - (d) 1. Pepsin      2. Acid      3. Fat
- (INBO 2013)

10. A cross between wild-type fruitfly *Drosophila melanogaster* [normal bristles and grey body ( $s^+s$ ,  $e^+e$ )] with a mutant fly [short bristles and ebony body ( $ss$ ,  $ee$ )] produces following progenies:

Normal bristles with grey body – 537 flies  
 Short bristles with ebony body – 542 flies  
 Normal bristles with ebony body – 76 flies  
 Short bristles with grey body – 75 flies

The map distance between 's' and 'e' genes will be

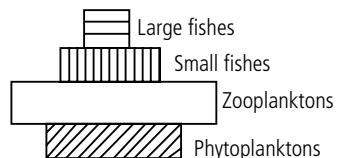
- (a) 87.7 map units
- (b) 50.2 map units
- (c) 12.3 map units
- (d) 49.8 map units.

(INBO 2013)

## SOLUTIONS

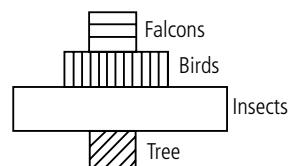
1. (a) : Progenies obtained through asexual reproduction are genetically identical to the parents as well as to each other. A bisexual plant contains flowers with both male and female reproductive organs. Such plants when grown in isolation may undergo self pollination if they have proper devices or contrivances and hence undergo sexual reproduction.

2. (d) : Pyramid I is spindle-shaped pyramid of biomass in aquatic ecosystem and it can be represented as follows:



Here, the biomass of phytoplankton is smaller than that of zooplankton because of lower reproductive potential and longevity.

Pyramid II represents spindle like pyramid of number in a tree ecosystem as given below :



Here a single large producer tree provides nourishment to several insects. These insects may be the food of comparatively small population of birds those are eaten by very small number of eagles or falcons.

The pyramid of energy is always upright, therefore, pyramid I and II cannot be based on energy.

3. (b)

4. (c) : In absence of enzyme, reaction is not catalysed and hence rate of reaction or velocity increases slowly in comparison to catalysed reaction with the increase in substrate concentration.

5. (b) : The amount of DNA in each diploid cell is 2C. During S phase, DNA replicates and the amount of DNA per cell doubles i.e., increases to 4C. Hence, when cell enters M phase and undergoes meiosis I, the amount of DNA in prophase I will be 4C. After completion of meiosis I DNA will reduce to 2C because meiosis I is a reductional division. Therefore, in prophase II of meiosis II the amount of DNA would be 2C.

6. (c) : Pituitary hormones are protein hormones. When they are treated with proteases or proteolytic enzymes, hydrolysis of their peptide bonds occurs that causes loss of their hormonal influence.
7. (a) : Water potential ( $\Psi_w$ ) helps in the movement of water within systems. Water flows from higher water potential to lower water potential. Therefore, to maintain smooth absorption and conduction of water the condition should be  $\Psi_{\text{atmosphere}} < \Psi_{\text{leaf}} < \Psi_{\text{root}} < \Psi_{\text{soil}}$ .
8. (d) : Gel electrophoresis separates fragments of DNA, RNA or protein on the basis of their size. The smaller fragment moves farther than larger fragment. In the given gel pattern DNA fragment of individual B travelled greater distance than the DNA fragment of individual A and normal DNA fragment. It means DNA fragment of B is shorter than other two which suggests deletion in DNA. Similarly, DNA fragment of A travelled lesser distance than that of

Contd. from Page No. 80

## MPP-4 | MONTHLY Practice Problems

Class XII

37. Match column I with column II and select the correct option. (There can be more than one match for items in column I).

| Column I                | Column II                                                             |
|-------------------------|-----------------------------------------------------------------------|
| A. Natural selection    | (i) Rubella                                                           |
| B. Autoimmune disease   | (ii) Whooping cough                                                   |
| C. Viral disease        | (iii) Glucose 6-phosphate dehydrogenase deficiency                    |
| D. Bacterial disease    | (iv) Multiple sclerosis                                               |
| E. Spirochaetal disease | (v) Rhinitis                                                          |
|                         | (vi) Sickle cell anaemia                                              |
|                         | (vii) Leprosy                                                         |
|                         | (viii) Pernicious anaemia                                             |
|                         | (ix) Syphilis                                                         |
|                         | (x) Gonorrhoea                                                        |
| (a)                     | A-(v), (vi); B-(iii), (iv); C-(viii), (ix); D-(vii), (x); E-(i), (ii) |
| (b)                     | A-(iv), (viii); B-(v), (vi); C-(i), (ii); D-(vii), (ix); E-(iii), (x) |
| (c)                     | A-(iv), (vi); B-(iii), (viii); C-(i), (x); D-(v), (vii); E-(ii), (ix) |
| (d)                     | A-(iii), (vi); B-(iv), (viii); C-(i), (v); D-(ii), (vii), (x); E-(ix) |

38. Lederberg's replica plating experiment provided an evidence in support of hypothesis that proves  
(a) evolution is a random probability process based on

individual B and normal DNA fragment which suggests that A is larger than normal fragment due to duplication.

9. (c) : Pancreatic secretion contains different enzymes for the digestion of starch, proteins, peptones, fats and sodium bicarbonate to neutralise hydrochloric acid of the chyme (food coming from stomach). Bar graph 1 shows high level of  $\text{NaHCO}_3$  which is the effect of high acid concentration. Bar graph 2 and 3 show high levels of enzymes due to high concentration of fat and peptone.

10. (c) : Progenies having normal bristles with ebony body and short bristles with grey body are recombinants. Hence, the recombination frequency can be calculated as -

$$\text{Recombinant frequency} = \frac{\text{Recombinants}}{\text{Total offspring}} \times 100\%$$

$$= 76 + 75 / 1230 = 0.123\% \text{ or } 12.3\%$$

Since 1 map unit = 1%

So, the map distance between s and e gene = 12.3 map unit.



events that occur by chance in nature and random mutations in organism

- (b) interspecific struggle for existence gives rise to survival of the fittest  
(c) strong selection pressure in a population having different forms results in one form, permanently replacing the other  
(d) stabilising selection does not favour evolution.

39. Given below are the various events that occur in a person, during AIDS, from the time of first exposure to virus. Choose the option with the correct sequence.

- I. Viral DNA gets incorporated in the genome of host cell.
  - II. Reverse transcriptase enzyme produces viral DNA in host cell.
  - III. Viral RNA is produced by infected cell.
  - IV. Virus attacks helper T-lymphocytes.
- (a) IV → II → III → I      (b) II → I → III → IV  
(c) II → III → I → IV      (d) IV → I → II → III

40. Which of the following is not true regarding amphetamines?

- (a) It is used in the dope test for athletes.  
(b) It is a CNS stimulator.  
(c) It is obtained from *Lophophora williamsii*.  
(d) It does not remove fatigue and cause wakefulness.

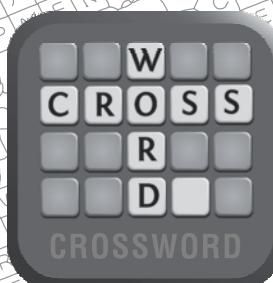
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# CROSS WORD



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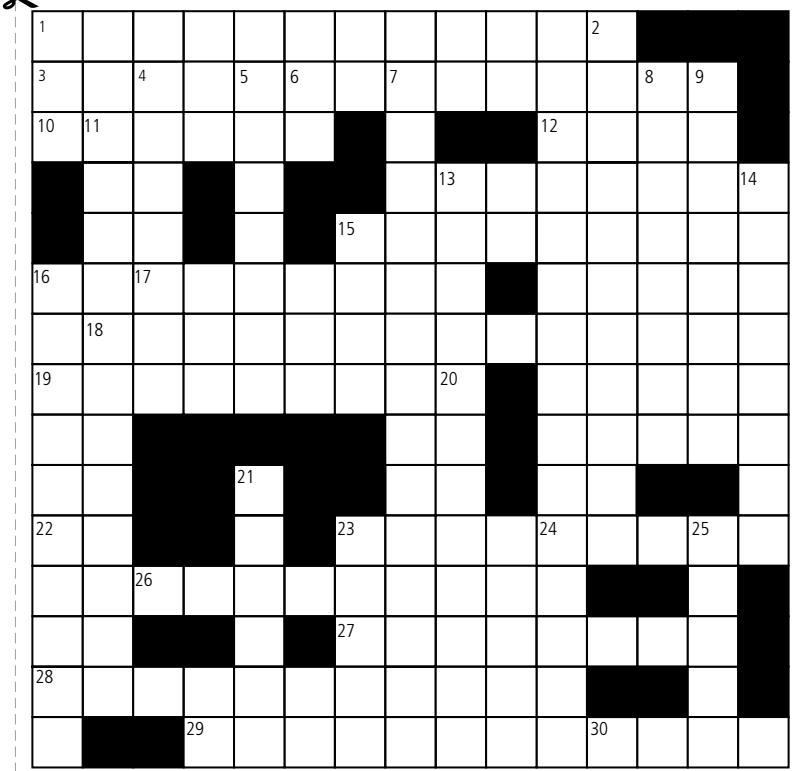
## ACROSS

- Inorganic inclusions found in some bacteria that help them align along the geomagnetic lines. (12)
- Sternum of a bird, to which the powerful flight muscles are attached. (4)
- Sepal that are modified hairy processes in some plants. (6)
- The female reproductive part that dilates under the influence of relaxin during child birth. (6)
- The process of fermentation brought about by yeast extract. (7)
- The complete sequence of developmental stages of biotic succession. (4)
- A triangular region of urinary bladder present between the openings of ureters and urethra. (7)
- Study of different appearances of a plant with the changing seasons. (9)
- The point of attachment between the homologous chromosomes where crossing over occurs. (7)
- Modified maxillary teeth of snakes. (5)
- An example of club fungi that produces thick walled black coloured spores. (4)
- A protein and carbohydrate deficiency disease resulting in impaired growth of infants. (8)
- Acrosomal enzyme that digests the zona pellucida of egg. (7)
- The space between the two pleural sacs. (11)
- Hole forming proteins secreted by cytotoxic T-cells to destroy foreign cells. (9)
- Black powdery substance produced by incomplete combustion of fuel. (4)

## DOWN

- Plants that require low intensity of light for growth. (10)
- An extract produced from *Claviceps purpurea* from which LSD is obtained. (5)
- An insoluble, fibrous protein that is responsible for blood clotting. (6)
- The special starch storing structures present in the chloroplasts of *Spirogyra*. (9)

*Cut Here*



- The animals that are active during dusk. (8)
- The sharp and stiff multicellular epidermal outgrowths found in some plants. (8)
- The pentapeptides produced by nerve cells that influence perception of pleasure and pain. (11)
- Enamel forming cells that disappear before tooth eruption. (11)
- The process of removal of introns from hnRNA. (8)
- An enzyme used to cut dsRNA molecule into small interfering RNAs. (5)
- A single long process of cyton that carries nerve impulse away from neuron towards the brain. (4)
- Little sacs of synovial fluid that act as cushions in some joints. (6)
- The unbranched underground stems of *Colocasia* used for vegetative propagation. (5)
- A popular Japanese food made from fermented soybean milk. (4)



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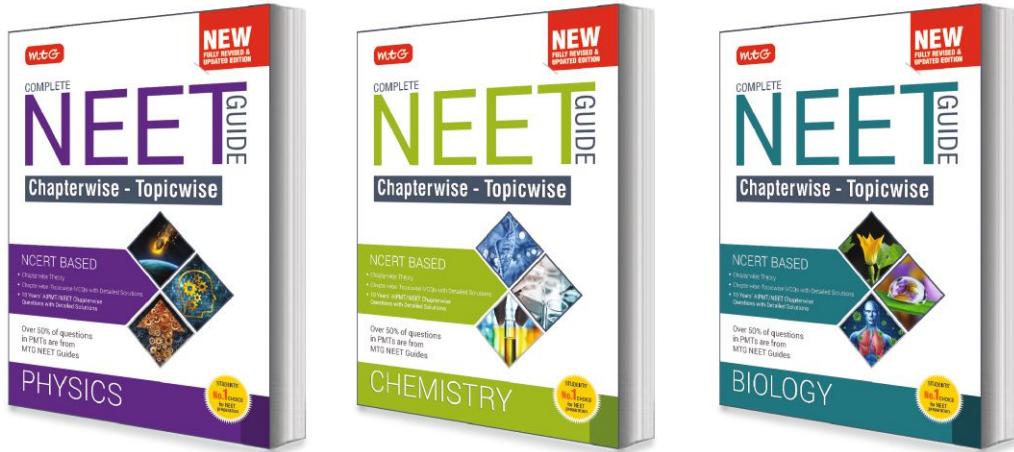
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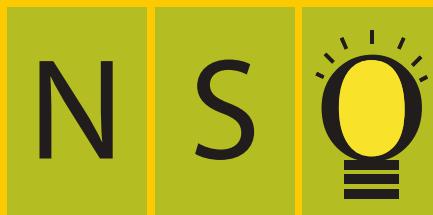
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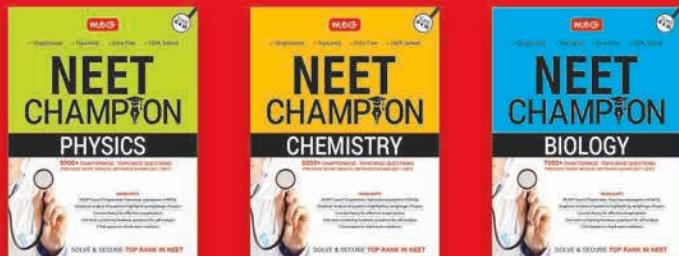
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