

Answers

Unit 3 :

1. Enzyme, a substance that acts as a catalyst in living organisms, regulating the rate at which chemical reactions proceed without itself being altered in the process. The biological processes that occur within all living organisms are chemical reactions, and most are regulated by enzymes.

There are six principal categories and their reactions:

- (1) [oxidoreductases](#), which are involved in electron transfer
- (2) [transferases](#), which transfer a chemical group from one substance to another
- (3) [hydrolases](#), which cleave the substrate by uptake of a water molecule (hydrolysis)
- (4) [lyases](#), which form double bonds by adding or removing a chemical group
- (5) [isomerases](#), which transfer a group within a molecule to form an isomer
- (6) [ligases](#), or synthetases, which couple the formation of various chemical bonds to the breakdown of a pyrophosphate bond in ATP or a similar nucleotide.

Enzymes are used in foods and beverages processing, animal nutrition, textiles, household cleaning and fuel for cars and energy generation.

2. An enzyme will interact with only one type of substance or group of substances, called the substrate, to catalyze a certain kind of reaction.

3. Enzymes are not consumed in the reactions they catalyze and can be used over and over again, only a very small quantity of an enzyme is needed to catalyze a reaction. A typical enzyme molecule can convert 1,000 substrate molecules per second. The rate of an enzymatic reaction increases with increased substrate concentration, reaching maximum velocity when all active sites of the enzyme molecules are engaged. The enzyme is then said to be saturated, the rate of the reaction being determined by the speed at which the active sites can convert substrate to product.

4. Enzyme is catalytic to its substrate

5. Carbonic anhydrase (CA) is a metalloenzyme that contains a zinc metal ion (Zn^{++}) in its active site, and it is encoded by almost all organisms.

6. CA stands for Carbonic Anhydrase.

7. **Restriction enzyme**, also called **restriction endonuclease**, a protein produced by bacteria that cleaves DNA at specific sites along the molecule. In the bacterial cell, **restriction enzymes** cleave foreign DNA, thus eliminating infecting organisms.

8. Another name of Restriction Enzymes is molecular scissors.

9. Nervous System is an organ system ascribed to send signals from the spinal cord and the brain throughout the body and then back from all the body parts to the brain. Neuron acts as the mediator and is the basic signalling unit of the Nervous system. the human nervous system consists of two parts, namely:

1. Central Nervous System (consists of the brain and spinal cord)
2. Peripheral Nervous System (includes all the nerves of the body)

10. CNS stands for Central Nervous System and PNS stands for Peripheral Nervous System.

11. Central Nervous System

Central Nervous System (CNS) is often called the central processing unit of the body. It consists of the brain and the spinal cord.

Brain

The brain is one of the important, largest and central organ of the human nervous system. It is the control unit of the nervous system, which helps us in discovering new things, remembering and understanding, making decisions, and a lot more. It is enclosed within the skull, which provides frontal, lateral and dorsal protection. The human brain is composed of three major parts:

1. **Forebrain:** The anterior part of the brain, consists of Cerebrum, Hypothalamus and Thalamus.
2. **Midbrain:** The smaller and central part of the brainstem, consists of Tectum and Tegmentum.

3. **Hindbrain:** The central region of the brain, composed of Cerebellum, Medulla and Pons.

Spinal Cord

The spinal cord is a cylindrical bundle of nerve fibers and associated tissues enclosed within the spine and connect all parts of the body to the brain. It begins in continuation with the medulla and extends downwards. It is enclosed in a bony cage called vertebral column and surrounded by membranes called meninges. The spinal cord is concerned with spinal reflex actions and the conduction of nerve impulses to and from the brain.

12. Basic unit of Nervous System is neurons or nerve cell.

13. Peripheral Nervous System

Peripheral Nervous System (PNS) is the lateral part of the nervous system that develops from the central nervous system which connects different parts of the body with the CNS. We carry out both voluntary and involuntary actions with the help of peripheral nerves.

PNS includes two types of nerve fibers:

1. **Afferent nerve fibers** – These are responsible for transmitting messages from tissues and organs to the CNS.
2. **Efferent nerve-fibers** – These are responsible for conveying messages from CNS to the corresponding peripheral organ.

Classification of the peripheral nervous system:

Somatic neural system (SNS): It is the neural system that controls the voluntary actions in the body by transmitting impulses from CNS to skeletal muscle cells. It consists of the somatic nerves.

Autonomic neural system (ANS): The autonomic neural system is involved in involuntary actions like regulation of physiological functions (digestion, respiration, salivation, etc.). It is a self-regulating system which conveys the impulses from the CNS to the smooth muscles and involuntary organs (heart, bladder and pupil). The autonomic neural system can be further divided into:

1. Sympathetic nervous system
2. Parasympathetic nervous system

14. A reflex is a very rapid motor response that is not directed by the brain. In a reflex, nerve impulses travel to and from the spinal cord in a reflex arc. In this example, the person jerks his hand away from the flame without any conscious thought. It happens unconsciously because the nerve impulses by pass the brain. The somatic nervous system (SNS) controls mainly voluntary activities that are under conscious control. It is made up of nerves that are connected to skeletal muscles. The somatic nervous system also controls some unconscious movements, called reflexes.

TYPES OF REFLEXES

UNCONDITIONAL REFLEXES: are inborn reflexes and are transmitted through heredity. They are also called inborn or inherited reflexes

e. g: swallowing in newly born babies and blinking of eyes

CONDITIONAL REFLEXES: These are acquired reflexes during the life time of an individual. They are absolutely an individual entity and are, therefore, not constant, viz., they may disappear and reappear again.

15. 12 Pairs of cranial and 31 pairs of spinal nerves.

16. A Neuron is a structured and functional unit of the nervous system and unlike other cells, neurons are irregular in shape and able to conduct electrochemical signals. The different parts of a neuron are discussed below.

- Dendrite stretches out from the cell body of a neuron, and it is the shortest fibre in the cell body.
- Axon is the longest thread on the cell body of a neuron and has an insulating and protective sheath of myelin around it.
- Cell body consists of cytoplasm and nucleus.
- Synapse is the microscopic gap between a pair of adjacent neurons over which nerve impulses pass, when moving from one neuron to the other.

17. **Resting potential**, the imbalance of electrical charge that exists between the interior of electrically excitable neurons (nerve cells) and their surroundings. If the inside of the cell becomes less negative (i.e., the **potential** decreases below the **resting potential**), the process is called depolarization.

18. Nerve impulse is the signal that travels along the length of a **nerve** fiber and ends in the release of

neurotransmitters. **Nerve** impulses are the means by which information is transmitted along the neuron and throughout the **nervous** system.

19. **Synapses** are the sites of contact between nerve cells. **Synapses** convert electrical signals into chemical information, which is conveyed between neurons at this site. The **synapse** consists of both pre- and postsynaptic elements.

20. A **refractory period** is a **period** of time during which an organ or cell is incapable of repeating a particular action, or (more precisely) the amount of time it takes for an excitable membrane to be ready for a second stimulus once it returns to its resting state following an excitation.

21. (i) Depolarization

(ii) Hyperpolarization.

22. CNS includes brain and spinal chord.

23. Axon is a tube-like structure that carries electrical impulse from the cell body to the axon terminals that passes the impulse to another neuron.

24. PNS includes ANS and SNS.

25. Paulien Hogeweg coined the bioinformatics.

26. Applications of Bioinformatics.

- In Gene therapy.
- In Evolutionary studies.
- In Microbial applications.

- In Prediction of Protein Structure.
- For the Storage and Retrieval of Data.
- In the field of medicine, used in the discovery of new drugs.
- In Biometrical Analysis for identification and access control for improvising crop management, crop production and pest control.

27. **BLAST** is an acronym for Basic Local Alignment Search Tool.

Types : (i) BLASTn (for DNA sequences)

(ii) BLASTp (Protein sequences)

(iii) PSIBLAST, or Position Specific Iterated BLAST

(iv) Pattern Hit Initiated BLAST, or PHI-BLAST

(v) **RPS-BLAST** is a “reverse” version of PSIBLAST.

28. **VAST**, short for Vector Alignment Search Tool

29. The development of bio informatics is the result of advances in both molecular biology and computer science.

30. data mining is a process of automatic generation of information from existing data. The major goals of data mining are “prediction” & “description”. The main tasks which can be performed with it are as follows:

- (i) Classification.
- (ii) Estimation

- (iii) Prediction
- (iv) Association rules
- (v) Clustering
- (vi) Description & Visualization

31. FASTA stands for fast-all” or “FastA”.

- It was the first database similarity search tool developed, preceding the development of BLAST.
- FASTA is another sequence alignment tool which is used to search similarities between sequences of DNA and proteins.
- FASTA uses a “hashing” strategy to find matches for a short stretch of identical residues with a length of k. The string of residues is known as ktuples or ktups, which are equivalent to words in BLAST, but are normally shorter than the words.
- Typically, a ktup is composed of two residues for protein sequences and six residues for DNA sequences.
- The query sequence is thus broken down into sequence patterns or words known as k-tuples and the target sequences are searched for these k-tuples in order to find the similarities between the two.
- FASTA is a fine tool for similarity searches.

32. FASTA is the first database similarity search tool developed, preceding the development of BLAST.

33. BLAST program was developed by Stephen Altschul of NCBI and in 1990.

34. (a) Human Immunodeficiency Syndrome.

(b) influenza-like illness including fever, headache, rash or sore throat.

swollen lymph nodes, weight loss, fever, diarrhoea and cough.

© HIV only infects white blood cells which have a specific receptor protein on their surface. This is called CD4 and is found on lymphocytes called T-helper cells (CD4+ cells) and certain other cells such as dendritic cells and macrophages. The CD4 receptor is normally involved in antigen recognition but HIV 'hijacks' it in order to get into the cell.

- HIV binds to CD4 receptor on cell surface
- The nucleocapsid containing RNA and reverse transcriptase is inserted into the cell
- Complementary single stranded DNA (cDNA) molecules are made using the RNA as a template
- The cDNA hybridises to make double stranded DNA
- The viral DNA integrates into the host genome
- Viral RNA and proteins are synthesised
- New HIV particles are assembled
- HIV leaves the cell by budding (acquiring its envelope in the process)
- This disrupts the cell membrane, leading to lysis and cell death

(d) The three main routes for HIV transmission are:

- Contaminated blood (for example between injecting drug users)
- Sex: vaginal, anal (and very rarely, oral)

- From mother to child (either in pregnancy, during birth or via breastmilk)

Worldwide, approximately 60% of new HIV infections are contracted through sex between men and women. The other cases are usually due to:

- Babies who acquire the virus from their mothers (10%)
- Drug users sharing used needles (10%)
- Sex between men (5-10%) In the early stages of the epidemic, some transmission occurred in health care settings, for example via infected blood for transfusion. This is now rare due to better screening and increased awareness.

(e) There is currently still no cure for HIV infection, or a vaccine to prevent it. Infection does not have to be seen as a death sentence. Doctors now have an arsenal of drugs to control the infection and increase the average life expectancy of HIV positive people. The drug regime that infected people require is called combination therapy and uses three or more anti-retroviral drugs (ARVs). It is also known as HAART (Highly Active Anti-Retroviral Therapy).

There are currently three kinds of HIV drugs available, all of which have a different mode of action:

Reverse transcriptase inhibitors (RTIs) block the role of reverse transcriptase in DNA synthesis and prevent the virus replicating. There are several different types sometimes categorised by the common names of ‘nukes’ and ‘non-nukes’.

Protease inhibitors (PIs) also prevent viral replication, this time by inhibiting the action of a protease enzyme involved in the production of new viruses.

Entry inhibitors (EI) are a relatively new class of drug which prevents HIV from binding to a co-receptor on the host cell. The combination therapy usually involves two ‘nukes’ plus either a ‘non-nuke’ or a protease inhibitor.

Other types of drugs (for example antibiotics) are also used to treat the opportunistic infections associated with the Phase Three or Crisis Stage of AIDS. Many patients find it extremely difficult to stick to complex drug regimes but ‘treatment adherence’ is vitally important to reduce the chances of drug resistance and keep the infection under control

Vaccines

A vaccine would be the best way to prevent HIV infection and halt the pandemic, but this goal has been elusive. There are many possible types of experimental HIV vaccines, although none have successfully passed a phase three clinical trial.

- (f) (i) Male and female condom use
- (ii) Testing and counselling for HIV and STIs
- (iii) Testing and counselling, linkages to tuberculosis (TB) care
- (iv) Voluntary medical male circumcision (VMMC)
- (v) Pre-exposure prophylaxis (PrEP) for HIV-negative partner
- (vi) ART.

35. (a) Type1

Type 2

Gestational

Pre diabetes.

(b) Type 2 diabetes

Symptoms include increased thirst, frequent urination, hunger, fatigue and blurred vision. In some cases, there may be no symptoms.

Type 1 diabetes

Symptoms include increased thirst, frequent urination, hunger, fatigue and blurred vision.

Prediabetes

Many people with prediabetes have no symptoms.

Gestational diabetes

In most cases, there are no symptoms. A blood sugar test during pregnancy is used for diagnosis.



Type 2 diabetes

Treatments include diet, exercise, medication and insulin therapy.

Type 1 diabetes

Treatment aims at maintaining normal blood sugar levels through regular monitoring, insulin therapy, diet and exercise.

Prediabetes

Progression from prediabetes to type 2 diabetes isn't inevitable. With lifestyle changes, weight loss and medication, it's possible to bring a blood sugar level back to normal.

Gestational diabetes

Treatment strategies include daily blood sugar monitoring, a healthy diet, exercise and monitoring the baby. If blood sugar is too high, medication is required.

(d) **Diabetes** is a chronic condition associated with abnormally high levels of sugar (glucose) in the blood. Insulin produced by the pancreas lowers blood glucose. Absence or insufficient production of insulin, or an inability of the body to properly use insulin **causes diabetes**.

(e) Blood test

(f) Develop and stick to a healthy eating and activity plan

Test your blood sugar and keep a record of the results

Recognize the signs of high or low blood sugar and what to do about it

Give yourself insulin by syringe, pen, or pump

Monitor your feet, skin, and eyes to catch problems early

Buy diabetes supplies and store them properly

Manage stress and deal with daily diabetes care.

36. Acquired Immune Deficiency Syndrome.

37. Red ribbon is the symbol for World AIDS Day.

38. (a) Complementary DNA

(b) Reverse transcriptase inhibitors

© Protease inhibitors

(d) Entry inhibitors

(e) anti-retroviral drugs

(f) Sexually Transmitted Infections.

(g) Highly Active Anti-Retroviral Therapy

(h) Assisted reproductive technology

(i) Tuberculosis.

(j) Voluntary medical male circumcision

(k) Pre-exposure prophylaxis

(l) Post-exposure prophylaxis

39. Coronaviruses fall in the virus family Coronaviridae, order Nidovirales.

- *Coronaviruses are enveloped, 120 to 160 nm particles that contain an unsegmented genome of single-stranded positive-sense RNA (27–32 kb).*
- *The large, plus-stranded [RNA](#) genome associates with the N protein to form a helical nucleocapsid.*
- *The helical nucleocapsid is 9–11 nm in diameter.*
- *There are 20 nm long club or petal-shaped projections that are widely spaced on the outer surface of the envelope, suggestive of a solar corona.*
- *The viral structural proteins include a 50–60 kDa phosphorylated nucleocapsid (N) protein, a 20–35 kDa membrane (M) glycoprotein that serves as a matrix protein embedded in the envelope lipid bilayer and interacting with the nucleocapsid, and the spike (S) a 180–220 kDa glycoprotein that makes up the petal-shaped peplomers.*
- *Some viruses, including human coronavirus OC43 (HCoV-OC43), contain a third glycoprotein (HE; 65 kDa) that causes hemagglutination and has acetylcholinesterase activity.*

Genome of Coronavirus

- *Coronavirus genomes are monopartite, single-stranded, positive-sense, polyadenylated, and capped RNAs ranging from 27 to 32 kb in length.*
- *The 5' approximately 20 to 22 kb carries the replicase gene, which encodes multiple enzymatic activities.*
- *The replicase gene products are encoded within two very large open reading frames, ORFs 1a and 1b.*
- *The order of the genes encoding the viral RNA-dependent RNA polymerase and the four common structural proteins, the spike (S), envelope (E), membrane (M), and nucleocapsid (N) proteins are indicated as Pol-S-E-M-N.*
- *Coronavirus genomes also include a variety of additional open reading frames (ORFs) that encode two to four nonstructural proteins of unknown functions.*
- *In the genome, a common intergenic sequence (IS) of about 7 bases is found at the 5' end of each gene.*
- *This IS sequence is essential for the formation of subgenomic RNAs.*
- *Coronavirus-infected cells contain multiple overlapping subgenomic, capped, and polyadenylated mRNAs with a common 3' end.*

- *Each subgenomic mRNA and the viral genomic RNA, which also serves as an mRNA, is translated to yield only the protein encoded by the 5' gene on the mRNA.*

Epidemiology of Coronavirus

- *Natural outbreaks of colds caused by coronaviruses occur predominantly during the winter months, although in children, two peaks in late autumn to early winter and early summer were detected.*
- *It is estimated that coronaviruses cause 15–30% of all colds.*
- *Studies using virus detection or serology have shown that HCoV 229E, OC43, and NL63 occur worldwide.*
- *The contribution of each HCoV may vary widely from year to year, for example, 229E contributing as little as 1% to acute respiratory infections in the community in one year and up to 35% in the next.*
- *The incidence of coronavirus infections varies markedly from year to year, ranging in one 3-year study from 1% to 35%.*

Novel coronavirus 2019 (SARS-CoV-2)

- *A novel coronavirus known as SARS-CoV-2 was identified in Wuhan, China when people developed pneumonia-like symptoms.*

- *SARS-CoV-2 could transmit from one human to another human.*

Replication of Coronavirus

- *Natural infection of humans with human respiratory coronaviruses occurs through exposure to respiratory secretions.*
- *Coronaviruses attach to their glycoprotein receptors on host cells via their S proteins.*
- *Viral entry is mediated by fusion of the viral envelope with the host cell membrane or by receptor-mediated endocytosis.*
- *Group 1 coronaviruses 229E and NL63 bind to the metalloproteases, human aminopeptidase N and angiotensin-converting enzyme 2 (ACE-2) respectively.*
- *The receptors for OC43 and HKU-1 have not been yet identified.*
- *The fusion of the viral and cell membranes (either at the cell surface or within the endocytic vesicle) is mediated by the S2 portion of the virus spike protein which functions as a class 1 fusion protein.*
- *Once the viral RNA is released into the cytoplasm, translation of the positive-strand genomic RNA gives rise to a*

large polyprotein that undergoes proteolytic processing to generate an RNA-dependent RNA polymerase.

- *An RNA-dependent RNA polymerase translated from the plus-stranded viral genomic RNA makes a negative-strand that serves as the template for a nested set of five to seven subgenomic mRNAs.*
- *Translation of subgenomic mRNAs gives rise to structural viral proteins.*
- *The N protein and newly synthesized genomic RNA assemble to form helical nucleocapsids.*
- *Membrane glycoprotein M is inserted in the endoplasmic reticulum (ER) and anchored in the Golgi apparatus.*
- *The nucleocapsid (N plus genomic RNA) binds to M protein at the budding compartment (ERGIC).*
- *E and M proteins interact to trigger the budding of virions, enclosing the nucleocapsid.*
- *These newly formed virions are transported via the Golgi apparatus to the plasma membrane where they are released by exocytosis.*

Pathogenesis of Coronavirus

- *The primary route of transmission of human coronaviruses is via the respiratory tract, most likely spread by aerosols and in large droplets (e.g., sneezes).*

- *Infection with the common-cold coronaviruses leads to loss of ciliary action (ciliostasis) and degenerative changes affecting the cilia of epithelial cells of the respiratory tract.*
- *Infection remains localized to the upper respiratory tract because the optimum temperature for viral growth is 33° C to 35° C and may lead to the lower respiratory tract.*
- *HCoV-OC43 is generally associated with mild upper respiratory tract infections, although it has been shown to have neuroinvasive properties.*

Treatment of Coronavirus

- There is no proven treatment for human coronavirus infections and no vaccine as of 1st Oct. 2020.

Prevention and control of Coronavirus

- Washing hands often with soap and water.
- Avoid touching eyes, nose, or mouth with unwashed hands.
- Avoiding close contact with people who are sick.
- Covering mouth and nose with a tissue while coughing or sneezing, then throw the tissue in the trash and washing hands.

40. A cancer that has spread from the place where it first started to another place in the body is called metastatic cancer. The process by which cancer cells spread to other parts of the body is called metastasis.

Metastatic cancer has the same name and the same type of cancer cells as the original, or primary, cancer. For example, breast cancer that spreads to and forms a metastatic tumor in the lung is metastatic breast cancer, not lung cancer.

Under a microscope, metastatic cancer cells generally look the same as cells of the original cancer. Moreover, metastatic cancer cells and cells of the original cancer usually have some molecular features in common, such as the presence of specific chromosome changes.

Types of Cancer :

- (i) Carcinoma
- (ii) Sarcoma
- (iii) Leukemia
- (iv) Lymphoma
- (v) Multiple Myeloma
- (vi) Melanoma

Symptoms :

- **Fatigue.**
- Lump or area of thickening that can be felt under the skin.
- Weight **changes**, including unintended loss or gain.
- Skin **changes**, such as yellowing, darkening or redness of the skin, sores that won't heal, or **changes** to existing moles.
- **Changes** in **bowel** or bladder habits.
- **Persistent cough** or trouble breathing.

Viruses and Other Infections.

Causes :

- **Smoking and Tobacco.**
- Diet and Physical Activity.
- Sun and Other Types of **Radiation.**
- **Viruses** and Other Infections.

41. Brain and Spinal Cord Tumors

There are different types of brain and spinal cord tumors. These tumors are named based on the type of cell in which they formed and where the tumor first formed in the central nervous system. For example, Brain tumors can be benign (not cancer) or malignant (cancer).

Germ Cell Tumors

Germ cell tumors are a type of tumor that begins in the cells that give rise to sperm or eggs. These tumors can occur almost anywhere in the body and can be either benign or malignant.

Neuroendocrine Tumors

Neuroendocrine tumors form from cells that release hormones into the blood in response to a signal from the nervous system. These tumors, which may make higher-than-normal amounts of hormones, can cause many different symptoms. Neuroendocrine tumors may be benign or malignant.

Carcinoid Tumors

Carcinoid tumors are a type of neuroendocrine tumor. They are slow-growing tumors that are usually found in the

gastrointestinal system (most often in the rectum and small intestine). Carcinoid tumors may spread to the liver or other sites in the body, and they may secrete substances such as serotonin or prostaglandins, causing carcinoid syndrome.

42. Both.

43. Corona.

44. **Applications of data mining to bioinformatics** include gene finding, protein function domain detection, function motif detection, protein function inference, disease diagnosis, disease prognosis, disease treatment optimization, protein and gene interaction network reconstruction, **data** cleansing.

45. Enzymes catalyze a number of reactions which occur in animal and plant bodies to maintain the life cycle. Therefore the enzymes are called biocatalysts.

46. an enzyme which breaks down proteins and peptides.

47. A restriction enzyme, restriction endonuclease, or restrictase is an enzyme that cleaves DNA into fragments at or near specific recognition sites within molecules known as restriction sites. Restriction enzymes are one class of the broader endonuclease group of enzymes

48. The **sticky** or **blunt ends** refer to the properties of the **end** of **DNA** molecules, which are commonly generated by restriction enzymes that cut the **DNA**. A straight cut of restriction enzymes generates **blunt ends**, where both strands **terminate** in a base pair.

49. A palindromic sequence is a nucleic acid sequence in a double-stranded DNA or RNA molecule wherein reading in a certain direction on one strand matches the sequence reading in the same direction on the complementary strand.