Section A (50 Marks)

1. Write the most appropriate answer in the space provided at the last column.

(0.5×20 = 10 Marks) Answer (A/B/C/D)

i.	Which term describes the cell membrane potential of a neuron at rest? (a) Polarized (b) Depolarized (c) Hyperpolarized (d) Repolarized	i. (A)
ii.	Pick the correct statement: (a) Effectors are sensory structures that detect changes in the internal or external environment. (b) Receptors are target organs whose activities change in response to neural commands. (c) Effectors are target organs whose activities change in response to neural commands. (d) None of the above.	ii. (C)
iii.	The part of the human brain responsible for interpreting informative signals from the eye is: (a) Temporal lobe (b) Occipital lobe (c) Cerebellum. (d) Parietal lobe	iii. (b)
iv.	The membrane potential of a neuron is typically as follows: (a) Resting: -70 mV; Threshold: 0 mV (b) Resting: 0 mV; Threshold: -50 mV (c) Resting: +70 mV; Threshold: +50 mV (d) Resting: -70 mV; Threshold: -50 mV	iv. (a)
v.	Hyperpolarization happens during an action potential because: (a) Sodium channel is slow to close (b) Potassium channel is slow to open (c) Sodium channel is slow to open (d) Potassium channel is slow to close	v. (d)
vi.	Action potentials are characterized by which of the following? (a) Depolarization or hyperpolarization (b) Slightly negative polarization (c) Rapid depolarization (d) Repolarization	vi. (d)

Division: IV

vii.	The type of receptors associated with detecting CO_2 concentration in blood is known as: (a) Nociceptor (b) Thermoreceptor (c) Chemoreceptor (d) Mechanoreceptor	(c)
viii.	Human eye can detect wavelengths ranging between (a) 90 - 210 nm (b) 380 - 750 nm (c) 15 - 20 nm (d) 380 - 950 nm	viii. (b)
ix.	The function of the iris is: (a) To control the size of the pupil (b) Phototransduction (c) To focus light rays on the retina wall (d) To control shape of the lens	ix. (a)
x.	In emmetropic vision (a) far objects may be seen more clearly than objects that are near (b) near objects may be seen more clearly than objects that are far (c) no image is formed in retina (d) eye does not have any refractive error	x. (a)
xi.	The part of the inner ear responsible for perceiving sound is (a) vestibule (b) cochlea (c) semicircular duct (d) ampulae	xi. (b)
xii.	Which layer of the eye ball carries blood vessels and provides nutrition to the other parts of the eye? (a) sclera (b) retina (c) fovea centralis (d) choroid	xii. (d)
xiii.	The central nervous system does NOT perform the following function: (a) carrying sensory input (b) motor commands (c) mathematical calculations (d) integrative function	xiii. (c)
xiv.	Which of the following is NOT a neurotransmitter? (a) glutamate (b) acetylcholine (c) hydrogen sulfide (d) nitrogen	xiv. (d)
xv.	Light adaptation is faster than dark adaptation because (a) cones do not function in dark ambience (b) rods do not function in day light condition (c) regeneration for cones is faster than rods (d) regeneration for rods is faster than cones	xv. (a) X
xvi.	In myopic vision (a) near object vision is hampered (b) both near and far object visions are hampered (c) the lens of the eye focuses the image beyond the retina (d) none of the above is true	xvi. (d)
xvii.	A functional example of convergent neural circuit is (a) the activity of breathing (b) motor command for body movement (c) mathematical calculations (d) the activity of waking up	xvii. (b)
xviii.	The function of the support cells in a macula is (a) to perceive sound (b) to perceive head rotation (c) to secrete otolithic membrane (d) to secrete cerumen or ear-wax	xviii. (b) X
xix.	What type of conversion takes place in the physiology of hearing? (a) kinetic energy to electrical signal (b) kinetic energy to potential energy (c) electrochemical energy to mechanical vibrations (d) none of the above is true	xix. (a)
xx.	The part of our brain that plays major role in tactile sensitivity is (a) occipital lobe (b) parietal lobe (c) temporal lobe (d) cerebellum	xx. (b)

Section: IV

2. Write ONLY True/False. No MARKS for just writing T/F in the blanks. (0.5×10=5 Marks)

Statement	True/False
1. Voltage gated Na^+ channels open allowing Na^+ into the neuron if there is a stimulus that is sufficient enough to reach threshold.	1. True ✓
2. Human beings have monocular vision only. ✗	2. False ✓
3. The middle ear houses all sound receptors. ✗	3. False ✓
4. When outside opsin, retinal has no role in the visual cycle. ✗	4. True ✗ → F
5. The three semicircular ducts in the vestibular apparatus detect static equilibrium. ✗	5. True ✗ → F
6. The type of receptors responsible for sensing pain is called nociceptor. ✓	6. False ✗ → T
7. The image formed onto the wall of retina is always inverse. ✓	7. True ✓
8. The chance of neural circuit regeneration is more in CNS than in PNS. ✓	8. False ✓
9. ANN is a statistical data modeling tool having ability to learn.	9. True ✓
10. Vestibular apparatus houses sensors for equilibrium.	10. True ✓

3.5?

3. Fill in the blanks. (0.5×10= 5 Marks)

i. Refractive power of a concave lens having focal length 50 cm is -2 (2) diopter.

ii. The type of neural circuit associated with the task of mathematical calculation is known as Parallel.

iii. The junction where stapes bone meets the inner ear is called Oval Window.

iv. While bound to an opsin, ~~Rhodopsin~~ Retinal can absorb photon.

v. Night blindness can happen due to deficiency of Vitamin A.

vi. Each hair cell in the macula contains 40-80 stereocilia plus one ✗.

vii. The smallest skeletal muscle in our body is ✗ → Stapedius muscle.

viii. ✗ is the ability of neurons to change its structure based on experience.

ix. The blind spot is the region in retina where there are no photoreceptors.

x. The Ciliary muscles are responsible for adjusting the shape of the lens in our eyes.

2.75?

4. Write down the names of the three auditory ossicles and briefly describe the mechanism of amplification of sound waves in our ear. (1×3+2=5 Marks)

Ans:

Three auditory Ossicles → Malleus, Incus, Stapes

5?

Amplification occurs basically due to two reason → Surface area, dimensions

Auricle collects the sound waves

↓

Auditory canal

↓

Tympanic membrane vibrates

↓

Connected Malleus vibrates 3

↳ Amplification by the three auditory ossicles due to their surface area & dimensions

Stapes attached to oval window sends the amplified version forward to inner ear

Division: IV

5. Using a flowchart, briefly showcase how Glaucoma occurs.

Ans:

Pressure inside eyes increases ⟹ Nerve Chokes (why?) (what happens to nerve cells) ⟹ No exchange of nutrients materials between eyes & body ⇓ Results in Glaucoma

3

6. What are the three main functions of the nervous system? What do you mean by receptors and effectors? (1×3+1×2=5 Marks)

Ans: Three main function of nervous system :-

(i) Body Balance (ii) Intelligence (iii) Reflex action

Receptors → which receives the input signal of the body (say touch)

Effectors → (target organs) which shows the output provided by the nervous system in response to a particular input.

2

7. Briefly describe the four stages of visual phototransduction in rhodopsin. (1×4=4 Marks)

Ans:

four stages of visual phototransduction :-

1. Light detection by rod cells
2. Rhodopsin absorbs photons
3. output signal to the cell ahead of it.
4.

(Isomerization Bleaching. Retinal Isomerase Regeneration)

Division: II

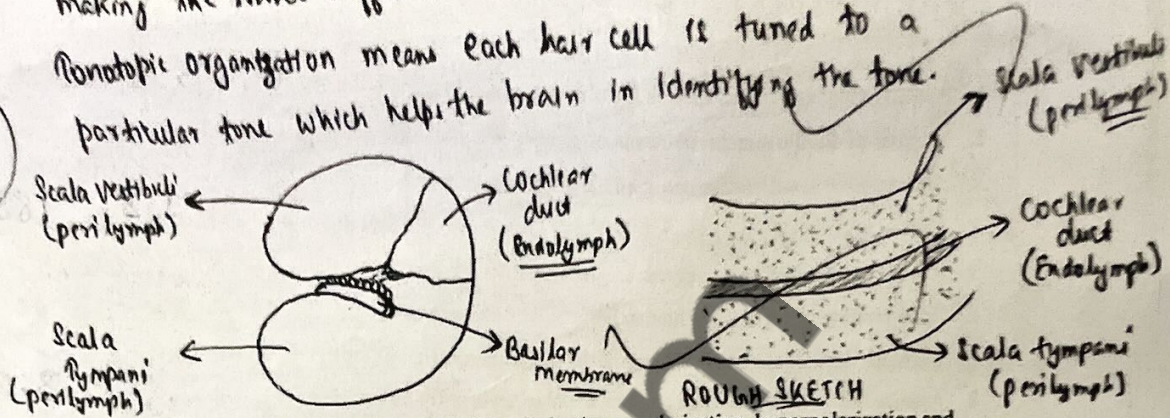
8. Why is pressure amplification needed before transferring the vibration to inner ear? Draw a rough sketch of the cross-sectional view of cochlea and label Scala Vestibuli, Scala Tympani and Cochlear Duct. (1+1+2=4 Marks)

Ans:

Pressure amplification is needed as the fluid through which the sound wave has to travel inside the inner ear has high inertia making the travel difficult.

Tonotopic organization means each hair cell is tuned to a particular tone which helps the brain in identifying the tone.

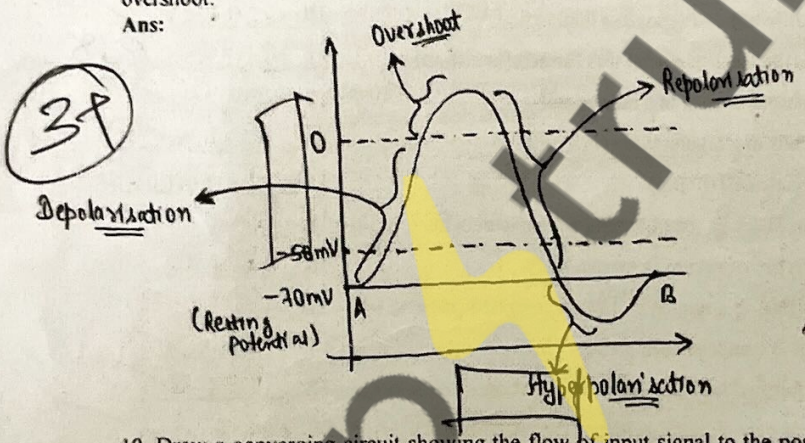
4P



9. Plot Action Potential (AP) of a neuron and label depolarization, repolarization, hyperpolarization and overshoot. (1×4=4 Marks)

Ans:

3P



No axis legends!!

From A to B

⇓

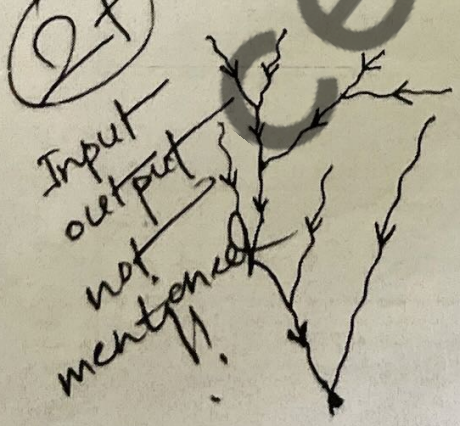
Action potential

10. Draw a converging circuit showing the flow of input signal to the post-synaptic neuron. Draw a feedforward ANN with input, output and hidden layer size of 3, 2 and 3, respectively. (2+2=4 Marks)

Ans:

2P

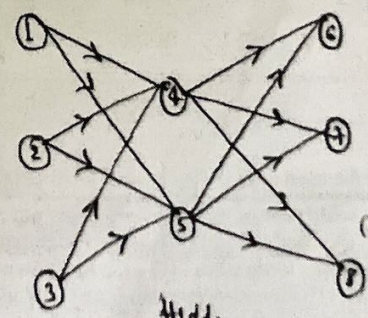
Converging circuit



Input output not mentioned!!

Converging circuit

ANN



Feedforward ANN

3 Input

Hidden Layer

3 Output

Layers not properly depicted.

Division: IX

Section B (25 Marks)

A. Pick a value (exact or the nearest one) from the box below and fill in the blanks. (0.5 X 20 = 10 Marks) — Striking and rewriting in blanks is strictly NOT allowed, and if done in any form, will result in "0" marks.

1. Approx. number of virus species identified in a human gut	1. >1,40,000
2. Number of double membrane bound organelles in a plant cell	2. 3
3. Approx. total number of genes in a human genome of a cell	3. 20,000
4. Year in which "Origin of species" by Dr. C Darwin was published	4. 1952, 1859
5. Approx. amount of peptidoglycan in gram-positive bacteria (in %)	5. 50-90
6. Total number of organs in a human body	6. 200-220 (79)
7. Currently known species of all organisms on this planet (in million)	7. 1.7-1.8
8. Approx. total number of base pairs in a human genome (in billion)	8. ~3.8 3.2
9. Year in which Urey and Miller experiment was conducted	9. 1859 – 1952
10. Approx. total number of different cell types in a human body	10. 200-220
11. Years before the first cell (life) on this planet was formed (in billion)	11. ~3.2 3.8
12. Total number of pairs of chromosomes in a human cell	12. 23
13. Approx. total number of cells in a human body (in trillion)	13. 37.2
14. Diameter of typical eukaryotic cell (in µm)	14. 10-100µm
15. Approx no. of base pairs of DNA wrapped around a histone octamer	15. 146
16. Total number of different types of tissues in human body	16. 4
17. Approx. length of human DNA in a human cell when stretched (in feet)	17. 6
18. Approx. % of human genome comprising of ancient viral remnants	18. 8
19. Year in which Lamarck published his hypothesis of evolution	19. 1809
20. Formation of planet Earth as per scientific evidence (in billion)	20. 4.6

8.5?

4; >140,000; 6; 23; 1809; ~20,000; 50-90; 79; 1.7-1.8; ~3.2; 8; 200-220; ~3.8; ~4.6; 1952; 10-100; 146; 37.2; 1859; 3

Approx. = Approximate (~)

B. Write the most appropriate answer (A/B/C/D) in the last column (0.5 X 20 = 10 Marks)

1.	Which one of the following gases was not used in Miller–Urey experiment? (A) Methane (B) Oxygen (C) Ammonia (D) Hydrogen	1. (B)
2.	Which word was never used by Darwin in his book "Origin of species"? (A) Competition (B) Mutation (C) Variation (D) Adaptation	2. (B)
3.	SARS-CoV-2 genome consists of (A) negative-sense, single-stranded RNA (B) positive-sense, single-stranded RNA C) negative-sense, double-stranded RNA (D) positive-sense, double-stranded RNA	3. (D)

Division: IV

4.	Which one of the following organelles is referred to as protein factories inside a cell? (A) Lysosomes (B) Endosomes (D) Peroxisomes (D) Ribosomes	4. (D)
5.	Cyanobacteria is _____ (A) a photosynthetic microbe (B) a Gram-positive bacteria (C) an extremophile (D) non-pathogenic	5. (A)
6.	The presence of _____ and _____ on the surface of the ER makes the ribosomes to get attached to ER. (A) Transporter and SRP (B) Translocon and SRP (C) Endosomes and SRP (D) Chaperone and SRP	6. (B)
7.	Which one of the below is not true about prokaryotic cells? (A) They are unicellular (B) They lack cytoplasmic organelles (C) They have linear chromosome localized to a region called the nucleoid (D) They have both cell wall and cell membrane	7. (C)
8.	Which one of the following does not have two (outer and inner) membranes? (A) Nucleus (B) Gram-positive bacteria (C) Mitochondria (D) Gram-negative bacteria	8.
9.	_____ functions as site of ribosome subunit biogenesis in a eukaryotic cells. (A) Rough ER (B) Nucleoplasm (C) Nucleus (D) Nucleolus	9. (D)
10.	Which one of the following is not an example of natural selection? (A) Rabbits that sprint quickly are more likely to escape predation. (B) Plant species that produce fragrances to attract pollinators produce more offspring. (C) Insect populations exposed to pesticides become resistant to the chemicals. (D) On a tree, leaves that grow in the shade are larger than those that grow in the sun.	10. (A)
11.	Arrange the steps of "Water cycle" in a proper order. (A) Collection → Evaporation → Condensation → Precipitation (B) Evaporation → Precipitation → Condensation → Collection (C) Evaporation → Condensation → Precipitation → Collection (D) Condensation → Evaporation → Collection → Precipitation	11. (C)
12.	"Drug Resistance in bacteria" is an example of _____. (A) Competition (B) Common descent with modification (C) Natural selection (D) Gradualism	12. (C)
13.	Which one of the following statements is true about Archaea? (A) The phytanyl side chain and glycerol are linked by ester linkage in cell membrane (B) They are found in extreme environments (C) They reproduce sexually and asexually (D) Their cell wall lack peptidoglycan	13. (B)
14.	Which of the below is an equation of cellular respiration? (A) $C_6H_{12}O_6 + 6O_2 \rightarrow CO_2 + 6H_2O + ATP$ (B) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (C) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$ (D) $6CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$	14. (C)
15.	The number of mitochondria present in a eukaryotic mature red blood cell is ____. (A) 0 (B) 1 (C) 10-100 (D) 100-1000	15. (A)
16.	Which one of the following enzymes synthesizes RNA from a DNA template? (A) Transcriptase (B) DNA polymerase (C) Reverse transcriptase (D) RNA polymerase	16. (D)
17.	According to Jean-Baptiste Lamarck, long-necked giraffes evolved because (A) nature selected only long-necked giraffes (B) short necks suddenly changed to long necks due to random variations (C) stretching of necks over many generations by short necked ones (D) no short trees were available at that time which resulted in giraffes with long necks	17. (C)
18.	_____ is the process by which random evolutionary changes are selected by nature in a consistent, orderly and a non-random manner. (A) Common descent (B) Random descent with modification (C) Natural selection (D) Gradualism	18. (C)
19.	Which one of the following organelles is not surrounded by a single phospholipid membrane in an animal cell? (A) Lysosomes (B) Smooth ER (C) Rough ER (D) Ribosomes	19. (D)
20.	Which one of the below reactions did not occur in Miller–Urey experiment? (A) $2CH_4 + NH_3 + 2H_2O \rightarrow NH_2\text{-}CH_2\text{-}COOH + 5H_2$ (B) $CH_2O + HCN + NH_3 \rightarrow NH_2\text{-}CH_2\text{-}CN + H_2O$ (C) $CH_2O + NH_3 \rightarrow NH_2\text{-}CH_2\text{-}CN + H_2O$ (D) $NH_2\text{-}CH_2\text{-}CN + 2H_2O \rightarrow NH_3 + NH_2\text{-}CH_2\text{-}COOH$	20. (C)

87

Division: III

C. Write ONLY True/False. No MARKS for just writing "T/F" in the blanks. (0.5 X 20 = 10 Marks)

S. No.	Statement	True/False
1.	Essential amino acids are amino acids which cannot be synthesized by the body.	1. True
2.	Glycolysis is the process in which glucose is broken down to produce energy and occurs in mitochondria.	2. False
3.	Cyanobacteria are the first organisms known to have produced carbon dioxide.	3. False
4.	Adaptation diversity is one of the types of biodiversity.	4. False
5.	The endosymbiont theory proposed that the main organelles of the eukaryotic cell were primitive prokaryotic cells that lacked the genetic material and were engulfed by a prokaryotic cell.	5. False
6.	The pH inside the lysosomes is highly alkaline.	6. False
7.	Peroxisomes are double membrane-bound organelles found only in the eukaryotic cells.	7. False
8.	Abiogenesis is the natural process by which life has arisen from non-living matter, such as simple organic compounds.	8. False
9.	Ribosomes are found in both prokaryotic and eukaryotic cells.	9. True
10.	Proteoglycans are macromolecules composed of mucopolysaccharides and proteins linked by a tetra-saccharide linkage.	10. True
11.	Insulin is a peptide hormone.	11. True
12.	A nucleotide is an organic molecule with a composition of a nitrogenous base, pentose sugar molecule and phosphate.	12. True
13.	Cytosine forms a double bond with Guanine whereas Adenine forms a triple bond with Thymine in DNA.	13. False
14.	Phosphorylation can occur on serine, threonine and tyrosine side chains through phosphoester bond formation.	14. True
15.	Mitochondrial DNA, unlike nuclear DNA, is inherited from father only.	15. True
16.	Archaea have unbranched hydrocarbons whereas bacteria have branched hydrocarbons in the phytanyl sidechain in its phospholipid layer.	16. True
17.	Glycoproteins have one or more oligosaccharides linked covalently to a protein.	17. True
18.	Humans with sickle cell anemia appear to be immune to the effects of malaria indicating that the sickle cell trait is an example of a natural selection at work.	18. True
19.	The size of mitochondrial genome is larger than the size of nuclear genome.	19. False
20.	Proteins are unbranched polymers of amino acids linked from carboxyl group to amino group, through a type of amide linkage called peptide bond.	20. True

8.5

D. Fill in the blanks. (0.5 X 20 = 10 Marks)

1. Methionine and ______ are sulphur-containing proteinogenic amino acids.

2. The Prokaryote is the organism from which all organisms now living on Earth is believed to have descended.

3. Lamarck theory is a theory of evolution based on the principle that physical changes in organisms during their lifetime - such as greater development of an organ or a part through increased use - could be transmitted to their offspring.

4. A phosphodiester bond is formed between two sugar molecules and a phosphate group and make up the backbones of DNA and RNA.

3.5

+0.5

Division: IX

5. Other than histidine, histone proteins contain a large number of basic amino acids such as _____ Arginine _____ and _____.

6. Sucrose is a sugar composed of _____ D-Fructose _____ and _____ D-Fructose _____ subunits.

7. _____ Melanine _____ is a substance in your body produced by melanocytes that produces hair, eye and skin pigmentation.

8. _____ Fatty Acid _____ and _____ Carbohydrate _____ are the two structural components of lipids

9. A _____ Phosphodiester _____ bond is a covalent bond that joins a carbohydrate to another functional group or molecule.

10. _____ Cilia _____ helps the bacteria direct their movement in response to certain chemicals in their environment.

11. The light areas containing the loose chromatin (DNA and protein) structure (active for transcription) are called _____ Euchromatin _____.

12. Chloroplast contains an extensive interconnected membrane bound sacs called _____ Grana Thylakoid _____.

13. _____ which degrade RNA and DNA into their respective mononucleotides.

14. _____ is a self-digesting mechanism responsible for removal of damaged organelles or other cellular components by lysosome.

15. _____ Based on Colour _____ is a method of staining used to classify bacterial species into two large groups.

16. _____ Biodiversity _____ is the variation among living organisms from different sources including terrestrial, marine and desert ecosystems, and the ecological complexes of which they are a part.

17. _____ HIV _____ is a virus that infects and replicates only within the body of bacteria.

18. Carl Woese discovered a microbial life called _____.

19. Apart from plants and animals, the other examples of multicellular organisms are _____ Fungi _____ and _____.

20. _____ Myopectin Mesentery _____ organ is a large single continuous stretch of tissue that support and position all the digestive organs in the abdomen.

Division: IV

E. Match GROUP I with GROUP II and fill in the blanks below. (0.5 X 20 = 10 Marks)

Group I	Group II
1. Genetic diversity	A. Plays a vital role in protein synthesis, folding, transport of cellular materials or transport of various proteins, specifically carrying them to the Golgi apparatus.
2. Smooth ER	B. Made of layers of cells that cover the surfaces of the body that come into contact with the exterior world, lines internal cavities and passageways, and form glands
3. Cytoskeleton	C. Hair-like filaments that extend from the cell surface of bacteria
4. Golgi apparatus	D. Generates most of the chemical energy needed to power the cell's biochemical reactions
5. Connective tissue	E. Function in cholesterol synthesis and breakdown, fat metabolism, and detoxification of drugs
6. Centriole	F. Stores substances, typically either waste or harmful substances, or useful substances the cell will need later on
7. Epithelial tissue	G. Packaging and secretion of proteins
8. Vacuole	H. Fluid that contains organelles
9. Cytosol	I. Protects the cell from its environment; acts as a barrier for cell contents
10. Nucleus	J. Composed of DNA and protein scattered throughout the nucleus
11. Pili	K. It is excitable and allows the body to receive signals and transmit information as electric impulses from one region of the body to another.
12. Cell membrane	L. Gelatinous layer comprising of polysaccharide covering the entire bacterium
13. Chromatin	M. Detoxify harmful substances and break down free radicals; involved in catabolism of very long chain fatty acids
14. Lysosomes	N. Variation in the genetic composition of individuals in a population, community or species
15. Muscle tissue	O. Control center of the cell
16. Peroxisomes	P. Microfilaments and microtubules
17. Nervous tissue	Q. Involved in the organization of mitotic spindle fibers during cell division
18. Rough ER	R. It binds the cells and organs of the body together and performs many functions, especially in the protection, support, and integration of the body.
19. Capsule	S. It is excitable, responds to stimulation and contracts to provide movement.
20. Mitochondria	T. Suicidal bag of the cell; contain enzymes that digest non-usable materials within the cell

ANS (fill with appropriate alphabets A to T in the blanks):

1. (N) ✓ 8. (F) ✓ 15. (S) ✓

2. (E) ✓ 9. (H) ✓ 16. (M) ✓

3. (P) ✓ 10. (O) ✓ 17. (K) ✓

4. (G) ✓ 11. (C) ✓ 18. (A) ✓

5. (R) ✓ 12. (I) ✓ 19. (L) ✓

6. (Q) ✓ 13. (J) ✓ 20. (D) ✓

7. (B) ✓ 14. (T) ✓

10/10