Somali Federal Ministry of Education, Culture & Higher Education
Form Four National Standardized Examinations.
MAY / JUNE 2022
SUBJECT: BIOLOGY
TIME: 2 HOURS

Part I: Circle the letter of the correct answer (40 Marks)

1. The structural and functional unit of nervous system is:
   a. Neurons
   b. Neurotransmitter
   c. Neuroglia
   d. Node of Ranvier

Correct Option is "A"

Explanation:

The nervous system is composed of specialized cells called neurons which are the structural and functional unit of the system. Neurons are responsible for transmitting electrical and chemical signals throughout the body. They are made up of a cell body, dendrites, and an axon. The cell body contains the nucleus and other organelles, while dendrites receive signals from other neurons and the axon carries the signal away from the cell body. Neurotransmitters are chemicals released by neurons to transmit signals to other neurons or target cells. Neuroglia, also called glial cells, are supportive cells in the nervous system that provide structural and metabolic support to neurons.

2. The substance responsible for skin color is referred to as
   a. Collagen
   b. Keratin
   c. Melanin
   d. Carotene

Correct Option is "A"

Explanation:

The substance responsible for skin color is melanin. Melanin is a pigment that is produced by specialized cells called melanocytes, which are found in the epidermis of the skin. The amount and type of melanin produced by these cells determine an individual's skin color. The more melanin produced, the darker the skin color. Melanin also provides some protection against the harmful effects of ultraviolet (UV) radiation from the sun.

3. Which of the following parts of the skeletal system protects the spinal cord?
   a. Skull Bones
   b. Sternum
   c. Vermor Bone
   d. Vertebral Column

Correct Option is "D"

Explanation:

The vertebral column, also known as the spine, is a series of bones that extend from the skull to the pelvis. It is composed of individual bones called vertebrae, which are stacked on top of each other and separated by intervertebral discs. The vertebral column plays an important role in protecting the spinal cord, which is a bundle of nerves that extends from the brain down through the vertebral canal. The spinal cord is responsible for transmitting messages between the brain and the rest of the body, so it is important to protect it from injury.

4. The type of sugar that is found in Ribonucleic acid (RNA) is
   a. Deoxyribose
   b. Ribose
   c. Fructose
   d. Xylose

Correct Option is "B"

Explanation:

Ribonucleic acid (RNA) contains the sugar ribose. RNA is a molecule that plays a vital role in protein synthesis and gene expression. It consists of a chain of nucleotides, each of which contains a sugar molecule, a phosphate group, and a nitrogenous base. In RNA, the sugar molecule is always ribose, which is a five-carbon sugar with a hydroxyl group attached to each carbon. The presence of the hydroxyl group in ribose makes RNA more chemically reactive than DNA, which has a similar structure but contains the sugar deoxyribose instead.

5. If a tall pea plant (Tt) is crossed with a short pea plants(tt) the phonotypical ratio will be:
   a. 0 : 2 tall to short
   b. 3 : 1 tall to short
   c. 1 : 1 tall to short
   d. 2 : 2 tall to short

Correct Option is "C"

Explanation:

When a tall pea plant (Tt) is crossed with a short pea plant (tt), the genotype of the offspring will be Tt and tt in equal proportions. However, the phenotype (observable trait) of the offspring will depend on the dominant/recessive nature of the alleles.

In this case, "T" is the dominant allele for tallness and "t" is the recessive allele for shortness. Therefore, the phenotype of the offspring will be either tall or short.

The genotype of the offspring will be Tt or tt in a 1:1 ratio. However, since the T allele is dominant, the phenotype ratio will be 1:1 tall to short.

6. The two main functions of human Ear are
   a. Hearing and taste
   b. Hearing and balance
   c. Hearing and pressure
   d. Hearing and temperature

Correct Option is "B"

Explanation:

The two main functions of the human ear are hearing and balance. The outer ear collects sound waves and directs them to the eardrum, which vibrates in response. The vibrations are then transmitted through the three small bones in the middle ear to the cochlea, a fluid-filled organ in the inner ear that converts the vibrations into electrical impulses that are sent to the brain.

The inner ear also contains the vestibular system, which is responsible for balance and spatial orientation. It consists of three semicircular canals and two otolith organs, which sense changes in head position and movement. These signals are integrated with visual and sensory information to help maintain balance and body position.

7. Look at the figure below and then describe the type of gene mutation.

A	B	C	D	E	F	G	H

↓

A	B	C	D	G	F	E	H

a. Inversion
b. Deletion
c. Duplication
d. Translocation

Correct Option is "A"

Explanation:

The type of gene mutation in the figure is an inversion. This is because a segment of the chromosome has been reversed in orientation, so that the order of genes has been changed. In this case, genes F and G have been inverted with respect to the rest of the chromosome, so that they are now located between genes D and E instead of between genes C and D.

8. The nucleotides of each strand of DNA molecule are binded together by
   a. Hydrogen bond
   b. Phophodiester bond
   c. Ionic bond
   d. Metallic bond

Correct Option is "B"

Explanation:

The nucleotides of each strand of DNA molecule are bound together by phosphodiester bonds. These are covalent bonds that form between the 3' carbon of one nucleotide and the 5' carbon of the adjacent nucleotide. The phosphate group of one nucleotide forms an ester bond with the hydroxyl group on the sugar of the adjacent nucleotide. This linkage creates a sugar-phosphate backbone that runs along the length of each DNA strand. The nitrogenous bases extend from this backbone and form the complementary base pairs that hold the two strands of the DNA molecule together via hydrogen bonds.

9. The branch of biology that deals with the study of interactions between living organisms and their environment is called:
   a. Ecology
   b. Entomology
   c. Embryology
   d. Etiology

Correct Option is "A"

Explanation:

The branch of biology that deals with the study of interactions between living organisms and their environment is called ecology. Ecologists study how organisms interact with each other and with their physical and biological surroundings. They also investigate how human activities impact the environment and the consequences of those impacts on ecological systems. Ecology is an important field of study as it helps us to better understand the natural world and how we can better protect and conserve it.

10. Ali got cerebellum injury due to car accident, what are the effects that he is most likely to experience
    a. Fluctuation of body temperature
    b. Increasing heart rate
    c. Loss of body balance and posture
    d. Decreasing heart rate

Correct Option is "C"

Explanation:

If Ali has suffered a cerebellum injury due to a car accident, he is most likely to experience loss of body balance and posture. The cerebellum is responsible for coordinating voluntary movements, including maintaining balance and posture. Damage to the cerebellum can result in unsteady gait, difficulty standing or walking, and poor coordination. Symptoms may also include dizziness, nausea, and difficulty with fine motor skills. Fluctuations in body temperature and heart rate are not typically associated with cerebellum injury.

11. The physiological inability of muscle to contract resulted of ATP depletion is termed

a. Muscle fatigue
b. Muscle tearing
c. Muscle cramps
d. Muscle strain

Correct Option is "A"

Explanation:

Muscle fatigue is the physiological inability of a muscle to contract effectively due to the depletion of ATP (adenosine triphosphate), which is the energy source for muscle contraction. This can result in a decrease in muscle strength, endurance, and coordination, as well as an increase in the perception of effort and fatigue. Muscle fatigue can occur due to a variety of factors, including inadequate oxygen supply, depletion of muscle glycogen, accumulation of metabolic waste products, and failure of the neuromuscular junction to transmit impulses effectively.

12. The technique aimed to correct the mutated genes that cause human disease is

a. Recombinant DNA
b. Gene therapy
c. Gene cloning
d. Polymerase chain reaction

Correct Option is "B"

Explanation:

Gene therapy is the technique aimed to correct the mutated genes that cause human disease. This technique involves introducing functional genes into a patient's cells to replace or supplement the mutated genes that cause the disease. The functional genes can be introduced using different methods, such as viral vectors or gene editing technologies. The goal of gene therapy is to restore the normal function of the affected cells and tissues, and potentially cure the disease. Gene therapy is still an experimental approach, but it has shown promising results in treating certain genetic disorders such as severe combined immunodeficiency (SCID), spinal muscular atrophy (SMA), and Leber's congenital amaurosis (LCA).

13. Which one of the following set of terms is mismatched?

a. Cranium and suture

b. Wrist and pivot joint

c. Shoulder and ball and socket join

d. Knee and hinge joint

Correct Option is "B"

Explanation:

The wrist joint is actually classified as a **condyloid joint**, which allows for movement in two planes (biaxial), while a pivot joint only allows rotation around one axis.

The condyloid joint is found in the wrist between the radius and the carpal bones, as well as in the metacarpophalangeal joints in the fingers.

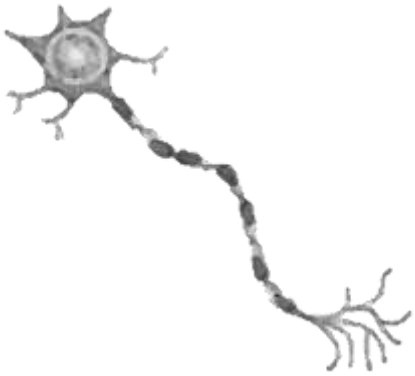
14. If the sequence (AGC) is a part of DNA, what is the complementary codon of *m*RNA?
    a. UGC
    b. GGC
    c. AGC
    d. GCU

Correct Option is "A"

Explanation:

If the DNA sequence is AGC, then the complementary RNA sequence would be UCG since RNA uses the base uracil (U) instead of thymine (T) found in DNA. Next, this RNA sequence can be divided into codons of three nucleotides each to yield UCG, which codes for the amino acid serine

15. The neuron in the diagram below represents a:



a. Multipolar neuron
b. Anaxonic neuron
c. Bipolar neuron
d. Unipolar neuron

Correct Option is "A"

Explanation:

A multipolar neuron is a type of neuron that has multiple dendrites and a single axon. It is the most common type of neuron in the human body and is found in the brain and spinal cord. The cell body of the neuron, also known as the soma, is located in the center of the cell and contains the nucleus. The dendrites receive signals from other neurons and transmit them to the cell body, while the axon sends signals to other neurons or muscles. Multipolar neurons are involved in many different functions, including sensory perception, movement, and cognition.

16. Hormones that work together in pairs to regulate the level of electrical substances are
    a. Lipophilic hormones
    b. Steroid hormones
    c. Antagonistic hormones
    d. Non-steriod hormones

Correct Option is "C"

Explanation:

The hormones that work together in pairs to regulate the level of electrical substances are called antagonistic hormones. Antagonistic hormones have opposing effects on a target organ or tissue. For example, insulin and glucagon are two antagonistic hormones that regulate blood glucose levels in the body. Insulin decreases blood glucose levels by promoting glucose uptake by cells, while glucagon increases blood glucose levels by stimulating the liver to release stored glucose into the bloodstream. Another example is parathyroid hormone and calcitonin, which regulate calcium levels in the body.

17. The building block of nucleic acids (DNA and RNA) is

a. Amino acids
b. Fatty acids
c. Deoxyribose
d. Nucleotide

Correct Option is "D"

Explanation:

The correct answer is d. Nucleotide. Nucleotides are the basic building blocks of nucleic acids such as DNA and RNA. A nucleotide is composed of a nitrogenous base, a five-carbon sugar (either ribose or deoxyribose), and a phosphate group. The sequence of nucleotides in DNA and RNA molecules determines the genetic information that is passed on from generation to generation.

18. The increasing concentration of toxic substances in an organisms as trophic level increase in a food chain or food web is described as:
    a. Biological magnification
    b. Biological concentration
    c. Biological accumulation
    d. Biological toxicity

Correct Option is "A"

Explanation:

The increasing concentration of toxic substances in an organism as trophic level increases in a food chain or food web is described as "biological magnification". This phenomenon occurs because as organisms consume other organisms, the toxins present in the prey become concentrated in the predator's body over time. This is particularly true for toxins that do not break down easily in the environment and can accumulate in fatty tissues. As a result, organisms at higher trophic levels, such as apex predators, may have much higher levels of toxic substances in their bodies than organisms at lower trophic levels. This can lead to negative effects on the health and survival of these organisms, as well as on the ecosystems in which they live.

19. An enzyme that cuts DNA or genes into fragments is termed as:

a. Isomerase
b. Helicase
c. Ligase
d. Restriction

Correct Option is "D"

Explanation:

Restriction enzymes are proteins that recognize and cut DNA at specific nucleotide sequences. They are used extensively in molecular biology for DNA manipulation, such as creating recombinant DNA molecules or cutting DNA fragments for analysis

20. The breeding of two closely related cows to increase milk production is said to be.

a. Inbreeding
b. Cross breeding
c. Hybridization
d. Crossing over

Correct Option is "A"

Explanation:

Inbreeding is the breeding of two closely related individuals within the same breed or line. It is often used to produce animals with desirable traits, but can also lead to genetic problems due to the limited genetic diversity. Cross breeding involves mating individuals from different breeds or populations to combine desirable traits from both. Hybridization is a form of cross breeding that involves breeding two different species or varieties to create a new hybrid organism. Crossing over refers to the exchange of genetic material between homologous chromosomes during meiosis.

PART II: Match the terms in column A with suitable description in column B (10 Marks)

Column A	Column B
1. Fertilization	(**6**) members of a pair homologous chromosome do not separate
2. Mutation	(**7**) lowers the level of glucose when it becomes rise above normal
3. Eutrophication	(**8**) controls the output of hormones from pituitary gland
4. Foramen magnum	(**9**) bundles of thread like structures found in skeletal muscles
5. Transcription	(**10**) an organism's complete set of genetic materials
6. Nondisjunction	(**1**) union of male gamete- sperm and female game-egg to form a zygote
7. Insulin	(**2**) sudden change or error that occur in the genetic materials
8. Hypothalamus	(**3**) excessive nutrients in the aquatic ecosystem that destroys the habitat of fish
9. Myofibrils	(**4**) large oval opening that locate at the base of the human skull
10. Genome	(**5**) transfer of genetic instruction in specific gene into RNA molecule

PART III: Use the information in the box below to fill the gabs (10 Marks)

Epidermis	Rods	Cerebrum
Pectoral girdle	Deoxyribose	Dwarfism
Consumer	Proteomics	Myosin
Peptide bond		

1. The largest part of the brain is **(Cerebrum)**
2. Too low growth hormone causes a condition referred to as **(Dwarfism)**
3. The type of sugar that consists of DNA is **(Deoxyribose)**
4. The outermost layer of human skin is called **(epidermis)**
5. In a food chain the trophic level of grazing animals can be categorized as primary **(Consumers)**
6. The light-sensitive cells that are excited by low levels of light is **(Rods)**
7. The thick filamentous protein that constitute the skeletal muscle fibers is **(myosin)**
8. The bond that links amino acids in a protein is called Peptide bead **(peptide bond)**
9. he large scale study and cataloguing of the structure and function of proteins in the human body is called **(Proteomics)**
10. The upper limbs are connected to the axial skeleton by **(Pectoral girdle)**

PART IV: Answer All of the following Questions

1. Define the following terms: (4 marks)

a) Genetic engineering

b) Biodiversity

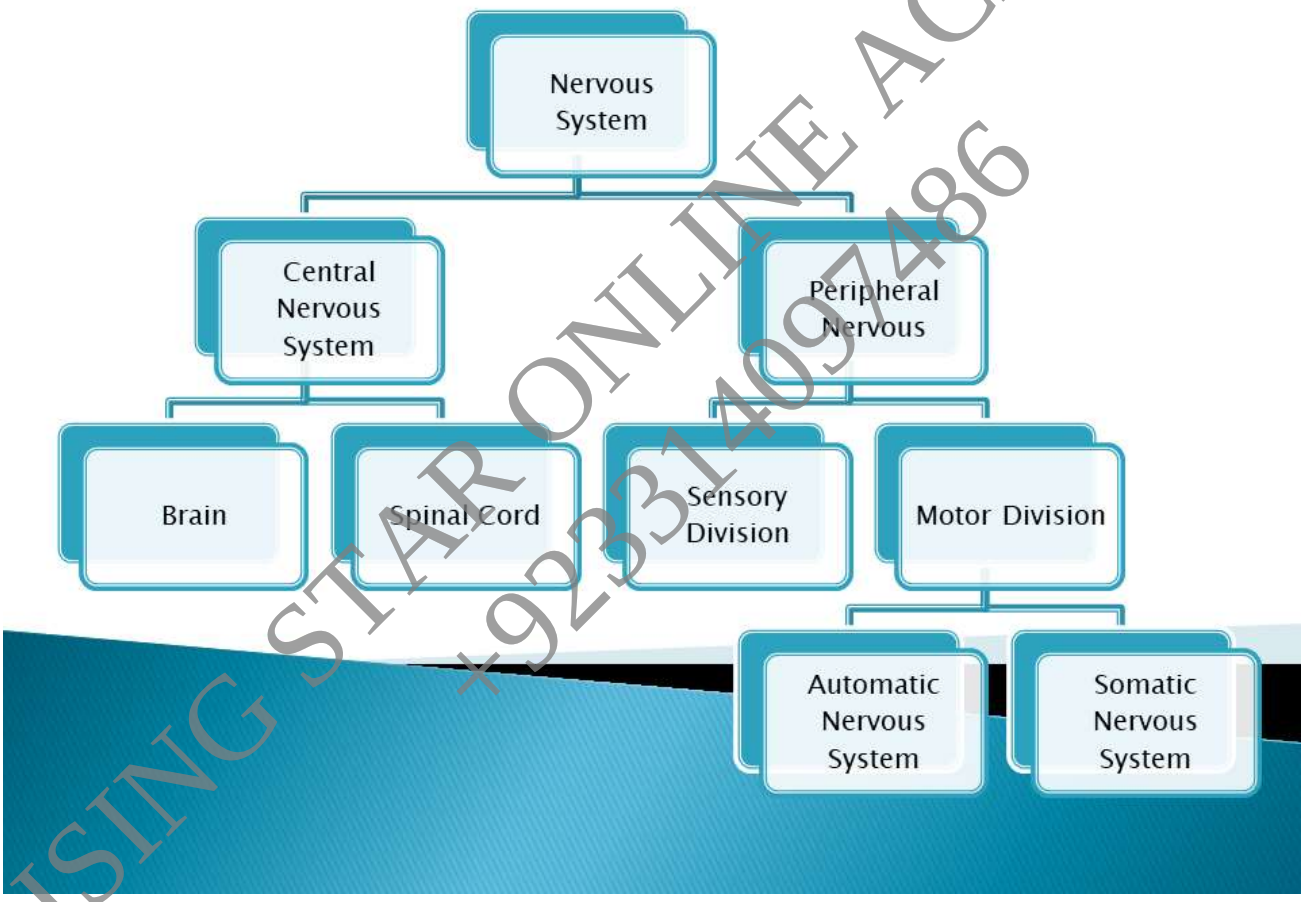
Answer:

a) ***Genetic engineering*** refers to the manipulation of an organism's genetic material using biotechnology techniques to introduce, remove, or modify specific genes. This process can be used to create new or improved products, such as genetically modified crops that are resistant to pests or have a higher nutritional content.

b) ***Biodiversity*** refers to the variety of living organisms and ecosystems that exist on Earth. It encompasses the diversity of species, genetic variation within those species, and the variety of ecosystems and ecological processes. Biodiversity is essential for the functioning of ecosystems and provides numerous benefits to human society, including food and medicine, climate regulation, and cultural and spiritual values. However, biodiversity is threatened by a range of human activities, such as habitat destruction, overexploitation of natural resources, and climate change.

2. Identify the main parts of nervous system based on the flow chart given (4 marks)

Answer:



3. Ahmed has broken his leg in football match to the extent that his bone was protruding through his skin, identify the type of fracture. (4 Marks)

Answer:

Ahmed has suffered a compound fracture, also known as an open fracture. This type of fracture occurs when the broken bone protrudes through the skin, creating an open wound.

4. Describe uses of DNA fingerprinting in our life? (4 marks)

Answer:

DNA fingerprinting, also known as DNA profiling or genetic fingerprinting, is a technique used to identify individuals based on their unique DNA characteristics. Here are some of the uses of DNA fingerprinting in our life:

1) ***Crime investigation:*** DNA fingerprinting is commonly used in forensic investigations to identify suspects and link them to a crime scene. By analyzing DNA samples found at a crime scene, investigators can determine whether the DNA belongs to a suspect or not.
2) ***Paternity testing:*** DNA fingerprinting can also be used to determine paternity. By comparing the DNA of a child and a potential father, scientists can determine whether the man is the biological father or not.
3) ***Identification of human remains:*** DNA fingerprinting is used to identify human remains in cases where identification through other means is not possible, such as after a natural disaster or a terrorist attack.
4) ***Conservation biology:*** DNA fingerprinting is used to monitor and protect endangered species. By analyzing the DNA of different individuals within a population, scientists can determine the genetic diversity of the population and track changes over time.
5) ***Agriculture and livestock breeding:*** DNA fingerprinting is used to improve agricultural and livestock breeding. By identifying individual genetic traits, farmers can select and breed plants and animals with desirable traits, such as disease resistance or higher yields.

5. Using a punnet square, find the phenotype ration of two heterozygote plants (Tt) for their F1 generation. (6 Marks)

Answer:

Assuming that "T" represents the dominant allele and "t" represents the recessive allele, the Punnett square for the cross between two heterozygous plants (Tt x Tt) would be:

	T	t
T	**TT**	**Tt**
t	**tT**	**tt**

The F1 generation would consist of the offspring resulting from this cross. The phenotypic ratio can be determined by looking at the dominant and recessive traits that are expressed in the offspring. In this case, the dominant trait (T) would be expressed in the TT and Tt genotypes, while the recessive trait (t) would only be expressed in the tt genotype.

From the Punnett square, we can see that there are 4 possible genotypes in the F1 generation: TT, Tt, Tt, and tt. Of these, 3 genotypes (TT, Tt, Tt) express the dominant trait (T), while only 1 genotype (tt) expresses the recessive trait (t). Therefore, the phenotypic ratio of the F1 generation would be 3:1 in favor of the dominant trait.

6. State the three structural parts of the nucleotide (3 marks)

Answer:

The three structural parts of a nucleotide are:

1. A sugar molecule (either ribose in RNA or deoxyribose in DNA)
2. A phosphate group
3. A nitrogenous base (adenine, thymine, cytosine, guanine in DNA; or adenine, uracil, cytosine, guanine in RNA)

7. Summarize the importance of DNA replication (4 Marks)

Answer:

DNA replication is the process by which cells make identical copies of their DNA molecules. It is an essential process that occurs during the cell cycle, and ensures that each new cell receives a complete and accurate copy of the genetic information stored in the parent cell's DNA.

The importance of DNA replication can be summarized as follows:

Ensuring accurate inheritance of genetic information: DNA replication ensures that each daughter cell receives a complete and accurate copy of the parent cell's genetic information, allowing for faithful inheritance of traits from one generation to the next.

Facilitating DNA repair: DNA replication also plays a critical role in repairing damaged DNA molecules, which can occur due to various environmental factors or errors during replication itself.

Supporting cellular growth and division: DNA replication is an essential component of the cell cycle, which allows cells to grow and divide to form new tissues and replace old or damaged cells.

8. The sequence of DNA strand is ACGTTG, Write the complementary strand of this DNA. (4 Marks)

Answer:

The complementary strand of the given DNA sequence ACGTTG would be TGCAAC.

9. Mention at least three functions of the human skin (3 Marks)

Answer:

The human skin has several important functions, including:

Protection: The skin acts as a barrier that protects the body from physical, chemical, and biological damage. It also protects against dehydration and UV radiation from the sun.

Regulation: The skin helps regulate body temperature through sweating and blood vessel dilation or constriction.

Sensation: The skin contains sensory receptors that allow us to feel touch, pressure, temperature, and pain. It also plays a role in detecting and responding to external stimuli such as heat, cold, and vibration.

10. Differentiate between species diversity and genetic diversity?

(4 Marks)

Answer:

Species diversity refers to the variety of different species that exist in a particular ecosystem or on Earth as a whole. It includes the number of different species present, as well as the abundance and distribution of those species.

On the other hand, genetic diversity refers to the variety of genes that exist within a particular species. It includes the range of genetic information found within individuals of a species, as well as the differences in genetic information between different populations of the same species.