

Multiple Choice Exam (Individual Round)

MCC

1. **Tay-Sachs disease is a genetic disease that causes the impairment of the nervous system due to the buildup of GM2 ganglioside, a lipid, in the body as a result of a mutation in an enzyme that normally breaks it down. In which organelle might you find this enzyme?**
 - a. Lysosome
 - b. Cell membrane
 - c. Smooth endoplasmic reticulum
 - d. Nucleus
 - e. Ribosome

2. **How many tubulin rings are in a centrosome?**
 - a. 27
 - b. 54
 - c. 20
 - d. 11
 - e. 9

3. **Bacterial artificial chromosomes are bacterial vectors large enough to be thought of as chromosomes, and they are used when a researcher wants to clone a much longer sequence of DNA. Like all plasmid vectors, BAC's contain a stable origin of replication (oriC), but compared to many other vectors, its oriC maintains the copy number of the BAC at roughly 2 copies per cell, an extremely small value. Why is this favorable?**
 - a. Since BAC's are quite large, low copy numbers lower the probability of recombination, preventing any unwanted changes in the DNA sequence the researcher wants to study
 - b. Since BAC's are quite large, low copy numbers increase the chance of recombination, allowing foreign DNA to thus integrate with the DNA.
 - c. A low copy number would ensure that BAC's do not clump or aggregate, a potentially detrimental outcome for the bacterial cell.
 - d. A high copy number of BACs would fatally increase the amount of bacterial protein being produced.

- e. None of the above
- 4. Which of the following molecules is produced in the oxidative phase of the pentose phosphate pathway?**
- a. NADH
 - b. NAD⁺
 - c. NADPH
 - d. NADP⁺
 - e. FADH₂
- 5. Where is the catalytic power of enzymes derived from?**
- a. Peptide bonds
 - b. Increase in entropy
 - c. Weak interactions with the substrate
 - d. Salt bridges
 - e. Disulfide bonds
- 6. Which of the following types of antibiotics acts by inhibiting the synthesis of proteins?**
- a. Aminoglycosides
 - b. Penicillins
 - c. Sulfonamides
 - d. Glycopeptides
 - e. Fluoroquinolones
- 7. You want to determine the amino acid sequence of an unknown protein. Which of the following techniques should you use?**
- a. Edman degradation
 - b. Western blotting
 - c. Sanger sequencing
 - d. ChIP-seq
 - e. Flow cytometry

8. How many stereoisomers are possible for the following tripeptide: Ala-Ile-Thr? (from N-terminus to C terminus)
- 4
 - 5
 - 8
 - 16
 - 32
9. tRNA nucleotides have many unique modifications that enable them to form the unique tRNA structure. Which of the following is not a nucleotide found in tRNA?
- Inosine
 - Pseudouracil
 - Dihydrouracil
 - Thymine
 - Thiouridine
10. Collagen is a crucial protein, consisting largely of the extracellular matrix and is the most abundant protein in mammals. Which of the following statements is false?
- Collagen is made up of a triple helix with 3 left-handed helices.
 - Collagen has Glycine, Proline, and Leucine in repetitions.
 - Collagen is involved in the intrinsic pathway of blood clotting.
 - Collagen is present in the cornea in a crystalline form.
 - Fibroblasts synthesize collagen.

ANP

11. Which of the following processes is NOT carried out by tissue that is derived from ectoderm in humans?
- Conduction and integration of sensory information
 - Secretion of Vasopressin/Antidiuretic hormone (ADH)
 - Meiosis and gametogenesis
 - Secretion of bicarbonate in response to secretin
 - Providing the first external barrier between the body and the environment

12. Which of the following is FALSE about the oxyhemoglobin dissociation curve?

- a. 2, 3-DPG concentrations are expected to increase at high altitudes
- b. An increased affinity for oxygen is optimal during exercise
- c. A decreased pH leads to a rightward shift in the oxyhemoglobin dissociation curve
- d. A decreased temperature leads to a leftward shift in the oxyhemoglobin dissociation curve
- e. Fetal hemoglobin has a higher affinity for oxygen than adult hemoglobin at all partial pressures

13. Toll-like Receptors(TLRs) are membrane proteins that play a key role in the innate immune system. Which of the following INCORRECTLY characterizes their action?

- a. TLR proteins bind to fragments of molecules characteristic of a set of pathogens
- b. TLR3, found on the inner membrane of endocytic vesicles, binds to double stranded RNA, which is typically produced by foreign bacteria
- c. Unmethylated CpG sequences can trigger a TLR-mediated response
- d. TLR4, necessary for the detection of bacterial lipopolysaccharide, is typically localized to the plasma membrane where it binds to extracellular ligands.
- e. One would expect TLRs to be found in macrophages and dendritic cells

14. Which of the following accurately describes long-term potentiation in the hippocampus?

- a. Hyperpolarization stimulates the opening of AMPA receptors
- b. Frequently occurs by the binding of glycine
- c. Particularly active in processes such as breathing
- d. Removal of the Mg^{2+} ion in NMDA is caused by strong depolarization
- e. Removal of the Mg^{2+} ion in AMPA is caused by strong depolarization

15. Which of the following statements is true about neural development

- a. The notochord extends along the ventral axis of a chordate embryo.
- b. Exposing the dorsal side of the embryo to BMP-4 would induce the formation of the notochord and neural tube.
- c. Sonic-hedgehog promotes the formation of the notochord and neural tube as compared to epithelial cells
- d. Wnt function is not similar to BMP-4 in the context of regulating neural/epithelial cell formation

- e. Segregation of rhombomeres in the brain is a direct result of mutually repressive negative feedback loops

16. Assume that Kevin screwed up his intestinal microbiome by taking too many antibiotics. Which of the following types of cells would work to regulate the microbiome as it forms?

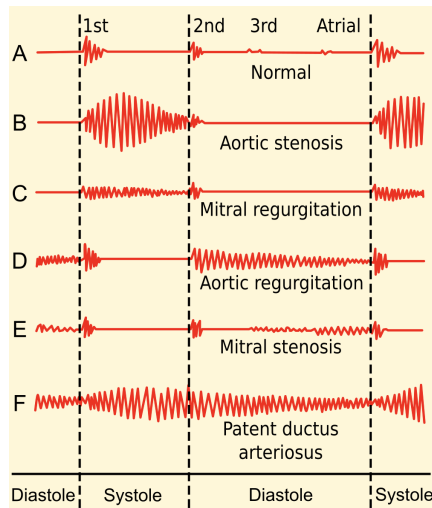
- a. Enteroendocrine cells
- b. Paneth cells
- c. Mast cells
- d. Enterocytes
- e. Enterochromaffin cells

17. Thiazide diuretics work by specifically targeting the ascending loop of Henle. Which of the following ion's concentrations will decrease in the final urine as a result of using loop diuretics?

- a. Na^+
- b. K^+
- c. Cl^-
- d. Ca^{2+}

18. Heart murmur is a cardiac condition marked by the irregular sound the heart produces. Based on the information provided, which of the following matches the condition correctly with the phonocardiogram?

- stenotic semilunar valves
- stenotic atrioventricular valves
- insufficient semilunar valves
- insufficient atrioventricular valves
- Both A and C



19. Cross-presentation is the process of antigen-presenting cells taking extracellular antigens and presenting them to the intracellular pathway. Cross presentation is performed by ___ cells and transfer cells from the ___ pathway to the ___ pathway.

- dendritic, MHC I, MHC II
- macrophage, MHC II, MHC I
- dendritic, MHC II, MHC I
- mast, MHC I, MHC II
- mast, MHC II, MHC I

20. Why does the immune system have a difficult time detecting and removing human immunodeficiency virus (HIV)?

- The immune system does not have interferons to defeat intracellular viruses
- It has lipopolysaccharide in its envelope, making it difficult to detect
- The immune system fails to detect STDs

- d. It integrates its genome into the genome of CD4+ cells
- e. None of the above

GGG

21. Initiation, elongation, and termination, are the main steps of which of the following processes?

- a. DNA Replication
- b. Transcription
- c. Translation
- d. All of the above
- e. None of the above

22. 1 in 12 men are colorblind, which is an X-linked recessive condition. What is the proportion of this allele in the population?

- a. 0.04
- b. 0.08
- c. 0.28
- d. 0.36
- e. 0.44

23. A mountain has separated a group of goats from each other and they eventually become different species. What is this an example of?

- a. Parapatric speciation
- b. Sympatric Speciation
- c. Allopatric Speciation
- d. Artificial Speciation
- e. Optimal Speciation

24. Suppose the uh oh disease gene is connected to an autosomal recessive allele and causes 95% of those affected to die before the age of 10. If the current generation has 5% affected by this disease, what is the expected frequency the next generation?

- a. 3%
- b. 4%
- c. 2%
- d. 2.5%

e. 1%

25. Suppose there are two types of kevinberries, long berries and flat berries. If true-breeding strains of these two berries are crossed, the F1 generation is composed of only flat berries. However, when two members of the F1 generation are crossed, a new phenotype "round" arises in a 9:6:1 ratio of long:round:flat berries. Which of the following are the genotypes of the P generation?

- a. $A/a ; b/b \times A/a ; b/b$
- b. $A/A ; b/b \times a/a ; B/b$
- c. $A/A ; B/B \times a/a ; b/b$
- d. $A/a ; B/b \times a/a ; b/b$
- e. $a/a ; b/b \times a/a ; b/b$

26. The height of a type of corn is controlled by gene HC. It is in a polygenic inheritance with 3 alleles (A/a, B/b, C/c). Each dominant Allele (Capital Letter) add 5 cm to the height of the corn. The base height of the corn is 80 cm, what is the proportion of the population with parents heterozygous (AaBbCc) on all three alleles has a height of 90cm?

- a. 1/64
- b. 5/64
- c. 15/64
- d. 30/64
- e. 20/64

27. Which of the following chromosomal abnormalities is correctly matched to its corresponding syndrome?

- a. Trisomy 21 - Edward Syndrome
- b. Deletion of chromosome 5 - cri du chat syndrome
- c. Extra Y chromosome - Klinefelter syndrome
- d. Trisomy 18 - Downs Syndrome
- e. Trisomy 12 - Patau's Syndrome

28. DNA gyrase is an enzyme that is essential for DNA replication. When bound to DNA, it creates a double-stranded break, turns, and ligates the DNA back again, introducing negative coiling to the DNA. What type of enzyme is DNA gyrase?

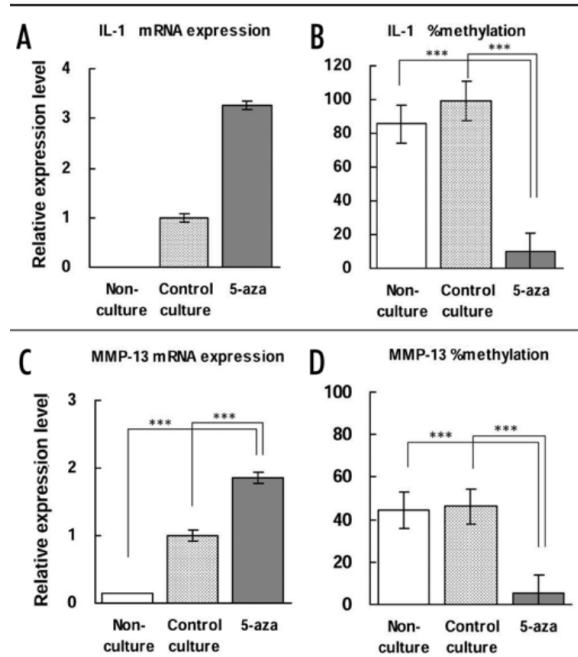
- a. DNA Polymerase

- b. Topoisomerase
- c. Helicase
- d. RNAase
- e. Primase

29. Bypass polymerases are a type of DNA polymerase that can carry out translesion synthesis, a process in which replication forks stalled by specific types of lesions (DNA damage) can be repaired or bypassed, at the cost of poor replication fidelity. Why might organisms have this polymerase if its replication fidelity is low?

- a. Organisms can use bypass polymerases in order to safely replicate areas with DNA damage without the possibility of cell death caused by stalled replication forks where other polymerases cannot synthesize DNA.
- b. The use of this polymerase only on lesions leads to novel mutations that can provide advantageous changes in an organism's phenotype, with little chance of producing deleterious mutations.
- c. The use of these polymerases can serve as an alternative way to repair double stranded breaks and protect the integrity of the genome
- d. Although these bypass polymerases are able to prevent cell death, this is at the risk of harmful mutations and are thus not used by most organisms.
- e. Organisms can easily proofread the DNA synthesized by bypass polymerases by using the polymerase's endonuclease activity.

30. You run an experiment on a human chondrocyte with the goal to investigate the relationship between mRNA synthesis of IL-1 and MMP 13 and DNA methylation. Based on the data you obtained, which of the following is correct?



- 5-aza is applied as a methylating agent
- Loss of DNA methylation suppresses transcription
- If CpG islands were shielded from 5-aza, the results would be less significant
- Changes in mRNA level are not observed in the absence of changes in methylation
- None of the above

SBI

31. You have identified a species of animal that has book lungs, malpighian tubules, and chelicerae. To which class does this animal belong to?

- Arachnida
- Malacostraca
- Insecta
- Chilopoda
- Diplopoda

32. A horse wearing a horseshoe is most analogous to which of the following?

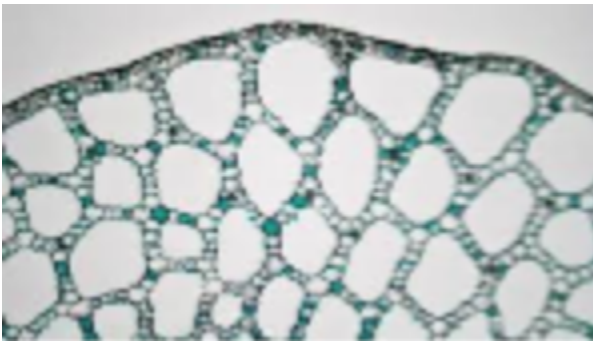
- A person wearing running shoes
- A person with fake nails glued on
- A person wearing a bracelet
- A person wearing fingerless gloves

- e. A person wearing a ring on their finger

33. Which of the following pairs are not homologous structures?

- a. A chloroplast in green algae and a chloroplast in red algae
- b. Feathers on a chicken and scales on a snake
- c. Spines on a cactus and tendrils on a pea plant
- d. Prickles on a rose and thorns on an Acacia tree
- e. Cilia of human tracheal cells and cilia of Paramecium

34. Which of the following characteristics would you see in the plant shown below?



- a. Aerenchyma
- b. Lack of developmental plasticity
- c. Stomata present on the lower half of leaves
- d. High levels of abscisic acid
- e. CAM metabolism

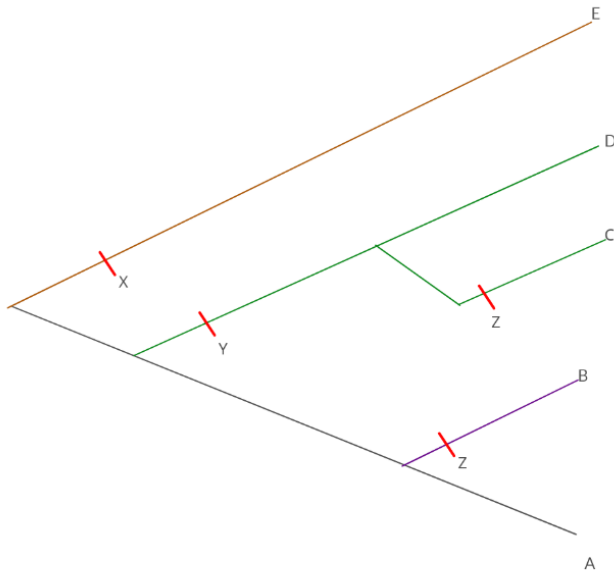
35. You are a plant researcher studying self-incompatibility among plants. You block an RNA-hydrolase enzyme produced in the style, and then mate pollen grains from an S1S2 plant to an S2S3 female sporophyte. Under gametophytic self-incompatibility, what would be the expected output of this cross? Under sporophytic self-incompatibility, what would be the expected output of this cross?

- a. This cross is viable 50% of the time; this cross is viable 50% of the time
- b. This cross is viable 100% of the time; this cross is never viable
- c. This cross is viable 25% of the time; this cross is viable 50% of the time
- d. This cross is never viable; this cross is viable 25% of the time
- e. This cross is never viable; this cross is viable 50% of the time.

36. Which of the following is accurate about angiosperms but NOT accurate about gymnosperms?

- a. Production of pollen
- b. Formation of seeds
- c. Double fertilization of the egg
- d. Pollination primarily by wind
- e. Naked seeds

37. Which of the following statements about the given phylogenetic tree is false?



- a. Trait X is an example of an autapomorphy.
- b. Trait Z is an example of a homoplasy.
- c. Species A and Species D share a most recent common ancestor with Species E.
- d. Species B is more closely related to species E than Species A.
- e. Trait Y is a synapomorphy between Species C and D.

38. What is the smallest taxonomic group that a Squirrel and a Sea Cucumber would both belong to?

- a. Animalia
- b. Bilateria
- c. Deuterostomia
- d. Ambulacraria
- e. Hemichordata

39. As a wise philosopher once said: "One of these things is not like the other". According to a taxonomist, which species does not belong in the following list of insects? (Hint: Life Cycle)

- a. Monarch Butterfly
- b. African Honey Bee
- c. Yellow Jacket
- d. Hercules Beetle
- e. Desert Locust

40. Your favorite pet frog, Philly, was just infected by *B. dendrobatidis* and got very sick. As a famous mycologist, you recalled that this fungus is in a phylum of Fungi that have flagellated spores. Which phylum does *B. dendrobatidis* belong to?

- a. Chytridiomycota
- b. Cryptomycota
- c. Ascomycota
- d. Basidiomycota
- e. Zoopagomycota

EEE

41. You have designed an experiment in which a treat is dispensed whenever a mouse would touch 2 buttons simultaneously. As time goes on, the mouse has learned to their whole body to press the buttons to repeatedly obtain the treat. What type of learning does this represent?

- a. Classical conditioning
- b. Spatial learning
- c. Habituation
- d. Operant conditioning
- e. Imprinting

42. A goat just stomped on a patch of grass while walking around, killing it. What kind of ecological relationship describes this situation?

- a. Competition
- b. Commensalism
- c. Synnecrosis
- d. Mutualism

e. Amensalism

43. On the faraway planet of Dagobah, there exists a population of a small green mammal: the Yoda. One day, a small group of the fierce predator D. Vader arrives on the planet, and immediately starts hunting down the Yodas on the planet with great success. The Yodas that have managed to survive did so by blending in with the predominantly brown-colored vegetation and ground. Over many generations, the average coloration of the Yoda population shifts from the original green color to a darker brown shade. Which of the following best describes what happened to the Yoda population?

- a. Founder Effect
- b. Disruptive Selection
- c. Frequency-dependent Selection
- d. Stabilizing Selection
- e. Directional Selection

44. Which of the following is NOT usually a limiting nutrient for primary production in marine ecosystems?

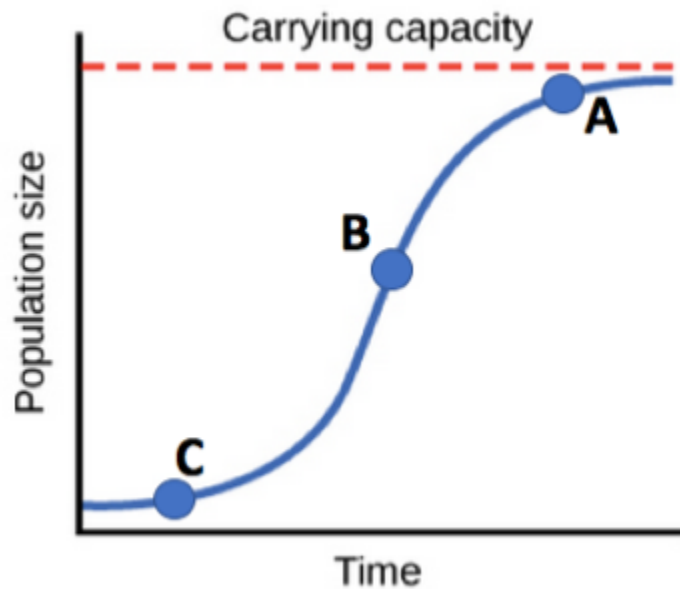
- a. Inorganic Nitrogen
- b. Phosphorous
- c. Magnesium
- d. Iron
- e. All of the above are limiting factors

45. Which of the following reservoirs of CO₂ is the largest?

- a. Oceans
- b. Plants
- c. Animals
- d. The atmosphere
- e. Sedimentary Rocks

46. At which point (A, B, or C) does this Logistic Growth Model have the highest overall population increase? Which point does it have the highest per capita population growth rate? (Formula of Logistic Growth: $Growth\ Rate = \frac{rN(K-N)}{K}$, where r is the

intrinsic growth rate, N is the current population size and K is carrying capacity)



- Highest overall growth rate - A & Highest per capita growth rate - B
- Highest overall growth rate - B & Highest per capita growth rate - C
- Highest overall growth rate - B & Highest per capita growth rate - B
- Highest overall growth rate - C & Highest per capita growth rate - A
- Highest overall growth rate - A & Highest per capita growth rate - A

47. Which of the following is NOT a true statement about the effect of turbidity on water quality?

- Suspended sediments and particles can clog fish gills, impairing their ability to perform gas exchange.
- Less sunlight is able to penetrate through turbid water, leading to decreased photosynthesis in aquatic plants. This results in less dissolved oxygen.
- Disease-causing bacteria, viruses and other pathogens can cling to suspended soil particles.
- Suspended particles absorb more sunlight which warms the surrounding water, and warmer water is less able to hold oxygen.
- Turbid water makes it more difficult for algae to photosynthesize, which is why intentional suspension of soil particles is sometimes utilized by agencies to combat algal

blooms.

48. A “stair-stepped” survivorship curve is one in which brief periods of high mortality are followed by periods of relatively low mortality, creating a survivorship curve that resembles a staircase. Which of the following species might you expect to see such curve?

- a. Birds
- b. Crabs
- c. Trees
- d. Humans
- e. Squirrels

49. You are observing 2 species living in the same habitat that capitalize on similar foods. In this habitat, there are nuts and insects. It is believed that one of these species is trending towards shorter but stronger beaks to crack the nuts while the other is evolving longer beaks to grab insects from hard-to-reach places. What phenomenon is occurring?

- a. Intraspecies competition
- b. Bottleneck effect
- c. Allee effect
- d. Disruptive selection
- e. Niche partitioning

50. Given a community with the following distribution of species A, B, C, D, and E, calculate the Shannon Diversity index: 15A, 34B, 6C, 20D, 25E.

- a. 1.489
- b. -1.489
- c. 0.2442
- d. -0.646
- e. 0.646