

I. Chose **ONE** best answer from the choices (2 points each) ※ 注意：請於試卷內之「選擇題作答區」依序作答。

1. How does a scientific theory differ from a scientific hypothesis?
 - A) Theories are proposed to test scientific hypotheses.
 - B) A theory is an explanation for a very general phenomenon or observation; hypotheses treat more specific observations.
 - C) A hypothesis is an explanation for a very general phenomenon; theories treat more specific issues.
 - D) Theories define scientific laws; hypotheses are used to set up experiments.
2. For a species to be called "invasive," it must
 - A) be introduced to a new area
 - B) spread rapidly in this new area
 - C) eliminate native species
 - D) All of above
3. What is the difference between a ribonucleotide and a deoxyribonucleotide?
 - A) Ribonucleotides contain a phosphate group.
 - B) Ribonucleotides have a hydroxyl group on the 2 carbon of their sugar subunit.
 - C) Ribonucleotides contain a sugar with five carbon atoms.
 - D) Ribonucleotides have a hydrogen atom on the 1 carbon of their sugar subunit.
4. Why do researchers think the first self-replicating molecule was RNA?
 - A) RNA is the only type of molecule that can catalyze a chemical reaction.
 - B) RNA has the capacity to provide a template and is known to catalyze reactions (although no existing self-replicating molecules of RNA have been discovered).
 - C) Self-replicating molecules of RNA exist today, in human cells.
 - D) Fossil evidence of such a molecule was recently discovered.
5. You have just discovered an organism that lives in extremely cold environments. Which of the following would you predict to be true about the phospholipids in its membranes, compared to phospholipids in the membranes of organisms that live in warmer environments?
 - A) The membrane phospholipids of cold-adapted organisms will have longer hydrocarbon tails.
 - B) The membrane phospholipids of cold-adapted organisms will have more saturated hydrocarbon tails.
 - C) The membrane phospholipids of cold-adapted organisms will have more unsaturated hydrocarbon tails.
 - D) The membrane phospholipids of cold-adapted organisms will have more short hydrocarbon tails.
6. Put the steps of the process of signal transduction in the order they occur:
 1. A conformational change in the signal-receptor complex activates an enzyme.
 2. Protein kinases are activated.
 3. A signal molecule binds to a receptor.
 4. Target proteins are phosphorylated.
 5. Second messenger molecules are released.
 - A) 1, 2, 3, 4, 5
 - B) 3, 1, 2, 4, 5
 - C) 3, 1, 5, 2, 4
 - D) 1, 2, 5, 3, 4
7. The first gap in the cell cycle (G₁) corresponds to _____.
 - A) normal growth and cell function
 - B) the phase in which DNA is being replicated
 - C) the beginning of mitosis
 - D) the phase between DNA replication and the M phase
8. The M-phase checkpoint is designed to make sure all chromosomes are attached to the mitotic spindle. If this fails to happen, in which stage of mitosis would the cells be most likely to arrest?
 - A) telophase
 - B) prophase
 - C) prometaphase
 - D) metaphase

9. Somatic cells of roundworms have four chromosomes. How many chromosomes would you find in an ovum from a roundworm?
 A) four B) two C) eight D) a diploid number

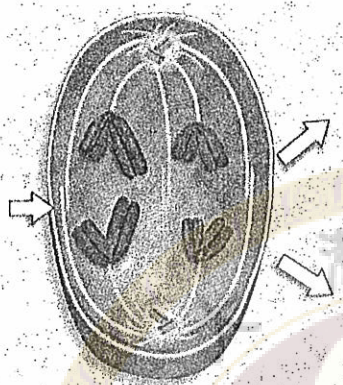


Figure 1

10. In Figure 1, what major event is taking place during this phase of meiosis?
 A) anaphase II B) anaphase C) homologues separate D) separation of sister chromatids
11. Asexual reproduction takes place by which of the following processes?
 A) meiosis
 B) fertilization
 C) chromosome exchange between organisms of the same species
 D) mitosis
12. A man and woman are both of normal pigmentation, but both have one parent who is albino (without melanin pigmentation). Albinism is an autosomal (not sex-linked) recessive trait. What is the probability that their first child will be an albino?
 A) 0 B) 1/8 C) 1/2 D) 1/4 E) 1
13. In birds, sex is determined by a ZW chromosome scheme that is much like the typical XY scheme seen in humans and many other organisms, except that the system is reversed: Males are ZZ (similar to XX in humans) and females are ZW (similar to XY in humans). A lethal recessive allele that causes death of the embryo occurs on the Z chromosome in pigeons. What would be the sex ratio in the offspring of a cross between a male heterozygous for the lethal allele and a normal female?
 A) 1:1 male to female B) 4:1 male to female C) 3:1 male to female
 D) 1:2 male to female E) 2:1 male to female

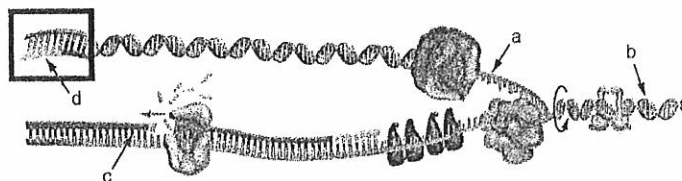


Figure 2

14. Identify the lagging strand during duplication of DNA starting from a double helix in Figure 2.
 A) a B) b C) c D) d

15. What is a major difference between eukaryotic DNA replication and prokaryotic DNA replication?
- A) Prokaryotic replication does not require a primer.
 - B) Prokaryotic chromosomes have a single origin of replication, while eukaryotic chromosomes have multiple origins of replication.
 - C) DNA polymerase III of eukaryotes has both endonuclease and exonuclease activity, while that of prokaryotes has only exonuclease activity.
 - D) DNA polymerases of prokaryotes can add nucleotides to both 3' and 5' ends of DNA strands, while those of eukaryotes function only in the 5'→3' direction.
16. All three domains (Bacteria, Archaea, and Eukarya) follow the same genetic code. Which of the following statements would most likely be accurate given that information?
- A) The genetic code evolved three times.
 - B) The genetic code evolved before DNA replaced RNA as the unit of genetic information.
 - C) There were no mutations following the evolution of the genetic code.
 - D) The genetic code evolved before the different domains diverged.
17. What molecule serves as a link between the information-containing macromolecule, DNA, and protein synthesis?
- A) rRNA B) tRNA C) mRNA D) ribosome
18. A mutation that results in premature termination of translation
- A) is a silent mutation
 - B) is a nonsense mutation
 - C) usually has no effect on the function of the protein
 - D) is a missense mutation
19. In the first step of their experiments, Jacob and Monod treated *E. coli* cells with UV light or X-rays in order to
- A) decrease the rate of gene expression
 - B) induce DNA repair enzymes
 - C) increase the frequency of mutations in all genes
 - D) selectively mutate the *lac* operon, leaving all other genes unmutated
20. Plasmids are used as cloning vectors in genetic engineering. This means that plasmids allow for ____.
- A) carrying of DNA into a cell and DNA replication
 - B) DNA to mutate within the gene of interest
 - C) DNA replication outside rather than inside cells
 - D) carrying of RNA into a cell and RNA replication
21. Why are transposable elements considered to be selfish genes?
- A) They have multiple promoters.
 - B) They require multiple RNA polymerases for transcription.
 - C) They replicate using the host's resources without direct benefit to the host.
 - D) They do not produce mRNA.
22. A DNA microarray is a tool that owes its existence to earlier genomics investigations. What essential contribution of genomics makes microarrays possible?
- A) recently improved RNA sequencing technologies
 - B) continuously improving methods of gene cloning
 - C) more efficient techniques for cDNA synthesis
 - D) knowledge of which DNA sequences to synthesize for the array

23. Why was Darwin and Wallace's theory of evolution by natural selection revolutionary?
- It was the first theory to refute the ideas of special creation.
 - It proved that individuals acclimated to their environment over time.
 - It dismissed the idea that species are constant and emphasized the importance of variation and change in populations.
 - It was the first time a biologist had proposed that species changed through time.
24. Which of the graphs best represents the relationship between the intensity of directional selection and the genetic variation present within a population?

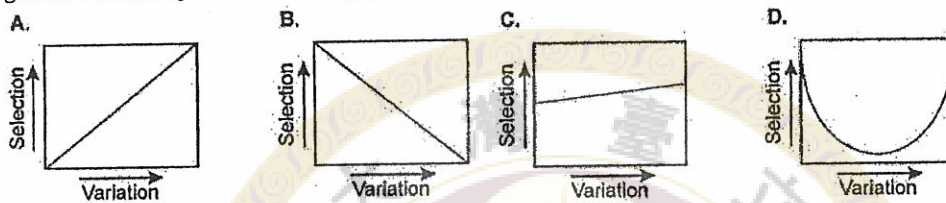


Figure 3

25. Which of the following trees depicts the same relationship among species as shown above (Figure 3)?
- -
 -
- D) None; the above trees all depict a different relationship among species.

26. Conifers and pines both have needlelike leaves. Why might their leaves be of this type?
- to increase surface area for photosynthesis
 - to increase surface area for gas exchange
 - to decrease surface area for gas exchange
 - to decrease surface area for water loss
27. What is the goal of bioremediation?
- Improve human health with the help of living organisms such as bacteria.
 - Clean up areas polluted with toxic compounds by using bacteria.
 - Improve soil quality for plant growth by using bacteria.
 - Improve bacteria for production of useful chemicals.
 - Killing pathogenic bacteria with the use of antibiotics.

28. While traveling in the Alps, you come across a butterfly that you cannot identify. You quickly find out that it is a new species. Which of the following is **not** a necessary step in studying biodiversity?
- A) naming and describing the species
 - B) measuring general physiology of the species
 - C) looking at what other species are related to the new species
 - D) assessing the species geographic range
29. Any process in which a signal from one individual modifies the behavior of a recipient individual is termed
- A) cognition B) communication C) reflex D) perception
30. Which level of ecological study focuses the most on abiotic factors?
- A) speciation ecology B) population ecology
 - C) community ecology D) ecosystem ecology

II. Short answer questions (5 points each)

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31. In the documentary film "The end of the line", it reveals the overfishing on our oceans. How could this happen? (5 points) What is your proposal to prevent this problem? (5 points)
32. What is epigenetic inheritance and why it becomes an important topic in life science? (5 points) Do you agree that epigenetic inheritance will be subjected to nature selection? (5 points)
33. What are the most important five unifying principles that can be said to be the fundamental axioms of modern biology? (10 points)
34. In 1977, Sanger and Gilbert invented DNA sequencing methods independently. Do you know which one is dominate the field and could you please explain the principle of this method? (5 points) In the past several years, scientists are able to decode genomes of any organism in a short time by the next generation sequencing methods. Could you please list one of the important inventions in the next generation sequence and the rational behind? (5 points)