一、單選題 (每題 1 分) **※ 注意：請於試卷「選擇題作答區」依題號作答 ※**

1. The bonding of two amino acid molecules to form a larger molecule requires _____.
   (A) the release of a water molecule (B) the release of a carbon dioxide molecule
   (C) the addition of a nitrogen atom (D) the addition of a water molecule
   (E) both B and C
2. Recent evidence shows that individual chromosomes occupy fairly defined territories within the nucleus. Given the structure and location of the following parts of the nucleus, which would be more probably involved in chromosome location?
   (A) Nuclear pores (B) The nucleolus (C) The outer lipid bilayer
   (D) The nuclear lamina (E) The nuclear matrix
3. According to the fluid mosaic model of cell membranes, which of the following is a true statement about membrane phospholipids?
   (A) They frequently flip-flop from one side of the membrane to the other.
   (B) They can move laterally along the plane of the membrane.
   (C) They occur in an uninterrupted bilayer, with membrane proteins restricted to the surface of the membrane.
   (D) They are free to depart from the membrane and dissolve in the surrounding solution.
   (E) They have hydrophilic tails in the interior of the membrane.
4. Zinc, an essential trace element for most organisms, is present in the active site of the enzyme carboxypeptidase. The zinc most likely functions as a(n) _____.
   (A) competitive inhibitor of the enzyme (B) noncompetitive inhibitor of the enzyme
   (C) allosteric activator of the enzyme (D) cofactor necessary for enzyme activity
   (E) coenzyme derived from a vitamin
5. In glycolysis, for each molecule of glucose oxidized to pyruvate _____.
   (A) 2 molecules of ATP are used and 2 molecules of ATP are produced
   (B) 4 molecules of ATP are used and 2 molecules of ATP are produced
   (C) 2 molecules of ATP are used and 4 molecules of ATP are produced
   (D) 2 molecules of ATP are used and 6 molecules of ATP are produced
   (E) 6 molecules of ATP are used and 6 molecules of ATP are produced
6. G proteins and G-protein-linked receptors _____.
   (A) are found only in animal cells, and only embedded in or located just beneath the cell's membrane
   (B) are found only in bacterial cells, embedded in the cell's plasma membrane only
   (C) are thought to have evolved very early, because of their similar structure and function in a wide variety of modern organisms
   (D) probably evolved from an adaptation of the citric acid cycle
   (E) are not widespread in nature and were unimportant in the evolution of eukaryotes
7. Which term describes centromeres uncoupling, sister chromatids separating, and the two new chromosomes moving to opposite poles of the cell?
   (A) Telophase (B) Anaphase (C) Prometaphase (D) Metaphase (E) Prophase
8. A karyotype results from which of the following?
   (A) A natural cellular arrangement of chromosomes in the nucleus
   (B) An inherited ability of chromosomes to arrange themselves
   (C) The cutting and pasting of parts of chromosomes to form the standard array
   (D) The ordering of human chromosome images
   (E) The separation of homologous chromosomes at metaphase I of meiosis

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9. How many unique gametes could be produced through independent assortment by an individual with the genotype AaBbCCDdEE?
(A) 4 (B) 8 (C) 16 (D) 32 (E) 64

10. New combinations of linked genes are due to which of the following?
(A) Nondisjunction (B) Independent assortment (C) Deletions
(D) Mixing of sperm and egg (E) Crossing over

11. Suppose you are provided with an actively dividing culture of *E. coli* bacteria to which radioactive thymine has been added. What would happen if a cell replicates once in the presence of this radioactive base?
(A) One of the daughter cells, but not the other, would have radioactive DNA.
(B) Neither of the two daughter cells would be radioactive.
(C) All four bases of the DNA would be radioactive.
(D) Radioactive thymine would pair with nonradioactive guanine.
(E) DNA in both daughter cells would be radioactive.

12. Which of the following is true for both prokaryotic and eukaryotic gene expression?
(A) After transcription, a 3' poly-A tail and a 5' cap are added to mRNA.
(B) Translation of mRNA can begin before transcription is complete.
(C) RNA polymerase binds to the promoter region to begin transcription.
(D) mRNA is synthesized in the 3' → 5' direction.
(E) The mRNA transcript is the exact complement of the gene from which it was copied.

13. Genomic imprinting, DNA methylation, and histone acetylation are all examples of _____.
(A) epigenetic phenomena (B) chromosomal rearrangements (C) karyotypes
(D) genetic mutation (E) translocation

14. Which of the following seals the sticky ends of restriction fragments to make recombinant DNA?
(A) Restriction enzymes (B) Gene cloning (C) Gel electrophoresis
(D) DNA ligase (E) Reverse transcriptase

15. Which of the following characteristics are keynote adaptations to the seed-producing plants?
(A) pollen & seeds (B) lignin present in cell walls & seeds (C) megaphylls & seeds
(D) use of air currents as a dispersal agent & seeds (E) sporopollenin & seeds

16. Which organisms listed below are thought to be the closest relatives of fungi?
(A) Animals (B) Vascular plants (C) Brown algae (D) Cyanobacteria (E) Mosses

17. What is the consequence of double fertilization in angiosperms?
(A) Both a diploid embryo and triploid endosperm are formed.
(B) The endosperm develops into a diploid nutrient tissue.
(C) Two embryos develop in every seed.
(D) A triploid zygote is formed.
(E) The antipodal cells develop into the seed coat.

18. In both lichens and mycorrhizae, what does the fungal partner provide to its photosynthetic partner?
(A) Antibiotics (B) Protection from harmful UV (C) Carbohydrates
(D) Fixed nitrogen (E) Water and minerals

19. Microevolution, or evolution at its smallest scale, occurs when
(A) a population's allele frequencies change over a span of generations.
(B) an individual's traits change in response to environmental factors.
(C) a microorganism mutate to adapt the environmental stress.
(D) a community of organisms changes due to the extinction of several dominant species.
(E) a new species arises from an existing species.

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20. The loss of plant biodiversity, including the wild relatives of crop species, is harmful because these wild relatives
(A) global warming kills most of them. (B) feed most of the world's population.
(C) may be suitable for domestication and regional production. (D) are often tastier than existing crops.
(E) are a source of genetic diversity that could be used to modify or bolster existing crops.

21. Genetic drift resulting from a disaster that drastically reduces population size is called
(A) microevolution. (B) natural selection. (C) gene flow.
(D) the founder effect. (E) the bottleneck effect.

22. Which of the following organisms first introduced oxygen into Earth's atmosphere?
(A) Bryophytes (B) Green algae (C) Early protozoans (D) Plants (E) Cyanobacteria

23. The recessive allele of a gene causes cystic fibrosis. For this gene among Caucasians, $p = 0.98$. If a Caucasian population is in Hardy-Weinberg equilibrium with respect to this gene, what proportion of babies is born homozygous recessive, and therefore suffers cystic fibrosis?
(A) 0.02 (B) $0.0004 = (0.02)^2$ (C) $0.03922 = 2(0.02 \times 0.98)$
(D) $0.9604 = (0.98)^2$ (E) $0.9996 = 1 - (0.02)^2$

24. The host range of a virus is determined by
(A) the enzymes carried by the virus. (B) the proteins on its surface and that of the host.
(C) whether its nucleic acid is DNA or RNA. (D) the proteins in the host's cytoplasm.
(E) the enzymes produced by the virus before it infects the cell.

25. The most important feature that permits a gene to act as a molecular clock is
(A) having a large number of base pairs. (B) having a reliable average rate of mutation.
(C) being acted upon by natural selection. (D) having a larger proportion of exon than of intron.

26. If organism A, B, and C belong to the same Class but to different Orders and if organisms D, E, F belong to the same Order but to different Families, which of the following pairs of organisms would be expected to show the greatest degree of structural homology?
(A) A and B (B) B and D (C) C and F (D) D and F

27. The correct sequence from the highest taxonomic levels to the lowest one is
(A) phylum, kingdom, class, order, family, genus, species.
(B) kingdom, phylum, class, order, family, genus, species.
(C) phylum, kingdom, class, family, order, genus, species.
(D) kingdom, phylum, order, class, family, genus, species.

28. Which of the following organisms has the farthest relationship with others?
(A) *E. coli* (B) *C. elegans* (C) *Drosophila sp.* (D) *Homo sapiens*

29. Why is amniotic egg considered an important evolutionary breakthrough?
(A) It prolongs embryonic development.
(B) It provides insulation to conserve heat.
(C) It allows incubation of eggs in a terrestrial environment.
(D) It permits internal fertilization to be replaced by external fertilization.

30. All of the following animals belong to Ecdysozoa (蛻皮動物) except _____.
(A) crab (B) snail (C) insect (D) nematode

31. Which of the following animals does not belong to invertebrates?
(A) Sponge and jelly fish (B) Earthworm and octopus
(C) Shrimp and sea cucumber (D) Ape and lizard

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32. Which of the following animals does not belong to living fossils?
(A) horseshoe crab (B) coelacanth (C) nautilus (D) panda

33. Which information about algal blooms is correct?
(A) Algal blooms often lead to black tides.
(B) The frequency of marine algal blooms has decreased globally.
(C) Red or brown tides are often correlated with the release of toxic compounds.
(D) Bacteria feeding on algal remains can use up CO_2 and benefit aquatic animals.

34. The native cycads (蘇鐵) in Taiwan are threatened by exotic cycads. What is the major reason?
(A) Exotic cycads invade the native one's habitat (i.e. 台東).
(B) Exotic cycads secrete chemical in soil and then kill the native one.
(C) Exotic cycads attract pollinators away from the native one.
(D) Exotic cycads support high populations of herbivores, which hurt the native cycads.

35. Which statement about nutrient cycles is not true?
(A) Earth is basically a closed system, and therefore life on Earth depends on the recycling of elements.
(B) Nitrogen gas makes up about 78% of our atmosphere. Therefore, nitrogen is usually not a limiting factor in plant growth.
(C) The most common nitrogen-fixing bacteria often form symbiotic relationships with the roots of legumes.
(D) Industrial nitrogen fixation facilitates agricultural development but also creates environmental problems (e.g. eutrophication due to excessive fertilization).

36. Which statement about trophic structure and ecosystems is true?
(A) Energy flow in ecosystems does not follow the pattern of "pyramid of energy".
(B) DDT concentration usually reached the highest level in species at lower trophic levels (e.g. primary producers), greatly reducing the population of these species.
(C) Higher species diversity often leads to higher ecosystem functions.
(D) *Prionailurus bengalensis* (石虎), an important top predator in Taiwan's ecosystem, is often found in high mountains.

37. Which statement about ecology is not true?
(A) Ecological studies investigate organism-organism or organism-environment relations.
(B) Plants can sequester a lot of excessive carbon produced by human activity.
(C) The world is green because predators can control herbivores, and also because plants have defenses against herbivores.
(D) Taiwan's ecosystems are rarely affected by invasive species, since Taiwan is isolated from other countries.

38. If you become a leader in Taiwan, what information about global ecology/climate change can you tell your people?
(A) Taiwan is lucky because land at similar latitudes around the world is often covered by deserts or savannas.
(B) Taiwan's ecosystems have very high biodiversity, compared to the majority of countries in the world.
(C) Species under climate change (i.e. warming) may have to move to higher elevations in Taiwan.
(D) All of the above

39. *Sousa chinensis* (中華白海豚) are facing strong anthropogenic impacts. Their population in Taiwan is estimated at around _____ individual(s).
(A) 1 (B) 100 (C) 1000 (D) 10000

40. The full range of abiotic or biotic conditions and resources a species can use for survival and reproduction is its _____.
(A) habitat (B) niche (C) ecosystem (D) community

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41. Which of the following about predator-prey coevolution should be true?
(A) Each species can exert selection pressure on the other.
(B) Predators are selective agents leading to improved prey defenses.
(C) Preys with better defenses are selective agents leading to better predator hunting skills.
(D) All of the above

42. Some introduced species become invasive and cause deleterious effects in introduced habitats. The success of these invasive species is often because
(A) there is a lack of associated parasites, competitors, or predators in introduced habitats.
(B) the invasive species are long-lived.
(C) the invasive species quickly form a mutualism with local species.
(D) all of the above.

43. When the birth rate and immigration equal the death rate and emigration in a population, the result is
(A) logistic growth. (B) exponential growth. (C) geometric growth. (D) zero population growth.

44. The high osmolarity of the renal medulla in mammals is maintained by all of the following except
(A) the spatial arrangement of juxtamedullary nephrons.
(B) diffusion of salt from the descending limb of the loop of Henle.
(C) diffusion of salt from the thin segment of the ascending limb of the loop of Henle.
(D) active transport of salt from the thick segment of the ascending limb of the loop of Henle.
(E) diffusion of urea from the medullary collecting duct.

45. Which of the following occurs during expiration?
(A) The diaphragm contracts and the alveoli inflate.
(B) The decrease of thoracic volume raises the intrapleural pressure above the atmospheric pressure, thereby causing air to flow out of the lungs.
(C) The ribs move upward to decrease the thoracic volume and the alveoli deflate.
(D) The diaphragm relaxes and the pressure in the alveoli becomes greater than the atmospheric pressure, thereby pushing the air out.

46. Which of the following is the correct sequence that describes the excitation and contraction of a skeletal muscle fiber?
1. The thin filaments are ratcheted across the thick filaments by the heads of the myosin molecules using energy from ATP.
2. Tropomyosin shifts and unblocks the cross-bridge binding sites on the thin filament
3. Transverse tubules depolarize the sarcoplasmic reticulum.
4. Calcium is released and binds to the troponin complex.
5. An action potential in a motor neuron causes the axon to release acetylcholine, which depolarizes the cell membrane of the muscle fiber.

(A) $5 \rightarrow 4 \rightarrow 3 \rightarrow 2 \rightarrow 1$ (B) $4 \rightarrow 2 \rightarrow 3 \rightarrow 5 \rightarrow 1$ (C) $4 \rightarrow 3 \rightarrow 1 \rightarrow 2 \rightarrow 5$
(D) $5 \rightarrow 3 \rightarrow 4 \rightarrow 2 \rightarrow 1$ (E) $5 \rightarrow 3 \rightarrow 2 \rightarrow 4 \rightarrow 1$

47. During an inhibitory postsynaptic potential (IPSP), the membrane of the postsynaptic neuron becomes more permeable to _____.
(A) Na^+ (B) K^+ (C) Cl^- (D) K^+ or Cl^- (E) Na^+ or Cl^-

48. Suppose that all the calcium could be removed from the extracellular fluid surrounding a neuron. Such removal would inhibit the ability of a neuron to
(A) produce action potentials. (B) produce synaptic potentials.
(C) release neurotransmitter. (D) degrade neurotransmitters.

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49. A physiologist is studying the homeostatic control of blood pressure. In a trial, a man goes from a lying to a standing position and the blood pressure is measured. A fall in blood pressure is compensated by a faster heart rate. Which component of the homeostatic feedback system is responsible for deciding if the blood pressure is far enough from normal that a response is necessary?
(A) sensor (B) integrator (C) effector (D) assimilator

50. Which of the following statements about skeletons is true?
(A) Hydrostatic skeletons are soft and do not protect body parts.
(B) Chitin is a major component of vertebrate skeleton.
(C) Vertebrate bones contain living cells.
(D) Most cnidarians must shed their skeleton periodically in order to grow.

51. All of the following statements are correct except
(A) Human photoreceptors release more neurotransmitter in the dark.
(B) Humans distinguish colors based on the pattern of stimulation of three types of opsins found in cones.
(C) Sensations from the left visual field of both eyes go to the right visual cortex and sensations from the right visual field go to the left visual brain in humans.
(D) A rattlesnake's facial pits detect the presence of prey using photoreception.
(E) Perception of visual information takes place in the brain.

52. Hormone Y activates the cAMP second messenger system in a cell. The greatest response by the cell would come from _____.
(A) applying a molecule of hormone Y to the extracellular fluid surrounding the cell
(B) injecting a molecule of hormone Y into the cytoplasm of the cell
(C) applying a molecule of cAMP to the extracellular fluid surrounding the cell
(D) injecting a molecule of cAMP into the cytoplasm of the cell
(E) injecting a molecule of activated, cAMP-dependent protein kinase into the cytoplasm of the cell

53. Which of the following cell types initiates a secondary immune response?
(A) Plasma cells (B) Effector cells (C) Memory cells (D) Natural killer cells (E) Immature leukocytes

54. The immune system is capable of mounting specific responses to particular microorganisms because
(A) lymphocytes are able to change their antigen specificity as required to fight infection.
(B) stem cells are able to change their antigen specificity as required to fight infection.
(C) the body contains an enormous diversity of lymphocytes, each with a specific kind of antigen receptor.
(D) stem cells make different antigen receptors depending on the invading microorganism.

55. Which of the following is not a feature of gas exchange in the respiratory system of birds?
(A) The exchange of gases between parabronchi and blood is in a countercurrent direction.
(B) The maximum P_{O_2} is significantly higher in bird lungs.
(C) The tidal volume is much larger than in a comparably sized mammal.
(D) Gas exchange occurs during both inhalation and exhalation.
(E) The thickness of respiratory surface is thinner than that of lungs in mammals.

56. In an egg cell treated with EDTA, a chemical that binds calcium and magnesium ions, then
(A) acrosomal reaction would be blocked. (B) fast block to polyspermy would not occur.
(C) fertilization envelope would not be formed. (D) fusion of sperm and egg nuclei would be blocked
(E) zygote would not contain maternal and paternal chromosomes.

57. If a person goes on a low sodium diet, which of the following will not happen?
(A) The blood volume decreases. (B) The blood pressure decreases. (C) ADH secretion increases.
(D) An increase in the glomerular filtration (E) The concentration of angiotensin II increases.

58. The hydrochloric acid in the stomach
(A) is secreted by the parietal cells.
(B) increases when chyme is emptied into the duodenum.
(C) is released in response to sympathetic stimulation.
(D) activates trypsinogen.
(E) decreases when the rate and strength of stomach contractions increase.

※下列題目請標明題號 (不必抄題)，依序作答於試卷內「非選擇題作答區」。※

二、填充

(A) 選擇一個你認為最適當的選項(題目後的括號內)填入空格中 (每題 1 分)

1. A recording of the electrical activity of a patient's heart show that the atria are contracting regularly and normally, but every few beats the ventricles fail to contract. The _____ is probably not functioning properly. **(semilunar valve, atrioventricular valve, SA node, AV node, coronary artery)**
2. During the menstrual cycle, estradiol peaks first, _____ peak next, and finally _____ surges. **(estradiol , luteinizing hormone and follicle-stimulating hormone, progesterone, testosterone)**
3. Particular groups of cells called organizers convey positional information to other cells through morphogens. These signal molecules play a role in development by_____. **(determination, differentiation, morphogenesis, induction, apoptosis)**
4. Leptin, a hormone that plays an important role in long-term appetite regulation in mammals, is secreted by _____. **(hypothalamus, pituitary gland, thyroid gland, adipose tissue, adrenal gland)**
5. The connection between structure and _____ is a basic concept of biology. **(adaptation, species, function, gene, evolution)**
6. Sensory-transducing cells that fire both graded potentials and action potentials are found in _____. **(vision, gustation/taste, olfaction, audition)**
7. A red blood cell is in an arteriole in the small intestine of a cat. This cell must pass through _____ capillary beds before it is returned to the left ventricle of the heart (along the shortest route). **(one, two, three, four, five)**

(B) 請在空格中填入適當的答案 (每格 0.5 分)

1. In angiosperms, _____ **(a type of functional cells)** has no nucleus at maturity.
2. Unlike animals, trees (perennial plants) perform the indeterminate growth throughout their life span because of the persistence of _____ **(a specific tissue)**.
3. In order to take up water from the environment, plant roots have to keep their water potential _____ (lower or higher) than that of soil solution.
4. Aleurone layers of cereal grains have provided a good model system for studying the action mechanisms of plant hormones. Application of _____ **(a type of plant hormone)** to isolated aleurone layers can stimulate the expression of _____ **(an enzyme)** which digests reserve starch in endosperm for the growth of seedlings.
5. Three tissue systems make up the plant body **(including root, stem and leaf)**: _____, vascular tissue, and _____.
6. The most popular model plant for basic academic researches is _____.

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7. The major functions of accessory pigments in photosynthesis are

(i) _____,

(ii) _____.

三、配合題 (每題 0.5 分)

(A) Match each structure with its major function

____	1	Pericycle	A. photosynthesis
____	2	Guard cells	B. Photo-splitting of water molecule
____	3	Protease inhibitor	C. Generate membrane potential
____	4	Mesophyll	D. Sugar translocation
____	5	Sieve tube	E. Defense against herbivorous insects
____	6	Membrane proton pump	F. Formation of lateral roots
____	7	Photosystem II	G. Transpiration control

(B) Match the functions with one specific plant hormone

____	1	Promote lateral bud growth	A. Auxin
____	2.	Keep seed dormancy	B. Gibberellins
____	3.	Stimulate flower wilting	C. Cytokinins
____	4.	Stimulate stem elongation	D. Brassinosteroids
____	5.	Promote leaf abscission	E. Abscisic acid
			F. Ethylene
			G. Strigolactones

四、名詞解釋 (每題 2 分) （可用中文回答）

1. Allele
2. Amphipathic molecule
3. Allosteric regulation
4. Deuterostomes

五、簡答題 (每題 2 分)（可用中文回答）

1. To compare the sexual reproduction and asexual reproduction of seed plants in terms of evolutional and ecological significances.
2. Genetic diversity in offspring population can increase the chance to survive against natural selection during evolution. By what mechanisms seed plants (higher plants) enhance the opportunity of out-crossing (not self-pollination) to reduce the genetic uniformity among their offsprings.
3. The Intergovernmental Panel on Climate Change (IPCC) predicts that the global mean surface temperature may increase between 2.6 and 4.8°C by the year of 2100 (RCP8.5 Scenario). If this is true, what impacts will this climate warming have on plants, animals, and their interactions in Taiwan?

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六、配合題 (Find the best term that satisfies the explanation from below.) (每題 1 分)

_____ 1. In regular flowers, any line drawn through the centre will divide the flower into two identical halves. When at least one petal of the corolla is different, the flower is zygomorphy.

_____ 2. Only the organisms best adapted to their environment tend to survive and transmit their genetic characteristics in increasing numbers to succeeding generations while those less adapted tend to be eliminated.

_____ 3. The study of evolutionary relationships among groups of organisms (e.g. species, populations), which are discovered through molecular sequencing data and morphological data matrices.

_____ 4. The life cycle of plants with a multicellular sporophyte, which is diploid, that alternates with a multicellular gametophyte, which is haploid.

_____ 5. The use of prokaryotes and other organisms to clean up pollution is called:

_____ 6. An organism's body form can be substantially changed through mutations or changes in the expression of one or a few "master control" genes that regulate development.

_____ 7. The existence of shared ancestry between a pair of structures, or genes, in different species.

_____ 8. Any evolutionary change at or above the level of species. It means *at least* the splitting of a species into two or the change of a species over time into another.

_____ 9. The process through which new species evolve from a single ancestral species while inhabiting the same geographic region.

_____ 10. The spreading of pollen from the male to the female part of a flower.

A.	Alternation of generation	B.	Allopatric speciation	C.	Artificial selection	D.	Biomimicry
E.	Bioremediation	F.	Evo-Devo	G.	Floral symmetry	H.	Fertilization
I.	Homoplasy	J.	Homology	K.	Macroevolution	L.	Natural selection
M.	Phylogeny	N.	Pollination	O.	Sympatric speciation		

試題隨卷繳回