

I. Reasoning (20%)

1. 如果你的指導教授給你一管細菌培養液，你要如何知道每一毫升的培養液中總共有多少顆細菌？其中又有多少顆是活的？
2. 一新生男嬰罹患了某性連遺傳疾病 (sex-linked disease)。請問 a) 此遺傳疾病的基因在 Y 染色體的機會是多少？ b) 他的姐姐是此疾病 carrier 的機會有多少？
3. 許多生物都有所謂的“生物時鐘”，譬如說某種果蠅會進行 12 小時活動然後 12 小時睡眠的週期。如果你被指定研究此種果蠅在連續 10 天的黑暗中其睡眠-活動週期的改變，你要如何進行紀錄？
4. 劉教授的研究室有一種紅色的細菌，經過突變劑處理後，發現產生了粉紅色、黃色以及白色三種不同的變異株。請提出你的理論解釋這個現象。
5. 你覺得人之所以會老化的原因有那些？

II. Recent findings (20%)

6. 何謂聖嬰現象 (El Nino phenomenon)？它對地球生態系有何衝擊？
7. 生物農藥是最近政府大力推動的研究方向。何謂生物農藥？它在使用上較傳統的農藥有甚麼優點？
8. 請舉兩個例子並簡單的說明生物技術在醫藥上可能的用途。
9. 上屆諾貝爾醫學獎頒給研究 Prions 的科學家，請說明你對 Prions 的瞭解。
10. 最近腸病毒 71 型在台灣大流行並造成恐慌。請說明這種病毒的特性、造成的病徵、傳播途徑及可能治療的方法。

III. Comprehension test. Read the paragraph and answer the questions briefly in CHINESE (10%)

In 1990, researchers from Vical report that intramuscular injection of mice with purified plasmid DNA encoding a foreign protein resulted in abundant production of the protein by muscle cells. Within two years of this discovery, several groups had demonstrated that injection with “naked DNA vaccine” led to the generation of long-lived humoral and/or cellular immune responses against a range of antigens encoded by such plasmids. The DNA used for immunization is composed of non-replicating transcription units, which drive the synthesis of specific foreign proteins within the inoculated host. It is generally believed that these host-synthesized foreign proteins are then processed and presented for immune surveillance similar to traditional antigen presentation. This vaccination technique is being explored as an immunization strategy against a variety of pathogens, including against HIV-1, hepatitis B virus and influenza A virus. Impressively, in these animal models, DNA immunization was shown to be protective against a live viral challenge.

- A) 注射純化過的 DNA 到動物體的肌肉裡會發生甚麼現象？
- B) 科學家認為這種現象可以有甚麼重要的用途？
- C) 目前在實驗動物的結果可知這種用途的效果如何？

IV. Basic knowledge. Choose ONE most appropriate answer (50%)

- Amoebas and bacteria are grouped into different kingdoms because
 - amoebas eat bacteria
 - bacteria are not made of cells
 - bacterial cells lack a nucleus
 - bacteria are smaller than amoebas
 - amoebas are photosynthetic
- A nucleotide molecule is to a nucleic acid as
 - a steroid is to a lipid
 - a protein is to an amino acid
 - a nucleic acid is to a polypeptide
 - a glucose is to glycogen
 - an amino acid is to a nucleic acid
- Which of the following is not directly involved in cell support or movement
 - microfilament
 - microtubule
 - cell wall
 - flagellum
 - lysosome
- A group of proteins produced by virus-infected cells that serve as an anti-virus signal for neighboring cells are
 - gastrin
 - histamine
 - complements
 - secretin
 - interferons
- The concentration of calcium in a cell is 0.3%. The concentration of calcium in the surrounding fluid is 0.1%. How could the cell obtain more calcium?
 - passive transport
 - diffusion
 - active transport
 - osmosis
 - none of the above.
- Which of the following processes produces the most ATP molecules per glucose molecule consumed?
 - lactic acid fermentation
 - the Krebs cycle
 - electron transport and chemiosmosis
 - alcoholic fermentation
 - glycolysis
- What of the following statements about photosynthesis is NOT correct
 - In the light reactions, electron transport chains generate ATP, NADPH, and CO_2 .
 - Chemiosmosis powers ATP synthesis in the light reactions
 - ATP and NADPH power sugar synthesis in the Calvin cycle
 - A photosystem is the light-harvesting unit of the thylakoid membrane
 - CAM plants have special adaptations that save water during photosynthesis
- A scientist measure the amount of DNA in cells growing in the laboratory and found that the quantity of DNA in a cell doubled
 - between prophase and anaphase of mitosis
 - between G1 and G2 phases of the cell cycle
 - during the M phase of the cell cycle
 - between prophase and prophase II of meiosis
 - between anaphase and telophase of meiosis
- Keratin is normally found in
 - connective tissues
 - epithelial tissues
 - cardiac muscle
 - cartilage
 - neuron
- A patient was found to be heterozygous (Ss) for sickle-cell trait. The alleles represented by the letters S and s are
 - on the X and Y chromosome
 - linked
 - both present in each of the patient's sperm cells
 - on homologous chromosomes
 - on the same chromosome
- Genetic messages are translated in
 - cytoplasm
 - nucleus
 - mitochondria
 - nucleolus
 - plasma membrane

12. Which of the following statements is NOT correct
- A. DNA is packed most compactly in metaphase than in other stages of cell cycle
 - B. DNA packing in eukaryotic chromosomes affects gene expression
 - C. Prokaryotic RNA is processed to remove noncoding segments and to add a cap and a poly(A) tail
 - D. In cells of female mammals, one of the two X chromosomes is inactivated
 - E. The homeotic gene is a master control gene that regulates batteries of other genes that direct the development of an organism's body plan.
13. A microbiologist found that some bacteria infected by phages had developed the ability to make a toxin that they could not make before. The new ability was probably a result of
- A. transformation
 - B. natural selection
 - C. conjugation
 - D. mutation
 - E. transduction
14. Which of the following technique would be most useful for increasing the amount of DNA available from an ancient bee trapped in amber?
- A. restriction fragment analysis
 - B. polymerase chain reaction
 - C. molecular probe analysis
 - D. Automatic sequencing technology
 - E. electrophoresis
15. Why are individuals with an extra chromosome 21, which causes Down syndrome, more numerous than individuals with an extra chromosome 3 or 16?
- A. There are probably more genes on chromosome 21 than on the others
 - B. Chromosome 21 is a sex chromosome and 3 and 16 are not
 - C. Down syndrome is not more common. Just more serious
 - D. Extra copies of the other chromosomes are probably fatal
 - E. Non-disjunction of chromosome 21 probably occurs more frequently
16. Which of the following statements about cancer genetics is NOT correct?
- A. A gene that causes cancer is called an oncogene
 - B. A normal gene with the potential to become an oncogene is called a protooncogene
 - C. Tumor suppressor genes often encode proteins that prevent uncontrolled cell growth
 - D. Oncogene proteins and faulty tumor-suppressor proteins interfere with normal signal-transduction pathways
 - E. None of the above.
17. Which of the following is NOT a potential cause of microevolution
- A. Mutation
 - B. Bottleneck effect
 - C. Founder effect
 - D. Random mating
 - E. Gene flow
18. Hemoglobin is normally found in
- A. erythrocytes
 - B. leukocytes
 - C. lymphocytes
 - D. platelets
 - E. adipocytes
19. Mass extinction that occurred in the past
- A. cut the number of species to the few survivor left today
 - B. resulted mainly from the separation of the continents
 - C. occurred regularly, about every three million years
 - D. were followed by diversification of the survivor
 - E. wiped out land animals, but had little effect on marine life

20. In terms of nutrition, autotrophs are to heterotrophs as
A. algae are to slime molds B. archaebacteria are to eubacteria
C. fungi are to algae D. nematodes are to mosquitoes
E. pathogenic bacteria are to harmless bacteria
21. Glycolysis is the only metabolic pathway common to nearly all organisms. To scientists, this suggests that
A. it evolved many times during the history of life
B. was first seen in early eucaryotes
C. first appeared early in the history of life
D. must be very complex
E. appeared rather recently in the evolution of life
22. The bacteria that cause tetanus can be killed only by prolonged heating at temperatures considerably above boiling. This suggests that tetanus bacteria
A. have cell walls containing peptidoglycan B. secrete endotoxins
C. produce endospore D. are autotrophic
E. protect themselves by secreting antibiotics
23. Angiosperms are different from all other plants because only they have
A. flowers B. a vascular system
C. a life cycle that involves alternation of generations
D. seeds E. a saprophyte phase
24. Diabetes mellitus is a metabolic disease normally associated with abnormal synthesis and secretion of A. insulin B. glucagon
C. parathyroid hormone D. calcitonin E. melatonin
25. The eggs of seed plants are fertilized within ovules, and the ovules then developed into A. seeds B. spores C. gametophytes D. fruit E. saprophytes
26. The tube which connects oral cavity and stomach A. Fallopian tube
B. trachea C. esophagus D. seminiferous tubules E. distal tubules
27. Which of the following groups of animal are most likely to transmit infectious diseases between humans A. arthropods B. echinoderms
C. mollusks D. amphibians E. cnidarians
28. Which of the following statements about plants is NOT correct
A. Phloem transports sugars B. Guard cells control transpiration
C. Transpiration pulls water up xylem vessels
D. Plants acquire all their nutrients from soil
E. The plasma membranes of root cells control solute uptake
29. Which of the following statements about plant hormones is correct
A. Cytokinin affects stem elongation by increasing the size of cells
B. Gibberellins stimulates cell division
C. Auxin is a only plant hormone that is gas
D. Absciseic acid play an important role in dormancy of seeds
E. Ethylene triggers seed germinating
30. Which of the following statements about ozone layer is NOT correct
A. It protects life on earth from the harmful ultraviolet rays in sunlight
B. Chlorofluorocarbons (CFC) deplete ozone layer
C. CFC are used as coolants in refrigerators
D. Naturally occurring CFC caused mass extinction in the past
E. A huge ozone hole above Antarctica has been observed

31. *Helicobacter pylori* is a bacterium that is associated with
A. meningitis B. diarrhea C. gastric ulcer
D. dental plaques E. food spoilage
32. The small air sacs in lung are called A. gizzards B. alveoli
C. gall bladders D. bronchioles E. sinuses
33. Urine is formed in A. kidney B. urinary bladder
C. urethra D. ureter E. uterus
34. The major role of glomerulus is A. filtration B. reabsorption
C. secretion D. digestion E. aspiration
35. The major hormone that controls the homeostasis of water in humans is
A. antidiuretic hormone B. follicle stimulating hormone C. insulin
D. thyroxine E. androgen
36. The vitamin that is essential for blood clotting
A. vitamin E B. vitamin B1 C. vitamin K D. vitamin D E. vitamin E
37. Skeletal muscles are attached to bone through A. tendons B. ligaments
C. blood vessels D. cartilages E. loose connective tissues
38. The tissue in testes that synthesizes sperms A. seminiferous tubules
B. vas deferens C. epididymis D. prostate glands E. seminal vesicles
39. A neuronal tissue that connects right and left hemispheres of cerebrum is
A. hypothalamus B. thalamus C. corpus luteum
D. corpus callosum E. basal ganglion
40. The number of base pairs in the DNA of a human diploid cell is about
A. 3×10^{11} B. 3×10^9 C. 6×10^7 D. 3×10^7 E. 3×10^5
41. How many follicles in the ovary of a normal woman would become mature?
A. 400,000 B. 40,000 C. 4,000 D. 400 E. 40
42. The normal human diastolic pressure is approximately how many mmHg
A. 1,000 B. 200 C. 120 D. 70 E. 10
43. A specialized region of cardiac muscle that sets the tempo of the heartbeat is called A. semilunar valves B. A-V valve C. aorta
D. pacemaker E. inferior vena cava
44. The lipoprotein that sometimes is called "bad cholesterol" A. corticosteroids
B. LDL C. mineralcorticoid D. HDL E. bile
45. Severe emphysema is most likely to occur in someone who
A. has low iron intake B. uses illegal drugs C. drinks too much wine
D. is a heavy smoker E. has a viral infection
46. The blood flows from right ventricle into
A. lung B. right atrium C. left atrium D. left ventricle E. aorta
47. Hepatic portal system is the circulatory system that carries nutrients from the alimentary tract to A. heart B. liver C. pancreas D. brain E. lung
48. The specific cellular immunity in humans is conferred by A. T-cells
B. B-cells C. neutrophils D. megakaryocytes E. basophils
49. Cardiac muscle cells are nourished and supplied with oxygen by blood vessels called A. pulmonary veins B. superior vena cava
C. lymphatic ducts D. coronary arteries E. renal arteries
50. The most predominant type of antibody in serum that is capable of crossing placenta is A. IgA B. IgM C. IgG D. IgE E. IgD