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並不得書寫、畫記、作答。

國立清華大學 110 學年度碩士班考試入學試題

系所班組別：生命科學院

甲組(生物與醫學科學組)

科目代碼：0403

考試科目：微生物學

—作答注意事項—

1. 請核對答案卷(卡)上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「↓ 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清(含未依範例畫記)致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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*請在【答案卷】作答

I. Single choice (2% each, total 50%)

1. Which of the following is correct for a bacterium and its corresponding human disease?
 - A. *Chlamydia trachomatis* : peptic ulcer disease
 - B. *Borrelia burgdorferi* : Lyme disease
 - C. *Pseudomonas aeruginosa* : plague
 - D. *Clostridium botulinum* : typhoid
 - E. *Vibrio alginolyticus* : syphilis
2. Which of the following statement is correct for comparison of *Bacteria*, *Archaea* and *Eukarya*?
 - A. Both *Bacteria* and *Eukarya* are insensitive to kanamycin that interferes with protein synthesis.
 - B. Chemolithotrophy is present in *Eukarya*, but not in *Bacteria* and *Archaea*.
 - C. Methanogenesis is absent in *Eukarya*, but is present in *Bacteria* and *Archaea*.
 - D. For membrane lipid, *Bacteria* have ester-linked, straight chained fatty acid, whereas *Archaea* have ether-linked, branched isoprene-derived chains.
 - E. Chlorophyll-based photosynthesis is existed in *Eukarya* and *Archaea*.
3. Which statement related to Gram-negative photosynthetic bacteria is correct?
 - A. Cyanobacteria use hydrogen (H_2) or water as photosynthetic electron donors.
 - B. Green sulfur and purple nonsulfur bacteria undergo oxygenic photosynthesis.
 - C. Aerobic photolithoautotrophs are the general metabolic type of cyanobacteria.
 - D. Chlorophyll a and phycobiliproteins are the major photosynthetic pigments for purple sulfur bacteria.
 - E. Sulfur deposition is outside of purple sulfur bacteria and inside of green sulfur bacteria.

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4. Microorganisms play important roles in carbon and nitrogen cycle. Please choose a correct one from the followings.
- A. Nitrifying bacteria can reduce atmospheric molecular nitrogen (N_2) into nitrite.
 - B. The anammox reaction is an aerobic reaction, in which ammonium ion (NH_4^+) is used as the terminal electron acceptor.
 - C. In carbon cycle, all fixed carbon can be oxidized back to CO_2 again only by anaerobic respiration, but not by fermentation.
 - D. In the second step of nitrification, bacteria convert ammonium ion (NH_4^+) into nitrite (NO_2^-).
 - E. Microorganisms can facilitate carbon fixation in anoxic environments by chemolithoautotrophy in the absence of light.
5. Please choose a statement that is not true for microbial toxins.
- A. In AB toxins, the "A" component is responsible for binding to a host cell receptor, while the "B" component has enzyme activity to cause toxicity.
 - B. An endotoxin is the lipopolysaccharides derived from the outer membrane of Gram-negative bacteria, and its toxic component is the lipid A portion.
 - C. Aflatoxins are produced by fungi and carcinogenic to cause liver cancer.
 - D. Superantigens are heat-labile exotoxins and can stimulate nearly 30% of T cells to overexpress and release large amounts of cytokines without a specific antigen.
 - E. Botulinum toxin is a neurotoxin binding to the same target as tetanus toxin.

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6. Antibiotics can kill or inhibit microbial growth. Please choose a correct description.
- A. Vancomycin is an inhibitor for bacterial protein synthesis, while tetracyclines inhibitor cell wall synthesis.
 - B. Chloramphenicol is a bacteriostatic antibiotic and can damage bacterial cell membrane.
 - C. Quinolones inhibit bacterial DNA gyrase and topoisomerase and therefore inhibit DNA replication.
 - D. Antibiotic resistance of methicillin-resistant *Staphylococcus aureus* (MRSA) is driven by the *mecA* gene encoding alternative ampicillin-binding protein.
 - E. None of the above.
7. Which of the following is not true about the light microscopy?
- A. A shorter wavelength of light can give a greater resolution.
 - B. An objective with a larger numerical aperture (NA) will have a smaller working distance.
 - C. An objective with a smaller numerical aperture (NA) will have a greater resolution power.
 - D. Parfocal microscopes remain in focus when objectives are changed.
 - E. Immersion oil can increase the refractive index between the specimen and the objective lens.
8. A new microbe has been discovered in the rumen (反芻胃) of sheep. Microscopy shows no evidence of a nuclear membrane and biochemical studies of the cell wall demonstrate the lack of peptidoglycan. Metabolic studies show that this microbe generates methane. This microbe would most likely be classified in the:
- A. Domain Eukarya, Fungi
 - B. Domain Eukarya, Protists
 - C. Domain Eukarya, Protozoa
 - D. Domain Bacteria
 - E. Domain Archaea

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9. All of the following statements are true except:
- A. Col plasmids encode colicin which kills strains of *E. coli*.
 - B. R factors have genes for resistance to antibiotics and these resistance genes are often within transposons.
 - C. Plasmids which carry genes encoding degradative enzymes for pesticides are called metabolic plasmids.
 - D. All bacteriocin genes are on plasmids.
 - E. F factor of *E. coli* is both a conjugative plasmid and an episome.
10. Which of the following is MOST effective against resistant endospores?
- A. 70% ethanol.
 - B. autoclaving.
 - C. chlorine.
 - D. pasteurization.
 - E. quaternary ammonium compounds.
11. Which of the following is not a characteristic of active transport?
- A. has a saturable uptake rate.
 - B. use of ATP or proton motive force as a source of metabolic energy.
 - C. can move materials against a concentration gradient.
 - D. ABC transporters are important examples of active transport systems.
 - E. chemically modifies the molecules as it is brought into cell.
12. Given a log phase bacterial culture with 10^6 cells per ml and a generation time of 30 minutes, how long does it take the culture to reach a density of 6.4×10^7 cells per ml?
- A. 1 hour
 - B. 2 hours
 - C. 3 hours
 - D. 5 hours
 - E. 6 hours

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13. Which of the following description about bacterial protein secretion pathway is not correct?

- A. ABC protein secretion pathway can secrete proteins which usually have N-terminal secretion signals.
- B. Some type III secretion machinery is syringe-shaped and secretes virulence factors directly into host cells.
- C. In some G(-) bacteria, proteins can first be removed across the plasma membrane through Tat pathway, then delivered to type II secretion system and passed through the outer membrane.
- D. Type IV secretion pathway can secrete proteins and transfer DNA during conjugation.
- E. Type V secretion pathway can transport some autotransporters through the outer membrane.

14. Which of the following is not true of capsules?

- A. They help bacteria escape phagocytosis by host cells.
- B. They retain water and help prevent desiccation of the bacteria.
- C. They prevent entry of many bacterial viruses.
- D. They are regularly structured layers of protein.
- E. They are one kind of glycocalyx.

15. Methods useful for purification of viruses include

- A. electron microscopy.
- B. differential gradient centrifugation.
- C. hemagglutination.
- D. X-ray diffraction.
- E. Cryogenic electron microscopy.

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16. A complete virus particle is called a
- A. capsid.
 - B. nucleocapsid.
 - C. virion.
 - D. cell.
 - E. matrix
17. Viruses with single-stranded RNA as their genome for which the base sequence is the same as the viral mRNA are said to be _____ viruses.
- A. plus-stranded
 - B. minus-stranded
 - C. mRNA-like
 - D. none of these
 - E. All of these
18. Which of the following is true of viruses in the extracellular phase?
- A. They possess many different enzymes.
 - B. They can reproduce independently of living cells but only at a slow rate.
 - C. They possess 12 different enzymes.
 - D. They possess many different enzymes and they can reproduce independently of living cells but only at a slow rate.
 - E. They behave as a macromolecular complex and are no more alive than are ribosomes.
19. Viral capsids are generally constructed without any outside aid once the subunits have been synthesized. This process is called
- A. self-assembly.
 - B. facilitated assembly.
 - C. spontaneous maturation.
 - D. self-maturation.
 - E. apoptosis.

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20. When a viral genome is integrated into the host chromosome but does not result in the lysis of the host cell, the condition is referred to as
- A. temperate infection.
 - B. a virulent infection.
 - C. acute infection.
 - D. a lytic infection.
 - E. lysogeny.
21. Entry of a virus into the lytic cycle after lysogeny has been established is called
- A. lysogenic conversion.
 - B. lysogenic reversion.
 - C. induction.
 - D. none of the choices.
 - E. All of the choices.
22. In which of the following stages of the viral infectious cycle do enveloped viruses usually acquire their envelopes?
- A. penetration
 - B. component biosynthesis
 - C. assembly
 - D. release
 - E. protein synthesis
23. The largest viruses known are the
- A. poxviruses.
 - B. hepadnaviruses.
 - C. adenoviruses.
 - D. herpesviruses.
 - E. coronavirus.

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24. Which of the following uses ssDNA as the genome?

- A. parvovirus
- B. adenovirus
- C. herpesvirus
- D. poxvirus
- E. coronavirus

25. Nonenveloped viruses most often gain access to eucaryotic host cells by

- A. fusion with the host cell plasma membrane followed by entrance of the nucleocapsid into the cytoplasm.
- B. endocytosis.
- C. pinocytosis.
- D. nucleic acid injection through the plasma membrane.
- E. None of these.

II. Term description and short answers (3% each, total 36%)

1. Microbiome
2. Pathogenicity islands
3. Pattern recognition molecule (PRM)
4. Bioremediation
5. Housekeeping genes
6. Spheroplast
7. Acid-fast staining
8. Facultative anaerobe
9. immune evasion
10. spike protein of coronavirus
11. mRNA vaccine
12. neutralizing antibody

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III. Short answer (6%)

1. Several different mechanisms are used for bacteria to exchange genetic information. Please explain what is transduction, conjugation and transformation. (6%)

IV. Long answer (8%)

1. Koch's postulates have been used to connect many diseases to their causative microorganisms. (a) Describe Koch's postulates. (4%) (b) What kinds of strategies could be used if the application of some of Koch's postulates is at times not feasible (可實行的)? (4%)