

注意：考試開始鈴響前，不得翻閱試題，
並不得書寫、畫記、作答。

國立清華大學 114 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院
丁組(醫學生物科技學程)

科目代碼：0703

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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系所班組別：生命科學暨醫學院甲組、丁組

考試科目（代碼）：微生物學(0403、0703)

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*請在【答案卷】作答

I. Single choice 單選題 (2 points/each) (共 52 分)

1. Which is incorrect regarding the relationship between an antimicrobial drug, its target, and its effect.
 - A. Fluconazole: fungal ergosterol synthesis & disrupting plasma membrane integrity
 - B. Rifampin: bacterial RNA polymerase & blocking RNA synthesis
 - C. Tetracycline: bacterial cell wall & disrupting cell wall integrity
 - D. Ciprofloxacin: bacterial DNA gyrase & blocking DNA replication
 - E. Gentamicin: bacterial 30S ribosomal subunit & inhibiting protein synthesis
2. Which statement is incorrect for microbial toxins?
 - A. Botulinum toxins can inhibit the release of neurotransmitter from nerve endings.
 - B. Aflatoxin B1 is the most toxic aflatoxin, which can induce liver injury and cause liver cancer in humans.
 - C. Cholera toxin disrupts ion transport of intestinal cells, leading to severe diarrhea.
 - D. Endotoxins are components of the outer membrane of Gram-positive bacteria.
 - E. Saxitoxin is a member of algal toxins (or cyanotoxins) and can cause paralytic shellfish poisoning.
3. Which is true regarding carbon and nitrogen cycles completed by bacteria?
 - A. Mineralization is a process in which carbon is converted into biomass become temporarily unavailable for nutrient cycling.
 - B. Only archaea can form methane (CH_4) from either $\text{H}_2 + \text{CO}_2$ or $\text{H}_2 + \text{acetate}$.
 - C. Nitrification is an anaerobic reaction performed by the bacteria *Planctomycetes* to convert nitrate into N_2 .
 - D. Denitrification is two-step chemolithotropic process to convert ammonium to nitrite.
 - E. Nitrogenase is the enzyme that can catalyze anaerobic ammonium oxidation (Anammox).
4. Choose a correct property from comparing *Bacteria*, *Archaea*, and *Eukarya*.
 - A. Gas vesicles are present in *Archaea* and *Eukarya*.
 - B. The size of ribosomes is 80S and 70S in *Bacteria* and *Archaea*, respectively.
 - C. Chlorophyll-based photosynthesis is present in *Bacteria* and *Archaea*.
 - D. Poly-A tailing and splicing are present in *Archaea* and *Eukarya*.
 - E. Both *Archaea* and *Eukarya* do not contain muramic acid in their cell wall.

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*請在【答案卷】作答

5. Please choose one wrong statement regarding pathogen transmission and infection?
- A. In airborne transmission of pathogens, droplet nuclei are large particles (>5 micrometer diameter) that can travel < 1 meter.
 - B. Colonization of a microbial pathogen on or within host is not necessarily result in tissue invasion or damage.
 - C. Based on lethal dose 50 (LD_{50}), bacterial strain A ($LD_{50} = 5000$) is more virulent than bacterial strain B ($LD_{50} = 7500$).
 - D. Intoxications are diseases that result from entry of a specific performed toxin into host.
 - E. Reservoir is a natural environmental location in which the pathogen normally resides.
6. Which of the following processes plays the smallest direct role in generating genetic diversity within bacterial and archaeal populations, despite potentially influencing their evolution over time?
- A. Conjugation
 - B. Binary fission
 - C. Transduction
 - D. Mutation
 - E. Transformation
7. Which of the following statements about light microscopy is incorrect?
- A. The resolution of a light microscope improves with the use of shorter wavelengths of light.
 - B. Objectives with larger numerical apertures (NA) generally provide greater resolution but have smaller working distances.
 - C. Immersion oil enhances resolution by increasing the refractive index between the specimen and the objective lens.
 - D. Parfocal microscopes require substantial refocusing when switching between objectives.
 - E. Numerical aperture (NA) directly influences the resolving power of a microscope.

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8. Which of the following infectious agents consists of nucleic acid enclosed within a protein shell?
- A. Viruses
 - B. Viroids
 - C. Prions
 - D. Satellites
 - E. Water molds
9. Which type of bacterial inclusion stores nitrogen?
- A. Glycogen inclusions
 - B. Polyphosphate granules
 - C. Cyanophycin granules
 - D. Sulfur globules
 - E. Magnetosomes
10. Which component is absent in bacterial membranes but present in eukaryotic membranes?
- A. Phospholipids
 - B. Hopanoids
 - C. Integral proteins
 - D. Lipopolysaccharides
 - E. Sterols
11. Which phase of the microbial growth curve is associated with genetic diversity and evolution?
- A. Lag phase
 - B. Exponential phase
 - C. Stationary phase
 - D. Death phase
 - E. Long-term stationary phase
12. What role does the divisome play in bacterial cell division?
- A. It condenses DNA for replication.
 - B. It synthesizes cytoplasmic membranes.
 - C. It assembles proteins necessary for septum formation and cell wall synthesis.
 - D. It regulates flagellar motion.
 - E. It maintains osmotic balance.

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*請在【答案卷】作答

13. Which strategy is suggested to combat drug resistance?
- A. Lowering drug concentrations to avoid toxicity
 - B. Using single-drug therapy
 - C. Eliminating use of new antibiotics
 - D. Combining drugs with distinct mechanisms of action
 - E. Increasing bacterial growth rates
14. What is a key characteristic of the measles virus?
- A. It has a segmented RNA genome.
 - B. It contains DNA as its genetic material.
 - C. It is resistant to heat and disinfectants.
 - D. It has a single-stranded negative-sense RNA genome.
 - E. It requires a host's DNA polymerase for replication.
15. Why are monoclonal antibody therapies less effective against emerging SARS-CoV-2 variants?
- A. Variants replicate slower than antibodies can bind.
 - B. Mutations in non-spike proteins prevent antibody binding.
 - C. Antibody production is delayed in vaccinated individuals.
 - D. Mutations in spike epitopes reduce antibody binding affinity.
 - E. Monoclonal antibodies degrade too quickly in the bloodstream.
16. What is the primary reason for using lipid nanoparticles (LNPs) in mRNA vaccine delivery?
- A. To enhance cellular uptake and prevent mRNA degradation.
 - B. To serve as a vaccine to boost the immune response.
 - C. To stabilize mRNA under neutralizing conditions.
 - D. To reduce the vaccine's half-life in circulation.
 - E. To enhance the storage temperature requirements.
17. In SARS-CoV-2's TMPRSS2-mediated entry pathway, what is the function of TMPRSS2?
- A. To block the virus from reaching the host cell surface.
 - B. To cleave the spike protein, exposing the fusion peptide.
 - C. To facilitate endocytosis of the virus.
 - D. To activate ACE2 for viral entry.
 - E. To neutralize acidic endosomal conditions.

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*請在【答案卷】作答

18. Which factor most significantly influences the population's dominance of a SARS-CoV-2 variant?
- A. Mutation in the N protein.
 - B. Immune evasion capability.
 - C. Lower replication fidelity.
 - D. Mutation in the C protein.
 - E. Reduced viral genome size.
19. Why does cathepsin L-mediated entry of SARS-CoV-2 depend on pH?
- A. Acidic pH triggers spike protein binding to ACE2.
 - B. Acidic pH activates cathepsin L, allowing spike protein cleavage.
 - C. Acidic pH increases viral genome stability in the cytoplasm.
 - D. Neutral pH prevents spike protein conformational changes.
 - E. High pH levels disrupt endosomal membrane integrity.
20. Which of the following is why influenza viruses require constant vaccine updates?
- A. Low replication rates in host cells.
 - B. Antigenic drift resulting in changes to hemagglutinin (HA) and neuraminidase (NA).
 - C. Assistance to antiviral drugs.
 - D. The ability to infect multiple animal species.
 - E. Stability of viral RNA in different environments.
21. What is the main role of neuraminidase (NA) in the influenza virus life cycle?
- A. Binding to sialic acid receptors on host cells.
 - B. Cleaving sialic acid residues to release newly formed virions.
 - C. Facilitating viral RNA replication in the nucleus.
 - D. Triggering endosomal escape of the viral genome.
 - E. Stabilizing the influenza virus in extracellular environments.
22. Why do RNA viruses typically exhibit higher mutation rates compared to DNA viruses?
- A. RNA viruses have fewer replication cycles.
 - B. RNA-dependent RNA polymerases lack proofreading mechanisms.
 - C. RNA viruses replicate exclusively in the nucleus.
 - D. DNA polymerases are more error-prone than RNA polymerases.
 - E. RNA genomes are more stable than DNA genomes.

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*請在【答案卷】作答

23. Which experimental technique is commonly used to screen large libraries of compounds to identify potential antiviral drugs?
- A. Reverse transcription polymerase chain reaction (RT-PCR)
 - B. High-throughput screening (HTS)
 - C. Gel electrophoresis
 - D. Immunoprecipitation
 - E. Flow cytometry
24. What is the primary role of interferons during viral infections?
- A. Enhance viral replication
 - B. Suppress immune responses
 - C. Activate antiviral states in neighboring cells
 - D. Facilitate viral assembly
 - E. Neutralize viral particles
25. What is a key function of cytotoxic T lymphocytes (CTLs) in viral immunity?
- A. Neutralizing free viruses in the bloodstream
 - B. Promoting viral antigen presentation
 - C. Destroying virus-infected cells
 - D. Removing cytokines for B-cell activation
 - E. Increasing antibody production
26. Which mechanism is commonly used by viruses to evade the immune system?
- A. Attacking apoptosis of infected cells
 - B. Rapid mutation of surface antigens
 - C. Increasing cytokine signaling
 - D. Promoting immune cell activation
 - E. Inducing phagocytosis of viral particles

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*請在【答案卷】作答

II. Matching questions 配合題 (2 points/each)(共 18 分)

Please match each of the following questions (on the top) with a proper answer (on the bottom).

(1) bacteria can convert ammonia to nitrites: ____; (2) smallest bacteria capable of self-reproduction: ____; (3) oral thrush: ____; (4) *Synechococcus* and ____ are two bacterial species account for ~1/3 of global CO₂ fixation; (5) the possible endosymbiotic ancestor of the mitochondria: ____; (6) a Gram-positive bacterium can cause dental caries: ____; (7) a bacterium useful for horizontal gene transfer to generate transgenic plants: ____; (8) Lyme disease: ____; (9) the only prokaryotes containing chlorophyll b: ____.

(A) *Lactobacillus acidophilus*, (B) *Rickettsia prowazekii*, (C) *Burkholderia cepacia*, (D) *Agrobacterium tumefaciens*, (E) *Campylobacter jejuni*, (F) *Borrelia burgdorferi*, (G) *Nitrococcus* species, (H) *Myxobacteria*, (I) *Haemophilus influenza*, (J) *Salmonella*, (K) *Prochlorophytes*, (L) *Bdellovibrio* species, (M) *Shewanella* species, (N) *Nitrosomonas* species, (O) the *Mollicutes*, (P) *Bordetella* species, (Q) *Caulobacter* species, (R) *Streptococcus mutans*, (S) *Helicobacter pylori*, (T) *Candida albicans*, (U) the phylum *Aquifex*, (V) *Pseudomonas* species, (W) *Mycoplasma*, (X) *Deinococcus* species, (Y) *Prochlorococcus*, (Z) the phylum *Thermotogae*.

III. Short answers 簡答題 (共 13 分)

1. What is the difference between a primary pathogen and an opportunistic pathogen? (5 points)
2. Explain the role of RNA-dependent RNA polymerase in replicating RNA viruses. (2 points)
3. Why are enveloped viruses more sensitive to environmental factors than non-enveloped viruses? (2 points)
4. What role does hemagglutinin (HA) play in entering influenza viruses into host cells? (2 points)
5. What is the significance of "cap-snatching" in influenza virus replication? (2 points)

IV. Term description (共 9 分)

1. Acid-fast staining (3 分)
2. Decimal reduction time (D value) (3 分)
3. Col plasmids (3 分)

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V. Long answers (8 分)

1. Compare and contrast Gram-positive and Gram-negative bacterial cell walls, focusing on their structural and functional differences. (8 分)