

國立臺灣大學 105 學年度碩士班招生考試試題

題號：199

科目：生命科學

Please choose the most appropriate terms/phrases/statements that complete or answer the questions. Attention: More than one of the choices provided may be correct.

(2.5 points for each question)

1. Which of the following organs are not in immune system?
(A) Lymph nodes
(B) Kidney
(C) Spleen
(D) Brain
(E) Liver
2. Which of the following cell types are immune cells?
(A) NK cell
(B) Cardiomyocyte
(C) Adipocyte
(D) Neutrophil
(E) B cell
3. Which one is not the class of pathogen?
(A) Virus
(B) Fungus
(C) Parasite
(D) Insect
(E) Bacterium
4. Which of the following techniques are applied with monoclonal antibody?
(A) ELISPOT
(B) Immunoprecipitation
(C) Western blot
(D) Flow cytometry
(E) Southern blotting
5. Which of the following statements are not true?
(A) The immune system recognizes infection and induces protective responses.
(B) The cells of the immune system derive from precursors in the bone marrow.
(C) The myeloid lineage comprises most of the cells of the adaptive immune system.
(D) Lymphocytes mature in the bone marrow or the thymus and then congregate in lymphoid tissues throughout the body.
(E) Most infectious agents activate the innate immune system and induce an inflammatory response.
6. Which of the following cancer therapy is a kind of immunotherapy?
(A) Surgical therapy
(B) Radiation therapy
(C) T cell therapy
(D) Targeting therapy
(E) Chemotherapy

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7. Regarding to antibody which statements are true?
(A) It has one pair of heavy chain and light chain.
(B) It is "V" shape.
(C) It is secreted by T cells.
(D) It can block the entry of virus into host cells.
(E) It can be classified into IgM, IgG, IgD, IgE, and IgA five isotypes.
8. Which of the following diseases can be controlled by vaccine?
(A) Polio
(B) Diphtheria
(C) Ebola infection
(D) Tuberculosis
(E) Measles
9. Which one is the strategy to generate gene-modified mice?
(A) Chemical reagents
(B) PCR
(C) CRISPR/Cas9
(D) Irradiation
(E) Gene targeting
10. Regarding to dendritic cell which statements are not true?
(A) It is the most potent antigen-presenting cell.
(B) It is activated in lymph node and then migrates to skin.
(C) It senses pathogens by pattern recognition receptors.
(D) It is the bridge linking innate and adaptive immunity.
(E) It can produce antibody.
11. What are the components of DNA?
(A) Phosphate
(B) Water
(C) Sugar
(D) Nitrogenous base
(E) Histone
12. Indicate if each of the following descriptions matches RNA.
(A) It is mainly found as a long, double-stranded molecule.
(B) It contains the sugar ribose.
(C) It normally contains the bases thymine, cytosine, adenine, and guanine.
(D) It can normally adopt distinctive folded shapes.
(E) It can be used as the template for protein synthesis.
13. Which of the following processes that happens inside a cell normally require consumption of free energy by the cell?
(A) Replication of the genetic material
(B) Import of nutrients from the environment
(C) Diffusion of small molecules within the cell
(D) Regulation of gene expression

- (E) Synthesis of enzymes that catalyze cellular reactions
14. Which of the following is **TRUE** regarding the members of a protein family in general?
- (A) They have similar three-dimensional conformations.
 - (B) They share an ancestry; i.e. they are homologs.
 - (C) They can functionally replace each other.
 - (D) Their structure is less well conserved than their gene sequence.
 - (E) Over evolutionary time scales, the family has expanded mainly through gene duplication events.
15. Scientists discover more than ten thousand new species of living organisms every year. Which of the following statements are **NOT true**.
- (A) They are made of cells, whose nuclei enclose their DNA.
 - (B) They obtain their energy from sunlight.
 - (C) They produce and use adenosine triphosphate (ATP).
 - (D) Their genome contains at least 1000 genes.
 - (E) They all have chromosomes.
16. Indicate whether the following statements are **TRUE**.
- (A) Plants do not require a cytoskeleton because they have a cell wall that lends structure and support to the cell.
 - (B) The cytoskeleton is used as a transportation grid for the efficient, directional movement of cytosolic components.
 - (C) Thermal energy promotes random movement of proteins, vesicles, and small molecules in the cytosol.
 - (D) Primitive plant, animal, and fungal cells probably acquired mitochondria after they diverged from a common ancestor.
 - (E) The first eukaryotic cells on Earth must have been aerobic; otherwise, they would not have been able to survive when the planet's atmosphere became oxygen-rich.
17. Indicate whether the following statements are **TRUE**.
- (A) The second law of thermodynamics states that the total amount of energy in the Universe does not change.
 - (B) The ultimate source of energy for living systems is sunlight.
 - (C) CO₂ gas is fixed in a series of reactions that are light-dependent.
 - (D) H₂ is the most stable and abundant form of hydrogen in the environment.
 - (E) Biological molecules are relatively stable and an input of energy is required to reach lower energy states.
18. The basic protein function on the right is matched with the type of protein on the left. Which of the following matches are **NOT correct**?
- (A) insulin: transport
 - (B) myosin: motor
 - (C) hemoglobin: storage
 - (D) tubulin: structural
 - (E) homeodomain proteins: signal

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19. Which of the following statements about membrane-enclosed organelles are **NOT true**?

- (A) In a typical cell, the area of the endoplasmic reticulum membrane far exceeds the area of plasma membrane.
- (B) The nucleus is the only organelle that is surrounded by a double membrane.
- (C) The cytosol is about half the volume of a typical eukaryotic cell, with membrane-enclosed organelles making up the other half of the volume.
- (D) The nucleus is the only organelle that contains DNA.
- (E) The ER is the major site for new membrane synthesis in the cell.

20. You have a piece of circular DNA that can be cut by the restriction nucleases EcoRI, HindIII, and NotI, as indicated in Figure 1.

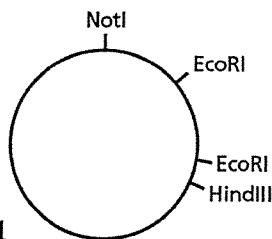


Figure 1

Which of the following statements are **TRUE**?

- (A) One piece of DNA will be obtained when this DNA is cut by NotI.
- (B) A piece of DNA that cannot be cut by EcoRI will be obtained by cutting this DNA with both NotI and HindIII.
- (C) Two DNA fragments that cannot be cut by HindIII will be obtained when this DNA is cut by EcoRI and NotI.
- (D) Two DNA fragments of unequal size will be created when this DNA is cut by both HindIII and EcoRI.
- (E) The double stranded DNA molecules are usually heated to 90°C to separate them into single strands before restriction nucleases digestion.

21. Which of the following statements for mRNA is True:

- (A) Prior to 5' mRNA capping, there are three phosphate at 5' end of mRNA
- (B) After 5' capping with GTP, there is one phosphate between capped Guanine and first nucleotide of the mRNA
- (C) Poly(A) tail of the mRNA is encoded in the DNA sequence
- (D) Maturation of intron containing mRNA requires splicing process
- (E) RNA splicing is one of the first discovered enzymatic reaction that can be catalyzed by Ribozyme

22. Which of following statements about RNA interference (RNAi) are True:

- (A) The discovery of RNAi was awarded with Nobel Prize
- (B) The trigger for RNAi is long double stranded RNA
- (C) microRNA is generated from RNAi pathway
- (D) The major components in RNA-induced silencing complex are a small interfering RNA and an Argonaute protein
- (E) Droscha is required for RNAi to be functional.

23. Which of following statement are True:
- (A) Ribonuclease is never made by RNA
 - (B) Riboswitch is another form of RNA enzyme
 - (C) A RNA world hypothesis suggesting RNA was the origin of biological molecules
 - (D) The catalytic core of ribosome is majority made with RNA
 - (E) The nucleotide sequence between different tRNAs are very diverse but their structure are similar
24. Which of the following statements are True:
- (A) *C. elegans* requires male mating to have progeny
 - (B) *C. elegans* is a hermaphrodite
 - (C) The largest organ in *C. elegans* is germline
 - (D) *C. elegans* can initiate RNAi by feeding
 - (E) The food for *C. elegans* is fungi
25. Which of following bonds do not belong to covalent bonds:
- (A) disulfide bond.
 - (B) hydrogen bond.
 - (C) phosphodiester bond.
 - (D) Ionic interaction
 - (E) van der Waals
26. Which of the following amino acid residues has non-polar side chain:
- (A) T
 - (B) N
 - (C) F
 - (D) Y
 - (E) W
27. Which of following statements for nucleic acid is True:
- (A) A, G are Purines
 - (B) There are two hydrogen bonds between CG pairing
 - (C) During the process of free nucleotides becoming RNA, every single nucleotide added, two phosphate groups are released.
 - (D) The higher the GC content, the lower the T_m value is.
 - (E) RNA at neutral pH buffer (pH=7) has no charge
28. Crossing a *C. elegans* male with genotype (chromosome I : gene a $-/-$) to a *C. elegans* hermaphrodite (chromosome III : gene b $-/-$), if the cross is successful, which of following statement are true: (F1: 1ST generation progenies. F2: 2nd generation progenies)
- (A) F1 are all have the same genotype.
 - (B) F1 for both mutations (a, b) are heterozygous
 - (C) 1/4 of F2 results in (chromosome I: gene a $-/-$; chromosome III: gene b $-/-$)
 - (D) 1/4 of F2 results in (chromosome I: gene a $-/-$)
 - (E) 1/4 of F2 results in (chromosome III: gene b $-/-$)

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29. Which of the following statements are True:
- (A) Transposable DNA elements present higher frequency in prokaryotic genomes
 - (B) Mitochondria contain its own DNA
 - (C) Mitochondria is evolved from a bacterium
 - (D) Nucleosome consists of DNA and histones
 - (E) Condense regions of chromatin is known as euchromatin
30. Which of the following statements are True:
- (A) tRNA are transcribed by RNA polymerase I
 - (B) Pre r-RNA are transcribed by RNA polymerase I
 - (C) mRNA are transcribed by RNA polymerase II
 - (D) rRNA are transcribed by RNA polymerase II
 - (E) microRNA precursors are transcribed by RNA polymerase II
31. Which of the following descriptions about cancer behaviors are correct?
- (A) Cancer is resulted from a mutation that drives both the uncontrolled proliferation and metastasis of cancer cells.
 - (B) The whole spectrum of tumorigenesis is a multistep process, from uncontrolled proliferation, local invasion, all the way to metastasis. In the process, cancer cells accumulate more than one mutation. Some mutations enable cancer cells to proliferate abnormally fast, while other mutations enable them to metastasize to distant tissues.
 - (C) Tumor growth requires formation of new blood vessels.
 - (D) Without exception, cancer stem cells are the most dominant cells type in a tumor mass.
 - (E) Patients with inherited difficulties in repairing his/her genomic DNA damage are more prone to various forms of cancers earlier than the general population.
32. Which of the following statements explain how the nervous system works
- (A) Information moves as pulses of ion flow called action potentials which propagate through neurons from dendrites to axons
 - (B) The further action potentials travel from dendrites down to axons, the smaller the amplitudes of action potentials are.
 - (C) Information flows between neurons via a specialized structure called synapse.
 - (D) A group of connected neurons form a circuit that executes a function or an action in the nervous system. For example, the circuit responsible for the knee-jerk response consists of three types of connected neurons: sensory neurons, interneurons, and motor neurons.
 - (E) Neurons are the only cell type in the nervous system. However, different types of neurons behave differently. The differences underlie the functional heterogeneities of the nervous system.
33. One goal of the developmental processes is to generate functionally diversification among the many daughter cells from an identical totipotent zygote. How the diversification is generated during the development?
- (A) Symmetric division of stem cells
 - (B) Asymmetric division of stem cells
 - (C) Gastrulation creates three germ layers: endoderm, mesoderm, and ectoderm.
 - (D) Morphogen gradients create differential signals and induce different cell fates
 - (E) Both VDJ joining and somatic hypermutation diversify T and B cell repertoire.

34. Which of the following statements about development are correct?
- (A) The fertilized egg, zygote, is considered as a totipotent cell because it has the capability to generate all the cell types of the body
 - (B) Each of the 8 cells resulting from the first three divisions of a mammalian zygote has the potential to give rise a complete animal. This means that these cells are totipotent.
 - (C) At the later stage, the 64 daughter cells of the zygote separate into two cell types: trophectoderm and inner cell mass
 - (D) The inner cell mass grows and differentiates into three germ layers: ectoderm, mesoderm, and endoderm. Each germ layer has distinct fates. Ectoderm gives rise to muscles, bones, blood cells. Mesoderm gives rise to stomach, colon, liver. Endoderm gives rise to central nervous system, epidermis, hair, and pigment cells.
 - (E) A developing embryo grows by cell division. Cell death does not play any role in the developmental processes.
35. Fast proliferation is one of the hallmarks of cancer cells. Which of the following methods DIRECTLY demonstrate that cancer cells proliferate faster than the normal, non-transformed cells
- (A) Sequence the whole cancer genome and profile the mutation hot spots in the cancer genome.
 - (B) Stain cells with DNA dye and count the number of mitotic cells in every 100 cells under microscope. Cancer cells have more mitotic cells than non-transformed epithelial cells.
 - (C) Culture cells with Bromodeoxyuridine (BrdU) for a fixed period of time and then stain cells with fluorescent-conjugated anti-BrdU. Cancer cells have more BrdU positive cells compared with non-transformed epithelial cells.
 - (D) Sequence total mRNA and measure the expression of oncogenes in cancer cells.
 - (E) Use "stable isotope labeling by amino acids in cell culture" (Silac) technique to highlight how cancer proteome differs from non-transformed one.
36. Our body mass is contributed by cells as well as extracellular matrix. What are the biological functions of extracellular matrix?
- (A) Components of the extracellular matrix bind to certain adhesion receptors, such as integrins, located on the cell surface to hold cells in a proper position.
 - (B) In this way, it delivers an environmental signal to the attached cell.
 - (C) Components of the extracellular matrix provide a lattice through or on which cells can migrate.
 - (D) Collagen is a component of the extracellular matrix that makes bones, which are the scaffold of our body.
 - (E) An injured organ uses newly synthesized extracellular matrix to heal the wound.
37. Cellular components are moved along the microtubule tracks by kinesins and dynein. Which of the following cellular components are microtubule cargos?
- (A) chromosomes in mitotic phase
 - (B) melanosomes
 - (C) mitochondria
 - (D) secretory vesicles
 - (E) lysosome

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38. Microfilaments are polymers of the protein actin organized into functional bundles and networks by actin-binding proteins. Microfilaments can assemble into many types of structures within a cell, including
- (A) Primary cilium
 - (B) Filopodia
 - (C) Stress fibers
 - (D) Microvilli
 - (E) Lamellipodium
39. Cell migration underlies many developmental processes, immune responses, wound healing, and even metastasis of cancers. Which of the following cellular processes contribute to cell migration?
- (A) At the membrane of the leading edge, actin is nucleated by the activated Arp2/3 complex and filaments are elongated by assembly onto (+) ends adjacent to the plasma membrane. As the actin meshwork is fixed with respect to the substratum, the front membrane is pushed out as the filaments elongate.
 - (B) When the membrane has been extended and the cytoskeleton has been assembled, the advanced plasma membrane becomes firmly attached to the substratum.
 - (C) After the forward attachments have been made, the cell body are translocated forward by myosin-dependent cortical contraction in the rear part of the cell.
 - (D) The activation of small GTP-binding protein Rac leads to myosin II activation at the rear end of a migrating cell.
 - (E) The activation of small GTP-binding protein Rho leads to actin filament assembly and treadmilling in the leading edge of a migrating cell.
40. Cell proliferation is normally regulated tightly by a panel of signaling pathways. Which of the following mutations or dysregulations in the signaling pathways disrupt normal control of cell proliferation and are found in human cancers?
- (A) Overexpression of HER2, a receptor tyrosine kinase, occurs in some breast cancers.
 - (B) Constitutively active mutations of epidermal growth factor receptor (EGFR) are found in a portion of non-small cell lung cancer patients
 - (C) Certain point mutations within the Ras gene lock the protein into a constitutively active state, which leads to aberrant cell signaling even in the absence of external mitogenic signals.
 - (D) A loss-of-function mutation of adenomatous polyposis coli (APC) leads to activation of Wnt pathway and increases the risk of colon cancer
 - (E) MYC is a potent oncogene initially identified as the target of the t(8;14)(q24;q32) chromosome translocation in Burkitt lymphoma. The t(8;14)(q24;q32) chromosome translocation results in a constitutive expression of MYC in the B-cell lineage.