

國立清華大學 104 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系 甲組(生物組)

考試科目 (代碼)：普通生物學(2202)

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一、問答題 (70%)

1. (10%)

- (1) Explain the purpose of using restriction enzymes during cloning experiments.
- (2) The restriction enzyme *M*_{all}I cuts the double-stranded sequence 5'-GATC-3' and its complement 5'-CTAG-3' in the center between A and T to form blunt ends. For the following double-stranded sequence, how many times does *M*_{all}I cut the sequence, and how many fragments result after treatment with *M*_{all}I?

5'-GCACCGATCTGTGTTGTTACCTAGCCCACGGTGGATCCAAGGC-3' /

5'-GCCTTGGATCCACCGTGGGCTAGGTGAACAACACAGATCGGTGC-3'

2.

- (1) In bacterium, how dose cyclic AMP (cAMP) regulate lac operon if glucose exists? (5%)
- (2) Mutations sometimes affect operons. Imagine a mutation in the regulatory gene that produces the repressor of the lac operon in *E. coli*. The altered repressor is no longer able to bind to the operator. What effect will this have on the bacterium? (5%)

3.

A fruit fly with a gray body and red eyes (genotype BbPp) is mated with a fly having a black body and purple eyes (genotype bbpp).

- (1) What ratio of offspring would you expect if the body-color and eye-color genes are on different chromosomes (unlinked)? (4%)
- (2) When this mating is actually carried out, most of the offspring look like the parents, but 3% have a gray body and purple eyes, and 3% have a black body and red eyes. Are these genes linked or unlinked? What is the recombination frequency? (4%)

4.

- (1) As you hold a book, nerve signals are generated in nerve ending in your fingertips and sent to your brain. What causes the nerve signal to move from that point along the length of the neuron to the other end? What is the nerve signal exactly and can't go backward? Describe the events that tak place when an action potential propagates to the end of the axon, the synaptic knobs, reaching the synapse? (4%)
- (2) How do calcium ion and ATP regulate muscle contraction stop when stimuli from the motor neurons stop? (4%)

5. Why would you predict that C4 photosynthesis evolved after C3 photosynthesis? (5%)

6. Excretion is ridding the body of a metabolic waste. How is the respiratory system involved in excretion? The digestive system doesn't excrete. Why not? (5%)

7. How to reproduce Dolly lamb? Sexual or asexual? Describe the procedure and point out the key method successfully to reproduce Dolly lamb. (8%)

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8. A red blood cell with an internal concentration equivalent to 0.15 M NaCl is placed in a solution with a concentration of 0.35 M NaCl. What happens to the red blood cell? What term describes the solution relative to the red blood cell? What relative term describes the interior concentration of the red blood cell relative to the surrounding solution? (8%)
- 9.
- (1) Compare sperm formation with egg formation. In what ways are the processes similar? In what ways are they different? (4%)
- (2) After ovulation, what is the function of corpus luteum? In general, why does only one sperm impenetrate into an egg? (4%)

二、單選題 (30%; 3 points/question)

1. You discover a novel DNA-binding protein. What would be the best technique to define the identity of the specific DNA sequence to which this protein can bind?
- (A) two-hybrid assay
(B) ChIP-Seq assay
(C) reporter gene assay
(D) ChIP assay
2. Consider a pre-mRNA that consists of four exons and three introns in the following arrangement:
5'-exon 1/intron 1/exon 2/intron 2/exon 3/intron 3/exon 4-3'
- The splice sites within each intron are the following (with the 5' splice sequence followed by the 3' splice sequence):
- intron 1 = GU and AG
intron 2 = AU and AG
intron 3 = AU and AC
- List all alternative mature mRNA splice forms that could arise if this pre-mRNA underwent spliceosome-mediated splicing. Only consider mature mRNA(s) that do not retain intron(s).
- (A) exons 1, 2, 4 joined together *or* exons 1, 3, 4 joined together
(B) exons 1, 2, 4 joined together
(C) exons 1, 3, 4 joined together
(D) exons 1, 2, 3 joined together *or* exons 1, 2, 3, 4 joined together
3. Why would the absence of DNA primers in PCR cause the reaction to fail?
- (A) The reaction lacks template DNA when primers are absent.
(B) The reaction lacks a primer:template junction, and thus a free 3'-hydroxyl group, when primers are absent.
(C) The reaction lacks a free 2'-hydroxyl when primers are absent.
(D) The reaction lacks single-stranded DNA when primers are absent.

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4. You have two samples of covalently closed, circular DNA (cccDNA)—one relaxed and one slightly negatively supercoiled—and you want to visualize the DNA using gel electrophoresis. You add a small amount of ethidium to each sample. Each cccDNA contains the same number of base pairs. Interestingly, you see that the relaxed cccDNA sample migrates faster in the gel than the negatively supercoiled cccDNA sample. Which of the following is a valid explanation for the results?
- (A) The treatment with ethidium relaxed the negatively supercoiled cccDNA and positively supercoiled the relaxed cccDNA.
 - (B) The treatment with ethidium caused both cccDNAs to become positively supercoiled.
 - (C) The treatment with ethidium caused both cccDNAs to become relaxed.
 - (D) The treatment with ethidium decreased the linking number of the negatively supercoiled cccDNA and increased the linking number of the relaxed cccDNA.
5. Chemotherapeutic agents target the growth of tumors through all of the following mechanisms, EXCEPT for _____.
- (A) incorporation of nucleotide analogs that prevent further DNA synthesis
 - (B) damaging template DNA to block DNA polymerase activity
 - (C) binding the active site of RNA polymerase
 - (D) inhibition of nucleotide precursor synthesis
6. Which of the following is true regarding the direction of new DNA synthesis during replication?
- (A) The lagging strand DNA polymerase synthesizes DNA in the same direction that the replication fork is moving.
 - (B) The leading strand DNA polymerase synthesizes DNA in the same direction that the replication fork is moving.
 - (C) The leading and lagging strand DNA polymerases synthesize DNA in the 5' to 3' direction, which is in the same direction that the replication fork is moving for either strand.
 - (D) The leading strand DNA polymerase synthesizes DNA in the 5' to 3' direction, while the lagging strand DNA polymerase synthesizes DNA in the 3' to 5' direction.
7. The fight-or-flight response includes greater heart output and a rise in blood pressure. This response is due to
- (A) insulin secreted by the pancreas
 - (B) thyroxine secreted by the thyroid gland
 - (C) oxytocin secreted by the pituitary gland
 - (D) adrenaline secreted by the adrenal glands

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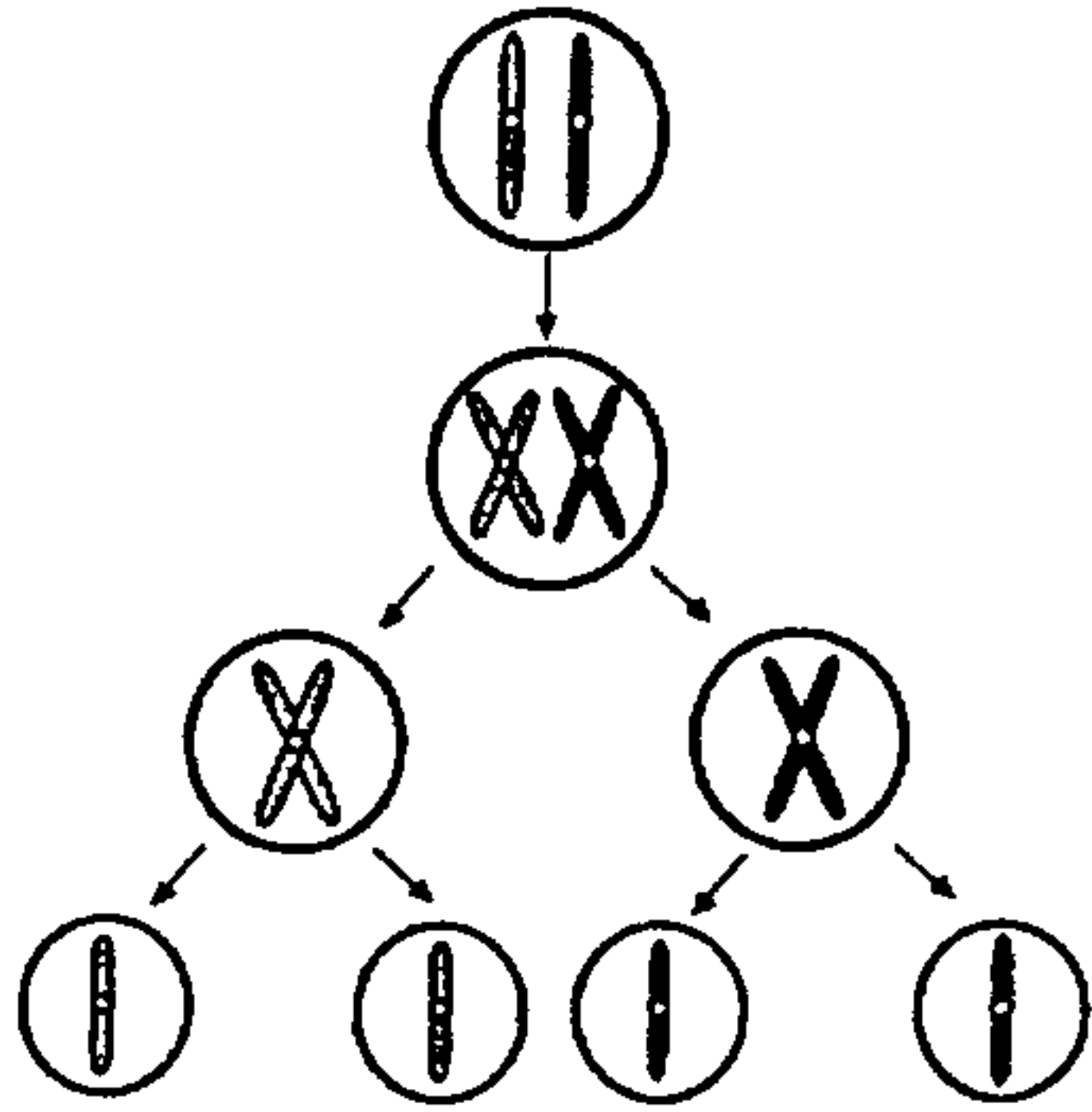
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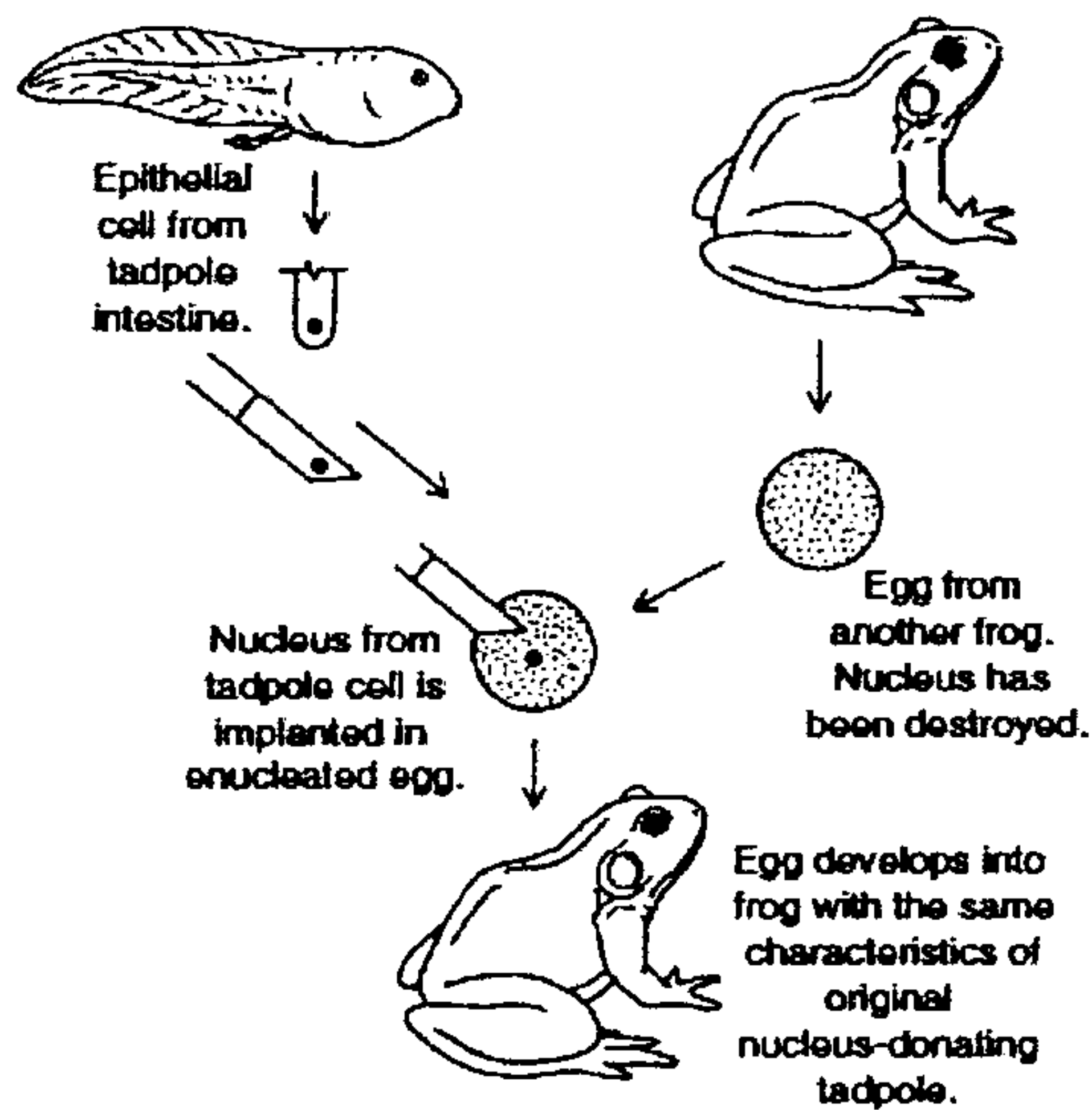
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8. The diagram below shows a cellular process that occurs in organisms. This process is known as
(A) meiosis (B) mitosis (C) endocytosis (D) phagocytosis



9. Which of these is best demonstrated by the experiment below?



- (A) Differentiated cells contain a complete set of gene
(B) All frogs are genetically identical
(C) Embryonic development is controlled by the cytoplasm
(D) The nucleus of a tadpole cell is unspecialized.
10. Injecting a person with a killed-bacteria vaccine can protect that individual from a disease because the proteins of the killed bacteria
(A) remain in the body, and live bacteria later prey on them instead of live tissues.
(B) bind with receptors in the body, so that live bacteria cannot bind with them later.
(C) stimulate the production of antibodies which can be manufactured later in response to infection.
(D) give the person a mild form of the disease, which conditions the body not to respond to later infection.

【END】