

시행일	2026년 7월 1일 (2)교시		2차 정기 시험		
과목코드	55	논술형 답지	과목명	AP 생물학	
문제 쪽수	총 5쪽	별도	학년 반	3학년 1A, 1B 반	

학번 : _____ 이름 : _____

총 문항 수

구분	선다형	논술형	기타
문항 수	20	4	0
배점	60	40	0
점수 합계	100		

[Multiple Choice Questions]

For each statement or question, select the number of the word or expression that, of those given, the BEST completes the statement or answers the question.

(20)×(3) point(s)=(60) points

1. A cell secretes a growth factor that binds to receptors on neighboring cells causing them to proliferate. This is an example of

- ① contact-dependent signaling.
- ② direct intercellular signaling.
- ③ autocrine signaling.
- ④ paracrine signaling.
- ⑤ endocrine signaling.

2. When insulin is secreted from the pancreas and acts on muscle cells to increase glucose uptake, this is an example of

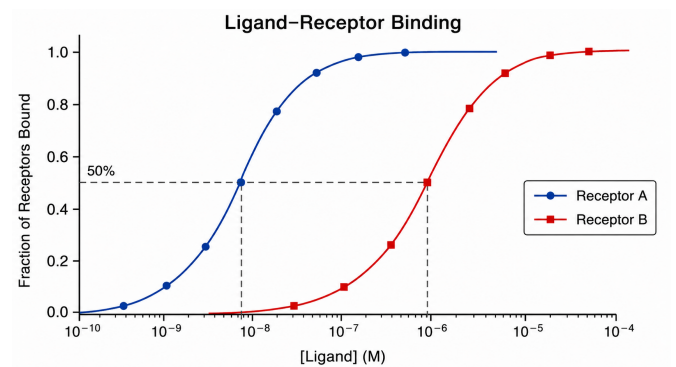
- ① contact-dependent signaling.
- ② direct intercellular signaling.
- ③ autocrine signaling.
- ④ paracrine signaling.
- ⑤ endocrine signaling.

3. The following table describes four types of cellular receptors.

Receptor	Description
A	Ligand binding directly causes ions to move across the plasma membrane.
B	Ligand binding activates G protein and leads to the production of a second messenger.
C	Ligand binding causes receptor dimerization and activates intracellular kinase domains.
D	The receptor is located in the cytoplasm or nucleus and binds a lipid-soluble signaling molecule.

Which of the following statements is correct?

- ① The ligand for receptor A must first cross the plasma membrane before binding to the receptor.
- ② Receptor B directly phosphorylates target proteins using its own kinase domain.
- ③ Receptor C may be an epidermal growth factor receptor, and ligand binding can induce receptor phosphorylation.
- ④ Receptor D must be located in the plasma membrane because its ligand is water-soluble.
- ⑤ Receptors A, B, C, and D are all activated only after their ligands enter the cytoplasm.



4. The graph shows the binding of the same ligand to receptor A and receptor B. Which of the following statements is correct?

- ① Receptor A has a higher affinity for the ligand because its K_d is smaller than that of receptor B.
- ② Receptor A has a larger K_d than receptor B because receptor A reaches saturation at a lower ligand concentration.
- ③ Receptor B has a smaller K_d than receptor A because B requires a higher ligand concentration for 50% binding.
- ④ Receptor B has a higher affinity for the ligand because a larger K_d indicates stronger ligand-receptor binding.
- ⑤ Receptors A and B have the same affinity because both eventually reach nearly 100% receptor occupancy.

5. Read the following passage and answer the question.

A drug inhibits a cytoplasmic relay protein that is normally activated after a signaling molecule binds to its receptor. The receptor can still bind the signaling molecule and undergo a conformational change, but the target cell no longer activates the transcription factors required for the cellular response.

Which of the following processes is most directly disrupted by the drug in the above situation?

- ① secretion of the signaling molecule
- ② receptor activation
- ③ signal transduction
- ④ ligand-receptor binding specificity
- ⑤ termination of the cellular response

6. In the Hershey-Chase experiment, bacteriophages with ^{32}P -labeled DNA were allowed to infect bacterial cells. After blending and centrifugation, most of the ^{32}P was detected in the bacterial pellet.

Which of the following conclusions is best supported by the result?

- ① Phage proteins enter bacterial cells and direct viral reproduction.
- ② Both phage DNA and protein remain outside bacterial cells.
- ③ Radioactive phosphorus is found only in phage proteins.
- ④ Bacterial DNA enters the phage during infection.
- ⑤ Phage DNA enters bacterial cells and contains genetic information.

7. Which of the following statements about DNA structure is correct?

- ① A DNA nucleotide consists of a phosphate group, ribose, and a nitrogenous base.
- ② Adenine and guanine are pyrimidines, whereas cytosine and thymine are purines.
- ③ Purines contain one ring, whereas pyrimidines contain two rings.
- ④ Each DNA strand consists of nucleotides joined by covalent bonds.
- ⑤ A DNA molecule maintains a uniform width because a purine always pairs with another purine.

8. Which of the following correctly compares DNA and RNA?

- ① DNA contains ribose, whereas RNA contains deoxyribose.
- ② DNA contains uracil, whereas RNA contains thymine.
- ③ Both DNA and RNA contain thymine as one of their nitrogenous bases.
- ④ DNA is usually double-stranded, whereas RNA is usually single-stranded.
- ⑤ DNA and RNA are both composed of amino acid monomers.

9. Three students are discussing how a new DNA strand is synthesized.

Sammy: "DNA polymerase adds new nucleotides to the 5' end of the growing strand."

Lengel: "No, Sammy. This is the policy of our body. DNA polymerase adds new nucleotides to the 3' end, so the new strand grows in the 5' to 3' direction."

Queenie: "(In a tone voice) I don't like that policy. DNA polymerase adds nucleotides to both ends, depending on the direction of the template strand."

Which student is correct?

- ① Sammy only
- ② Lengel only
- ③ Queenie only
- ④ Sammy and Lengel only
- ⑤ Lengel and Queenie only

10. A mutation causes RNA polymerase to lose its ability to function, while DNA polymerase remains normal. Which of the following processes will be directly affected?

- ① transcription only
- ② translation only
- ③ DNA replication only
- ④ both DNA replication and transcription
- ⑤ both transcription and translation

11. The following sequence is the template strand of a gene.

3' – TACGCACTTACT – 5'

Which of the following is the correct mRNA sequence transcribed from this DNA strand?

- ① 3' – AUGCGUGAAUGA – 5'
- ② 5' – ATGCCTGAATGA – 3'
- ③ 5' – AUGCGUGAAUGA – 3'
- ④ 5' – UACGCACUUACU – 3'
- ⑤ 3' – TACGCACTTACT – 5'

12. Examine the following two DNA sequences

Sequence 1: *ATGCGATGCTAGCAT*

Sequence 2: *ATGCGATGATAGCAT*

Then, use the figure below to answer the questions that follow.

		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } Ser UCC } UCA } UCG }	UAU } Tyr UAC } UAA } Stop UAG }	UGU } Cys UGC } UGA } Stop UGG }	U C A G
	C	CUU } CUC } CUA } CUG }	CCU } CCC } CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } CGA } CGG }	U C A G
	A	AUU } AUC } Ile AUA } AUG } Met	ACU } ACC } ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } GUA } GUG }	GCU } GCC } GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } GGA } GGG }	U C A G

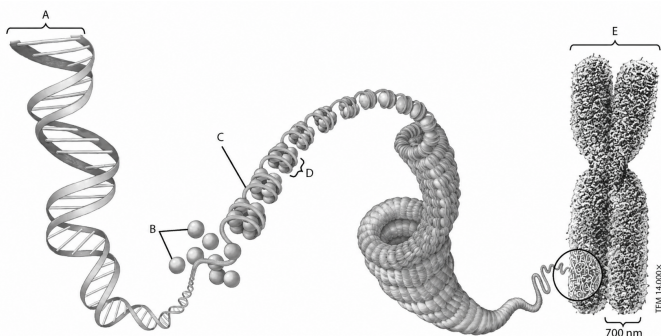
If both of these sequences code for proteins, how might the function of protein 2 differ from the function of protein 1?

- ① Protein 1 and protein 2 will function exactly the same.
- ② Protein 1 will be shorter than protein 2, so they will not function the same.
- ③ Protein 2 will be shorter than protein 1, so they will not function the same.
- ④ Protein 2 has a different sequence, so it will function differently from protein 1.
- ⑤ Protein 2 will contain one amino acid that differs from that of protein 1.

13. A nucleotide is inserted into the coding region of a gene near the beginning of the sequence. Which of the following is the most likely result?

- ① Only one amino acid in the protein will be changed.
- ② The mutation will have no effect because the genetic code is redundant.
- ③ Translation will stop only if the inserted nucleotide is thymine.
- ④ The reading frame will shift, changing many codons after the insertion.
- ⑤ The protein will always be longer than the normal protein.

14. Which structure in this figure shows one complete nucleosome?



- ① structure A
- ② structure B
- ③ structure C
- ④ structure D
- ⑤ structure E

15. A mutation changes the lac repressor so that it can still bind to the operator but can no longer bind to lactose. What will most likely happen when lactose is present?

- ① The lac genes will be transcribed continuously, regardless of lactose concentration.
- ② RNA polymerase will bind to the repressor and begin transcription.
- ③ Lactose will bind directly to the operator and activate transcription.
- ④ The repressor will detach from the operator, and the lac genes will be transcribed.
- ⑤ The repressor will remain bound to the operator, and the lac genes will not be transcribed.

16. A mutation prevents tryptophan from binding to the trp repressor. Which of the following will most likely occur when tryptophan is abundant in the cell?

- ① The repressor will become active and block transcription of the trp operon.
- ② The trp operon will be permanently deleted from the chromosome.
- ③ RNA polymerase will be unable to bind to the promoter because tryptophan is present.
- ④ Tryptophan will bind directly to the operator and stop transcription.
- ⑤ The repressor will remain inactive, and the genes for tryptophan synthesis will continue to be transcribed.

17. Both prokaryotic and eukaryotic cells use _____ to turn certain genes on or off

- ① activators
- ② enhancers
- ③ transcription factors
- ④ RNA polymerase
- ⑤ DNA polymerase

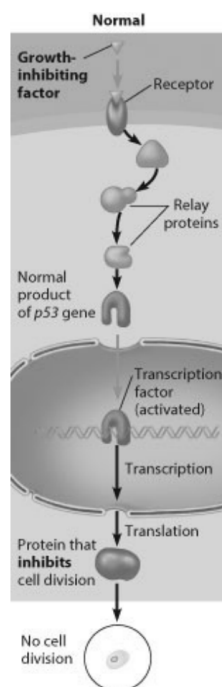
18. Which of the following correctly compares embryonic stem cells and adult stem cells?

- ① Embryonic stem cells can develop into a wider variety of specialized cell types than adult stem cells.
- ② Adult stem cells can form every cell type in the body, whereas embryonic stem cells can form only cells of one tissue.
- ③ Embryonic stem cells lack a complete set of genes, whereas adult stem cells contain all genes.
- ④ Adult stem cells are completely differentiated and can no longer divide.
- ⑤ Embryonic stem cells are found only in fully developed adult tissues.

19. During an experiment assessing the development of a fly embryo, a scientist artificially turns on a homeotic gene that controls eye development in somatic cells that normally develop into the wings. Which of the following is the most likely outcome of this experiment.

- ① A normal adult fly will develop.
- ② A mutant adult fly will develop that has legs on its head.
- ③ A mutant adult fly will develop that has eyes on its wings.
- ④ A mutant adult fly will develop that has no eyes on its head but has eyes on its wings.
- ⑤ The embryo will die because homeotic genes cannot function outside their normal tissues.

20. The figure below shows a normal cell transduction pathway. A mutation eliminates the receptor from the cell membrane. Which of the following best explains how this mutation could contribute to cancer?



- ① The absence of the receptor causes p53 to stimulate DNA replication directly.
- ② The cell can no longer respond to growth-inhibiting signals, so division may continue even when it should stop.
- ③ The mutation converts p53 into a growth factor that promotes cell division.
- ④ The growth-inhibiting factor enters the nucleus and permanently activates oncogenes.
- ⑤ The loss of the receptor prevents all transcription and causes immediate cell death.

[Free Response Questions]

Read the question carefully and completely. Answer must be written out in paragraph form. Bulletin lists, or diagrams alone are not acceptable.

1. The following DNA sequence represents the template strand of a gene. A codon chart is provided below the DNA sequence.

DNA template strand:

3' – TACCGATTTCTACT – 5'

(a) **Determine** the nucleotide sequence of mRNA transcribed from the DNA template strand. Clearly label the 5' and 3' ends of the mRNA. (3pts)

(b) **Identify** the amino acid sequence encoded by the mRNA. Begin with the start codon and terminate translation at the stop codon. (3pts)

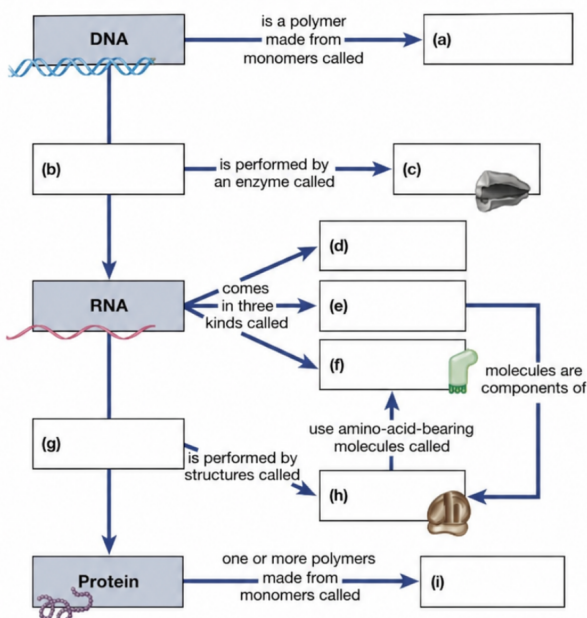
(c) **Explain** why RNA polymerase moves along the DNA template strand in the 3' to 5' direction while synthesizing mRNA in the 5' to 3' direction. (3pts)

(d) **Predict** the effect on the amino acid sequence if the ninth nucleotide of the DNA template strand is changed from T to C. **Justify** your prediction using the codon chart. (1pts)

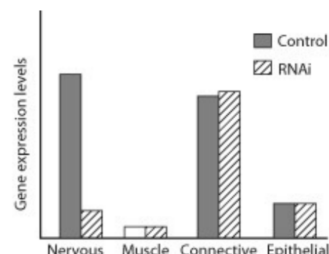
2. The diagram below summarizes the flow of genetic information in a cell. **Fill in each blank** (a) through (i) with the correct term or phrase. Each blank is worth 1 point.

CONNECTING THE CONCEPTS

1. Check your understanding of the flow of genetic information through a cell by filling in the blanks.



3. Gene knockdown is a procedure used to reduce gene expression in cells or organisms so that scientists can investigate gene function. While there are several ways to knock down gene expression, RNAi is one of the most commonly used approaches. Suppose that a research team wants to investigate where a new gene X is expressed in the fruit fly, *Drosophila melanogaster*. Using RNAi, they obtained the results shown below examining the expression of gene X in four types of tissues.



(a) **Identify** the tissue in which RNAi caused the greatest decrease in the expression of gene X. (1pt)

(b) **Describe** the effect of RNAi on the expression of gene X in other three tissues shown in the graph. (2pt)

(c) **Explain** how siRNA reduces the expression of gene X after transcription has occurred. (4pt)

(d) **State** one difference between siRNA and miRNA in how they bind to target mRNA. (3pt)

4. Scientists removed the nucleus from an unfertilized egg cell of one sheep. They then obtained a nucleus from a differentiated somatic cell of another adult sheep and inserted the somatic-cell nucleus into the egg cell. The reconstructed egg was stimulated to divide and eventually developed into a cloned sheep.

(a) **Describe** the process of nuclear transplantation used to produce the cloned sheep. (6pts)

(b) **Explain** what the successful development of the cloned sheep demonstrates about the nucleus of a differentiated somatic cell. (4pts)

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<Answers>

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[FRQ]

1.

(a) 5' – *AUGGCUAAAGGAUGA* – 3'

(b) Met-Ala-Lys-Gly

(c) RNA polymerase can add nucleotides only to the 3' end of the growing RNA strand. Therefore, mRNA is synthesized in the 5' → 3' direction. Because the DNA template strand and the mRNA strand are antiparallel, RNA polymerase must read the DNA template strand in the 3' → 5' direction.

(d) The mutation changes the mRNA codon from AAA to AAG. Both codons encode lysine, so the amino acid sequence remains unchanged. Therefore, the mutation is silent.

2. a. nucleotides; b. transcription; c. RNA polymerase; d. mRNA; e. rRNA; f. tRNA; g. translation; h. ribosomes; i. amino acids

3.

(a) Nervous tissue

(b) RNAi caused little or no change in gene X expression in muscle, connective, and epithelial tissues.

(c) The siRNA has a nucleotide sequence complementary to the mRNA of gene X. It binds to the target mRNA by complementary base pairing. The mRNA is then cleaved or degraded, so it cannot be translated into protein. Therefore, gene X expression decreases.

(d) siRNA usually bind to its target mRNA with complete or nearly complementarity, whereas miRNA usually binds with partial complementarity.

4.

(a) An unfertilized egg cell is obtained from a female sheep, and the nucleus is removed from the egg. A differentiated somatic cell is obtained from an adult sheep, and its nucleus is isolated. The somatic-cell nucleus is then inserted into the enucleated egg cell. The reconstructed egg is stimulated to begin mitotic cell division and develop into an embryo.

(b) The successful development of the cloned sheep demonstrates that the nucleus of a differentiated somatic cell retains the complete genetic information needed to produce an entire organism. During differentiation, cells do not normally lose genes. Instead, different cell types develop because different sets of genes are turned on or off.