



Biology Olympiad - Final Stage

- Exam consists of 20 multiple choice questions. No solutions are required. Every correct answer is worth 5 points.
- Duration is 1 hour. Pick your own strategy to win.
- Write your full name below and do not open the booklet until instructed to do so. Good luck!

FULL NAME:

1. Some features of cells are listed.

Which features are found in both animal and prokaryotic cells?

I. cytoplasm

II. cell surface membrane

III. ribosomes

A) I, II and III

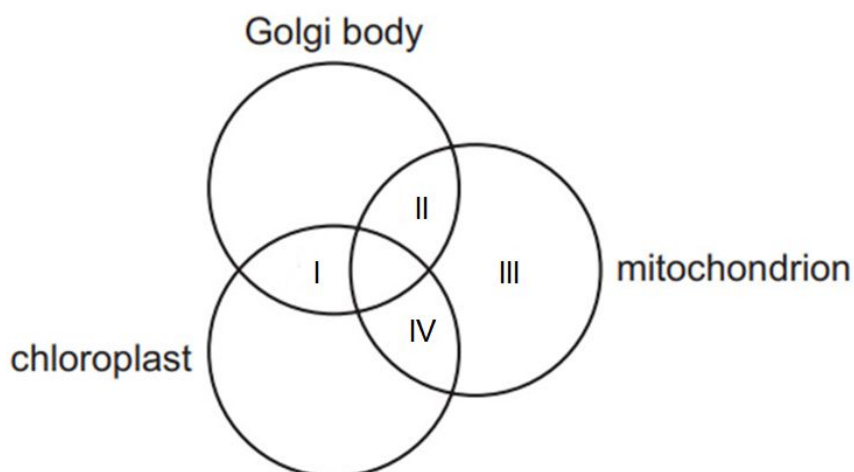
B) I and II

C) I and III

D) II and III

E) No answer

2. In which of these organelles is ATP synthesized?



A) I

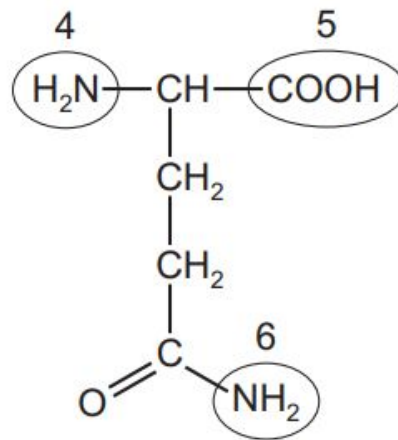
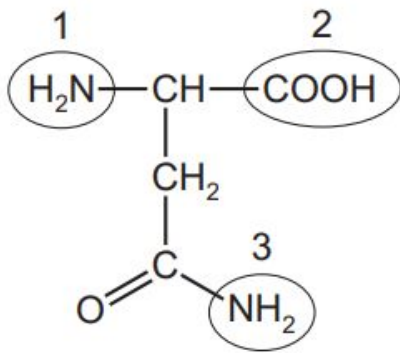
B) II

C) III

D) IV

E) No answer

3. The diagrams show the structures of two amino acids, each of which has two amine (-NH_2) groups.



A peptide bond is formed between the two amino acids.
Which groups could form the peptide bond?

- A) 1 and 4
- B) 1 and 5
- C) 2 and 6
- D) 3 and 5
- E) No answer

4. What is the correct sequence of stages in the mitotic cell cycle?

- A) $G1 \rightarrow G2 \rightarrow \text{mitosis} \rightarrow S \rightarrow \text{cytokinesis}$
- B) $G1 \rightarrow G2 \rightarrow S \rightarrow \text{mitosis} \rightarrow \text{cytokinesis}$
- C) $G1 \rightarrow S \rightarrow G2 \rightarrow \text{mitosis} \rightarrow \text{cytokinesis}$
- D) $S \rightarrow G1 \rightarrow \text{mitosis} \rightarrow G2 \rightarrow \text{cytokinesis}$
- E) No answer

5. The statements describe events during the mitotic cell cycle.

1. Chromosomes migrate to opposite poles of the spindle.
2. Chromosomes arrange themselves at the equator of the spindle.
3. Chromosomes condense and the nuclear membrane disappears.
4. Centromeres divide.

What is the correct order of three of these events in the mitotic cell cycle?

- A) $2 \rightarrow 3 \rightarrow 4$
- B) $3 \rightarrow 2 \rightarrow 4$
- C) $3 \rightarrow 4 \rightarrow 2$
- D) $4 \rightarrow 2 \rightarrow 1$
- E) No answer

6. Which statement about nitrogenous bases is correct?

- A) Adenine is a pyrimidine with a double ring structure.
- B) Cytosine is a purine with a double ring structure.
- C) Guanine is a purine with a single ring structure.
- D) Uracil is a pyrimidine with a single ring structure.
- E) No answer

7. Rifampicin is an antibiotic used to treat tuberculosis.

It works by inhibiting RNA polymerase in bacteria.

Which of these processes will be DIRECTLY inhibited by this antibiotic?

- 1. ATP synthesis
- 2. transcription
- 3. translation

- A) 1 and 2
- B) 1 and 3
- C) 2
- D) 3
- E) No answer

8. Which eyepiece and objective lens combination of a light microscope allows the greatest number of cells in a field of view to be seen?

- A) ×5 (eyepiece lens) and ×10 (objective lens)
- B) ×5 (eyepiece lens) and ×40 (objective lens)
- C) ×10 (eyepiece lens) and ×10 (objective lens)
- D) ×10 (eyepiece lens) and ×40 (objective lens)
- E) No answer

9. Cholesterol is an integral component of the cell surface membrane.

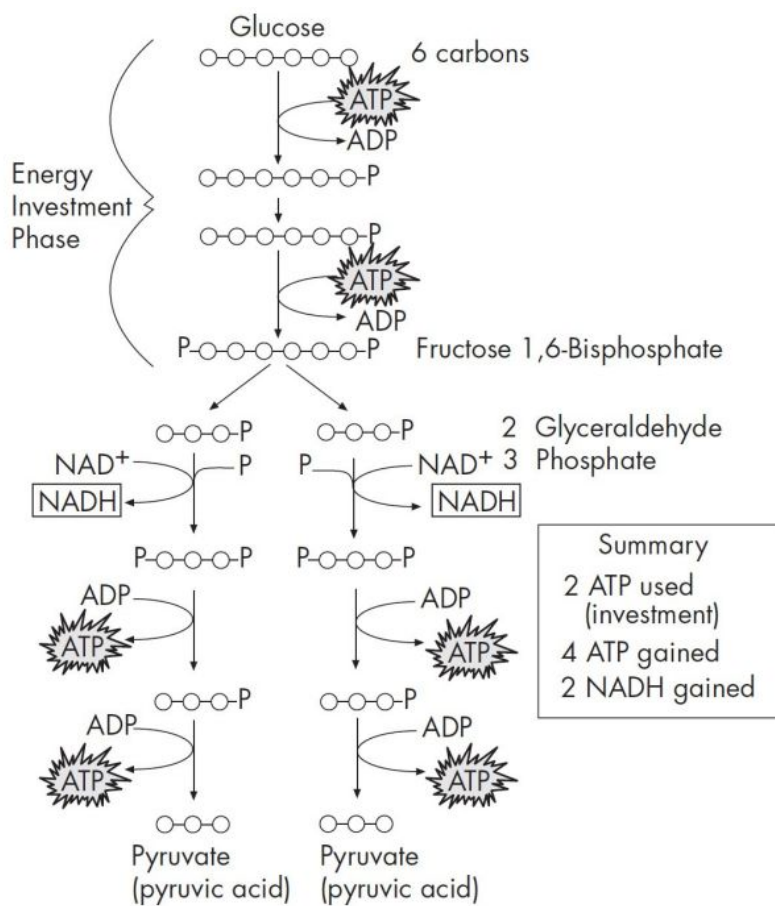
Which statement about cholesterol is correct?

- A) It allows ions to pass freely through the cell surface membrane.
- B) It has a hydrophobic head and hydrophilic tails.
- C) It helps to regulate the fluidity of the cell surface membrane.
- D) It reduces the mechanical stability of the phospholipid bilayer.
- E) No answer

10. 21.2% of the bases in a molecule of DNA are cytosine.
What percentage would be adenine?

- A) 21.2%
- B) 28.8%
- C) 42.4%
- D) 57.6%
- E) No answer

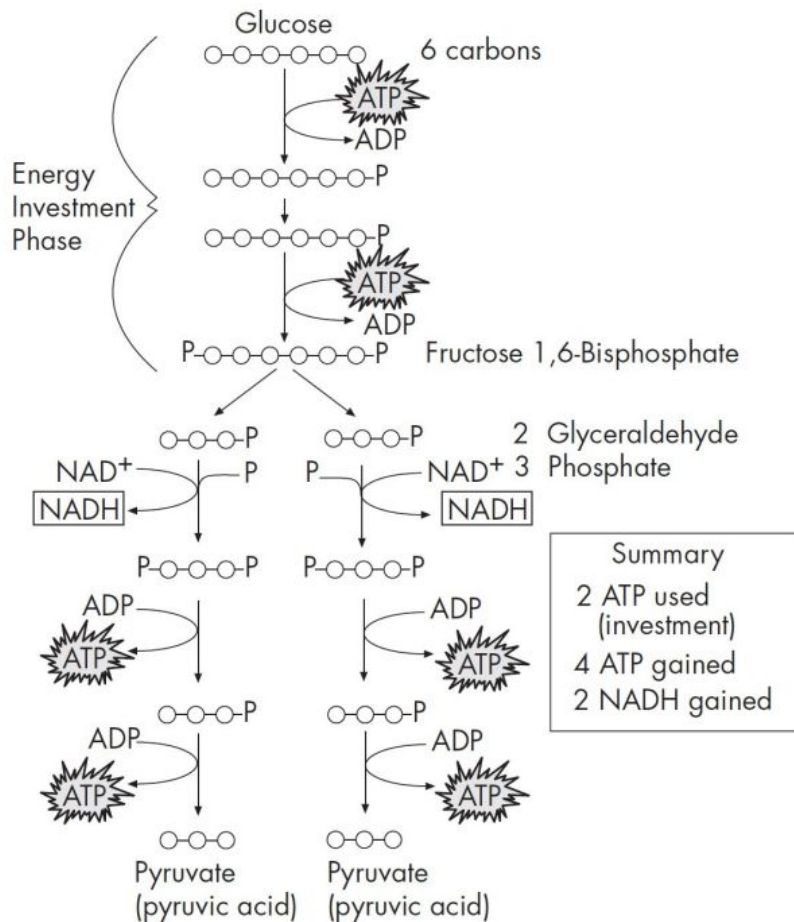
11. Glycolysis (shown below) is a critical metabolic pathway that is utilized by nearly all forms of life. The process of glycolysis occurs in the cytoplasm of the cell and converts 1 molecule of glucose into 2 molecules of pyruvic acid.



How many net ATP would be generated directly from glycolysis from the breakdown of 2 glucose molecules?

- A) 2
- B) 4
- C) 8
- D) 12
- E) No answer

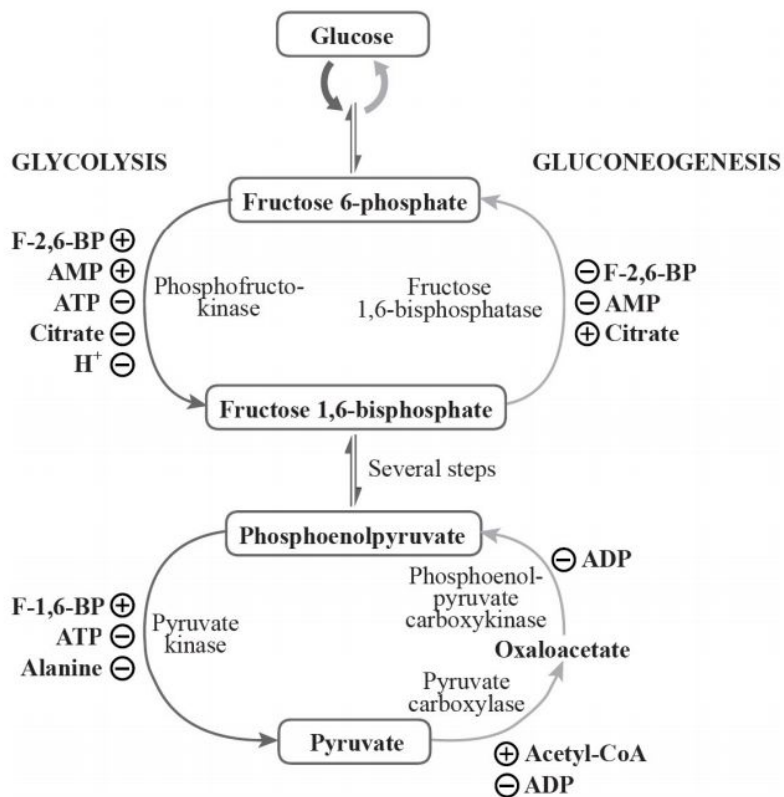
12. Glycolysis (shown below) is a critical metabolic pathway that is utilized by nearly all forms of life. The process of glycolysis occurs in the cytoplasm of the cell and converts 1 molecule of glucose into 2 molecules of pyruvic acid.



Which of the following most accurately describes the net reaction of glycolysis?

- A) It is an endergonic process because it results in a net increase in energy.
- B) It is an exergonic process because it results in a net increase in energy.
- C) It is an endergonic process because it results in a net decrease in energy.
- D) It is an exergonic process because it results in a net decrease in energy.
- E) No answer

13. Diabetes mellitus is a disease characterized by an inability of the cells to properly produce (type I) or respond (type II) to insulin, a hormone produced by the pancreas in response to high levels of blood glucose. Without insulin, glucose accumulates in the blood. In situations of low blood glucose, another pancreatic enzyme, glucagon, is released, which triggers the process of gluconeogenesis shown on the right side of the pathway below. The stimulators and inhibitors of each step are shown with (+) and (-) signs, respectively.



Which of the following conditions would lead to increased production of fructose 1,6-bisphosphate?

- I. High AMP and high F-2,6-BP
- II. High AMP and high citrate
- III. High ATP and high citrate

- A) I
- B) I and II
- C) II and III
- D) I, II and III
- E) No answer

14. Taq polymerase, a DNA polymerase derived from thermophilic bacteria, is used in polymerase chain reactions (PCR) in the laboratory. During PCR, Taq catalyzes DNA polymerization, similar to how it would in bacteria. A normal PCR cycle is as follows:

1. Melting/Denaturing 95°C
2. Primer Annealing 50°C
3. Elongation of DNA (repeat 20–30 cycles) 72°C

Which of the following conditions likely describes the living environment of Taq bacteria?

- A) Freshwater with acidic pH
- B) Hydrothermal vents reaching temperatures between 70–75°C
- C) Hot springs of 40°C
- D) Tide pools with high salinity
- E) No answer

15. A geneticist has discovered a yeast cell, which encodes a DNA polymerase that may add nucleotides in both the 5' to 3' and 3' to 5' directions. Which of the following structures would this cell not likely generate during DNA replication?

- A) RNA primers
- B) Okazaki fragments
- C) Replication fork
- D) Nicked DNA by topoisomerases
- E) No answer

16. A eukaryotic gene, which does not normally undergo splicing, was exposed to benzopyrene, a known carcinogen and mutagen. Following exposure, the protein encoded by the gene was shorter than before exposure.

Which of the following types of genetic rearrangements or mutations was likely introduced by the mutagen?

- A) Silent mutation
- B) Missense mutation
- C) Nonsense mutation
- D) Duplication
- E) No answer

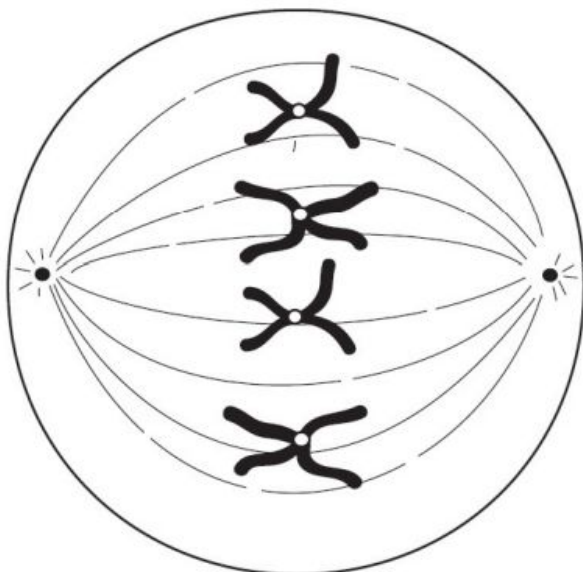
17. Griffith was a researcher who coined the term transformation when he noticed that incubating nonpathogenic bacteria with heat-killed pathogenic bacteria produced bacteria that ultimately became pathogenic, or deadly, in mice.

What caused the transformation in his experiment?

- A) DNA from the nonpathogenic bacteria revitalized the pathogenic bacteria.
- B) Protein from the pathogenic bacteria was taken up by the nonpathogenic bacteria.
- C) DNA from the pathogenic bacteria was taken up by the nonpathogenic bacteria.
- D) DNA in the nonpathogenic bacteria turned into pathogenic genes in the absence of pathogenic bacteria.
- E) No answer

18. A scientist is testing new chemicals designed to stop the cell cycle at various stages of mitosis. Upon applying one of the chemicals, she notices that all of the cells appear as shown below.

Which of the following best explains how the chemical is likely acting on the cells?



- A) The chemical has arrested the cells in prophase and has prevented attachment of the spindle fibers to the kinetochore.
- B) The chemical has arrested the cells in metaphase and has prevented dissociation of the spindle fibers from the centromere.
- C) The chemical has arrested the cells in metaphase and is preventing the shortening of the spindle fibers.
- D) The chemical has arrested the cells in anaphase and is preventing the formation of a cleavage furrow.
- E) No answer

19. Which of the following statements is true?

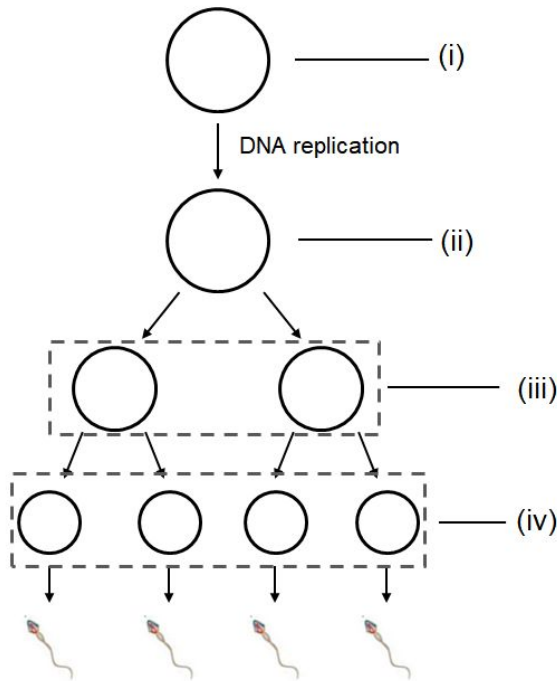
The Figure below shows the formation of sperm from the cell (i) in G1 phase of the cell cycle in a certain animal with a genotype EeFFHh. The table shows the amounts of DNA per cell of genes e, F, and h. ①~④ represent (i)~(iv) without considering the order. E and e, F and F, H and h are alleles, respectively.

(Mutations and crossing over are not considered.)

(E, e, F, H, h □ the relative amount of DNA per each is the same.)

(Note that (iii) can be either of the two circles.)

(Note that (iv) can be any of the four circles.)



Cell	Amount of DNA		
	e	F	h
①	a	1	1
②	1	2	b
③	2	c	0
④	d	4	2

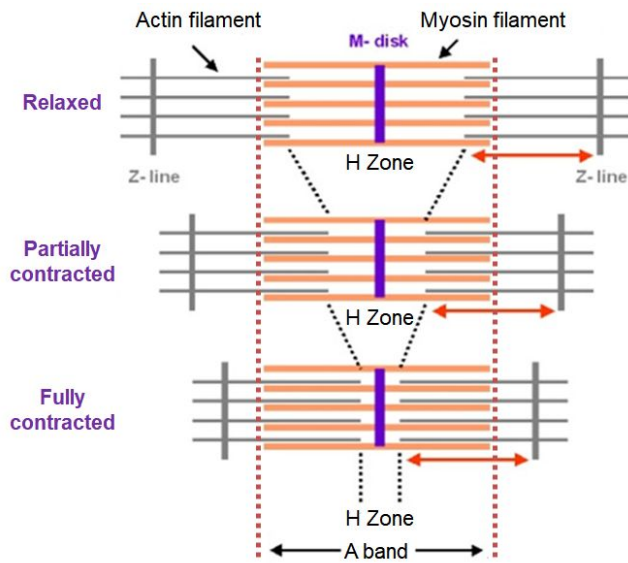
I. The cell ③ is the cell (iii).

II. a+b+c+d = 4

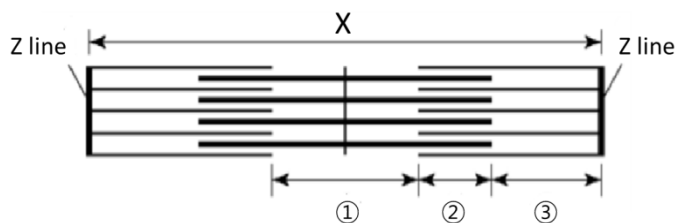
III. In (iv), $\frac{\text{The amount of DNA of F}}{\text{The amount of DNA of E} + \text{The amount of DNA of H}} = 1$

- A) I
- B) I and II
- C) I and III
- D) I, II and III
- E) No answer

20. The figure below shows the skeletal muscle contraction process. (It is related to the movement of active filament and myosin filament.) A band is the entire length of the myosin filament of the sarcomere. H-zone is the length of A-band without actin filaments.



The following is data from the skeletal muscle contraction process. The figure shows the structure of the muscle fiber, and the table shows the length of ① and the length of ② (①+②) and ③ at two time points t1 and t2 of the skeletal muscle contraction process. X is a left-right symmetry, and when t1, the length of A band is 1.8 μm .



Time points	① + ②	③
t1	1.3 μm	0.8 μm
t2	?	0.6 μm

Section ① is the part with only myosin filaments without the overlap of actin filaments, ② is the part where actin filaments overlap with myosin filaments, ③ is the part with only actin filaments.

Which of the following statements is true?

- I. When t1, the length of X is 3.4 μm .
 - II. The length of (X - ①) (when t1) < The length (X - ①) (when t2)
 - III. When t2, length of H zone / Length of (② + ③) = 4/13
- (Please refer to the figure showing the muscle contraction process above.)

- A) I
- B) I and II
- C) I and III
- D) I, II and III
- E) No Answer