

1. Answer all the questions in the question paper.
2. Answer ALL of the questions in the test book.
3. Work neatly
4. Read your questions carefully.
5. Good Luck.

Please read the following instructions carefully:

NUMBER OF PAGES: 20 PAGES

TOTAL MARKS:

150

DURATION:

3 HOURS

INTERNAL MODERATOR:

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26 NOVEMBER 2016

DEPARTMENT BOTANY AND PLANT BIOTECHNOLOGY

BIO1A1E

BIOLOGY EXTENDED 1A

APK CAMPUS

NOVEMBER 2016 EXAM

MEMORANDUM

26 NOVEMBER 2016

FACULTY OF SCIENCE



BIO1A1E NOVEMBER EXAM 2016

QUESTION 1

[20]

Choose the alternative that best completes the statement or answers the question. Only write down the correct letter next to the question number in your answer book.

- 1.1 All the organisms on your campus make up _____
- A) an ecosystem.
B) a community.
 C) a population.
 D) an experimental group.
 E) a taxonomic domain.
- 1.2 Evolution is biology's core theme that ties together all the other themes. This is because evolution explains _____
- A) the unity and diversity of life.
 B) how organisms become adapted to their environment through the differential reproductive success of varying individuals.
 C) why distantly related organisms sometimes resemble each other.
 D) explains why some organisms have traits in common.
E) all of the above
- 1.3 A slice of pizza has 500 kcal. If we could burn the pizza and use all the heat to warm a 50-L container of cold water, what would be the approximate increase in the temperature of the water? (Note: A liter of cold water weighs about 1 kg.)
- A) 50°C
 B) 5°C
C) 10°C
 D) 100°C
 E) 1°C
- 1.4 Equal volumes of vinegar from a freshly-opened bottle are added to each of the following solutions. After complete mixing, which of the mixtures will have the highest pH?
- A) 100 mL of pure water.
 B) 100 mL of freshly-brewed coffee.

C) 100 mL of household cleanser containing 0.5M ammonia.

D) 100 mL of freshly-squeezed orange juice.

E) 100 mL of tomato juice.

1.5 Altering which of the following levels of structural organization could change the function of a protein?

A) Primary

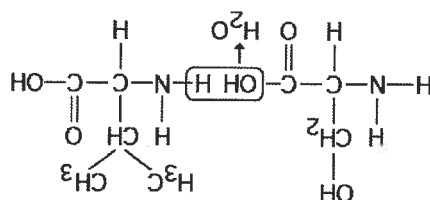
B) Secondary

C) Tertiary

D) Quaternary

E) All of the above

1.6 Which of the following statement(s) is/are true regarding the chemical reaction illustrated in the diagram below?



A) It is a hydrolysis reaction.

B) It results in a peptide bond.

C) It joins two fatty acids together.

D) A and B only

E) A, B, and C

1.7 Which of the following statements correctly describe some aspect of protein disposal from prokaryotic cells?

A) Prokaryotes are unlikely to be able to excrete proteins because they lack an

endomembrane system.

B) The mechanism of protein excretion in prokaryotes is probably the same as that

in eukaryotes.

C) Proteins that are excreted by prokaryotes are synthesized on ribosomes

that are bound to the cytoplasmic surface of the plasma membrane.

- 1.8 Which of the following produces and modifies polysaccharides that will be secreted?
- A) Lysosome
 - B) Vacuole
 - C) Mitochondrion
 - D) Golgi apparatus
 - E) Peroxisome
- 1.9 True or false: The breakdown of food molecules in the gut does not require coupling of ATP hydrolysis, but enzymes are required to speed up these spontaneous reactions.
- A) True
- B) False, because enzymes change the ΔG to a negative value
- C) False, because enzymes are not required, as breakdown is spontaneous and spontaneous reactions always occur very rapidly.
- 1.10 Vioxx and other prescription nonsteroidal anti-inflammatory drugs (NSAIDs) are potent inhibitors of the cyclooxygenase-2 (COX-2) enzyme. High substrate concentrations reduce the efficacy of inhibition by these drugs. These drugs are _____
- A) competitive inhibitors.
- B) noncompetitive inhibitors.
- C) allosteric regulators.
- D) prosthetic groups.
- E) feedback inhibitors.
- 1.11 Cellular respiration can best be described as _____
- A) using energy released from breaking high-energy covalent bonds in organic molecules to force ATP formation from ADP and phosphate.
- B) taking electrons from food and giving them to phosphate to make ATP.

- C) taking electrons from food and giving them to oxygen to make water and using the energy released to drive ATP formation.
- D) converting higher-energy organic molecules to lower-energy organic molecules and using the energy released to drive ATP formation.
- 1.12 Newborn mammals have a specialized organ called brown fat, where cells burn fat to CO_2 without capturing the energy to reduce electron carriers or drive ATP formation. How can this energy be used instead?
- A) To synthesize glucose from CO_2
- B) To directly power muscle contraction.
- C) To provide energy for endergonic biosynthetic reactions.
- D) To generate heat.
- 1.13 Assume a thylakoid is somehow punctured so that the interior of the thylakoid is no longer separated from the stroma. This damage will have the most direct effect on which of the following processes?
- A) The splitting of water.
- B) The absorption of light energy by chlorophyll.
- C) The flow of electrons from photosystem II to photosystem I.
- D) The synthesis of ATP.
- E) The reduction of NADP^+ .
- 1.14 Which of the following statements best represents the relationships between the light reactions and the Calvin cycle?
- A) The light reactions provide ATP and NADPH to the Calvin cycle, and the cycle returns ADP , P_i , and NADP^+ to the light reactions.
- B) The light reactions provide ATP and NADPH to the carbon fixation step of the Calvin cycle, and the cycle provides water and electrons to the light reactions.
- C) The light reactions supply the Calvin cycle with CO_2 to produce sugars, and the Calvin cycle supplies the light reactions with sugars to produce ATP.
- D) The light reactions provide the Calvin cycle with oxygen for electron flow, and the Calvin cycle provides the light reactions with water to split.

E) There is no relationship between the light reactions and the Calvin cycle.

1.15 You have in your possession a microscope slide with meiotic cells on it and a light microscope. What would you look for if you wanted to identify metaphase I cells on the slide?

- A) A visible nuclear envelope.
- B) Separated sister chromatids at each pole of the cell.
- C) Tetrads lined up at the centre of the cell.
- D) A synaptonemal complex.
- E) A cleavage furrow.

1.16 How does the sexual life cycle increase the genetic variation in a species?

A) By allowing independent assortment of chromosomes.

- B) By allowing fertilization.
- C) By increasing gene stability.
- D) By conserving chromosomal gene order.
- E) By decreasing mutation frequency.

1.17 John, age 47, has just been diagnosed with Huntington's disease, which is caused by a dominant allele. His daughter, age 25, now has a 2-year-old son. No one else in the family has the disease. What is the probability that the daughter will contract the disease?

- A) 0%
- B) 25%
- C) 50%
- D) 75%
- E) 100%

1.18 ABO blood type in humans exhibits codominance and multiple alleles. What is the likelihood of a type A father and a type A mother having a type O child?

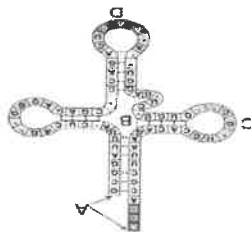
- A) It is impossible.
- B) 25% if both parents are heterozygous
- C) 50% if both parent are heterozygous

- D) 25% if only the father is heterozygous
E) 25% if only the mother is heterozygous

1.19 Which of the following is not a modification made to eukaryotic mRNA before it goes to the cytosol?

- A) The 5' end is capped
B) A poly-A tail is added to the 3' end
C) Introns are removed
D) Exons are joined together
E) Spliceosomes are removed

1.20 Which of the following is incorrectly identified in the figure below?



- A) 5' and 3' ends
B) Hydrogen bond
C) Amino acid attachment site
D) Anticodon loop

QUESTION 2

[20]

Give the correct biological term for each of the following definitions. Only write down the correct term next to the appropriate question number in your answer book.

2.1 The term used for all the individuals of a species living in a specific area at a specific time. Population

2.2 The type of scientific reasoning whereby one draws general conclusions from many observations. Inductive reasoning

2.3 Deficiency of this element prevents production of thyroid hormones, resulting in the formation of a goiter. **Iodine**

2.4 The chemical bond that forms when sodium and chloride react. **Ionic bond**

2.5 The major component in cell membranes. **Phospholipid**

2.6 A protein that acts as a catalyst to speed up chemical reaction without being consumed by the reaction. **Enzyme**

2.7 The first person to describe a sperm cell. **Antoni van Leeuwenhoek**

2.8 Part of the cytoskeleton which reinforce cell shape and anchor organelles. **Microfilaments**

2.9 Groove or pocket on the surface of an enzyme. **Active site**

2.10 The process whereby hydrolysis of ATP releases energy by transferring its third phosphate from ATP to some other molecule. **Phosphorylation**

2.11 The type of bacteria which carry out fermentation and cannot survive in the presence of O_2 . **Obligate anaerobes**

2.12 The site of glycolysis. **Cytoplasm**

2.13 The five (5) carbon molecule which accepts carbon dioxide during the dark phase of photosynthesis (do not write an abbreviation). **Ribulose biphosphate**

2.14 The protein responsible for transferring photons during the light phase of photosynthesis. **Photosystem**

2.15 The failure of chromosomes or chromatids to separate normally during meiosis. **Non disjunction**

2.16 The division of the cytoplasm. **Cytokinesis**

2.17 An early explanation for inheritance suggested by Hippocrates. **Pangenesis**

2.18 The appearance or physical expression of a trait. **Phenotype**

2.19 The beginning of the DNA code which signals the starting point of transcription.

Promotor

2.20 The projecting spikes around an animal virus. Glycoprotein

QUESTION 3

[11]

3.1 The diversity of life can be arranged into three (3) domains. Explain this statement.(6)

○ The diversity of life is divided into three domains according to their main

structure e.g.

- Bacteria are the most diverse and widespread prokaryotes
- Archaea are prokaryotes that often live in Earth's extreme environments (Primitive bacteria)
- Eukarya have eukaryotic cells and include

- single-celled protists and
- multicellular fungi, animals, and plants.

3.2.1 What is proven to be the lowest level of biological organization that can perform all the activities required for life?

Cell

3.2.2 Name and distinguish between the two (2) basic forms of the answer given in question 3.2.1. (8 x ½ = 4)

○ Prokaryotic cells

- were the first to evolve,

- are simpler, and

- are usually smaller than eukaryotic cells.

○ Eukaryotic cells

- contain membrane-enclosed organelles,

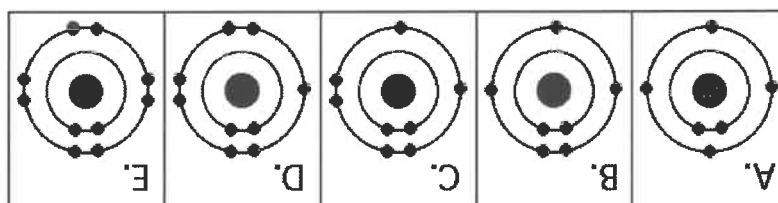
- including a nucleus containing DNA,

- are found in plants, animals, and fungi

QUESTION 4

[11]

4.1. Please refer to the diagram below to answer the following questions.



4.1.1 Which drawing depicts the electron configuration of neon ($^{20}_{10}\text{Ne}$)?

E

4.1.2 Which drawing depicts the electron configuration of oxygen ($^{16}_8\text{O}$)?

C

4.1.3 Which drawing depicts the electron configuration of nitrogen ($^{14}_7\text{N}$)?

B

4.1.4 Which drawing is of an atom with the atomic number of 6?

A

4.1.5 Which drawing depicts an atom that is inert or chemically unreactive?

E

4.1.6 Which drawing depicts an atom with a valence of 3?

B

4.1.7 Which drawing depicts an atom with a valence of 2?

C

4.2 In addition to benefits, there are also dangers associated with using radioactive substances. Briefly discuss this statement critically.

(2)

- Uncontrolled exposure can cause damage to some molecules in a living cell, especially DNA.
- Chemical bonds are broken by the emitted energy, which causes abnormal bonds to form.

4.3 Why do astrobiologists believe that there once was life on Mars? (1)

They found evidence of water

4.4 What forces is utilized by a gecko to walk on walls? (1)



Van der Waals interactions

QUESTION 5

[11]

5.1 Name and distinguish between the lipids found in the plasma membrane and the lipids found in bacon. Tabulate your answer. (4)

<u>Phospholipids</u>	<u>Triglycerides or fats</u>
<u>Have a phosphate group</u>	<u>No phosphate group</u>
<u>Have a glycerol</u>	<u>Have a glycerol</u>
<u>Contains 2 fatty acids</u>	<u>Contain 3 fatty acids</u>

5.2 Why is it beneficial to buy cotton towels rather than nylon towels? (4)

Cotton towels consist of cellulose which is a polysaccharide and therefore very hydrophilic (water-loving) therefore it is very water absorbent.

5.3 Distinguish between the following:

5.3.1 Aldoses and Ketoses

(2 x ½ = 1)

- 6.3 Eukaryotic cell structures can be grouped on the basis of four (4) functions. Briefly mention these basic functions. (4)
- 6.2 How do adjacent cells communicate, interact, and adhere to one another? (5)
- 6.1 In developed countries over the last 50 years, there has been a decline in human sperm quality. Give possible reasons for this. (2 x ½ = 1)
- QUESTION 6** [11]

- Maltose – disaccharide consisting of 2 glucose molecules bonded with a glycosidic bond**
- Sucrose – disaccharide consisting of 1 glucose and 1 fructose molecules bonded together with a glycosidic bond**
- 5.3.3 Maltose and Sucrose (2 x ½ = 1)
- 5.3.2 Pentose and Hexoses (2 x ½ = 1)
- Aldoses: Position of carbonyl group – aldehyde (C1)
 - Ketoses: Position of carbonyl group – Ketone (C2)
 - Pentose: Sugar with 5 C in its structure
 - Hexose: Sugar with 6 C in its structure

- 6.4 Why are peroxisomes important to a cell? (1)
- genetic control,
 - manufacturing, distribution, and breakdown,
 - energy processing, and
 - structural support, movement, and communication between cells.
- It breaks down toxic hydrogen peroxide by products.

QUESTION 7

[11]

- 7.1 Study the diagram of a U-tube with 50% sugar solution in side A, separated by a selectively permeable membrane that only allows water to pass through, and a 70% sugar solution in side B.

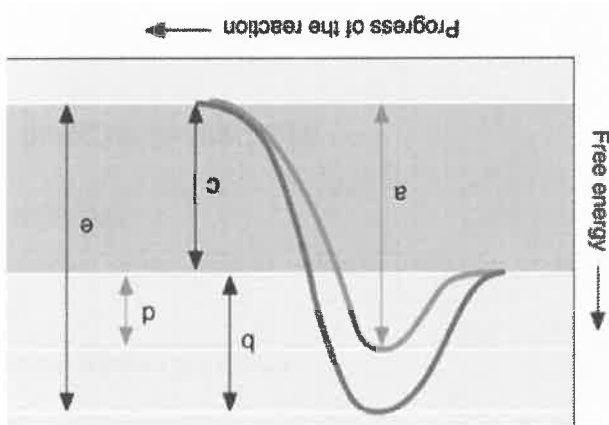


- 7.1.1 What process will occur across the selectively permeable membrane? (½)

Osmosis

- 7.1.2 Explain and briefly discuss what will happen in the next few minutes if this tube is left undisturbed. (5)

- Water will move from side A to side B.
 - Side A has 50% water and Side B 30% water – side A has a higher WP than side B.
 - Therefore water will move from a high WP in A to a low WP in B.
 - Decreasing the water level of A
 - Increasing the water level in B.
- Study the energy diagram below and answer the questions that follow.



7.2.1 Supply labels for a, b, c, d and e. (5)

- Total energy used when an enzyme is present (catalysed reaction)
- activation energy for an uncatalysed reaction
- difference in free energy/ ΔG
- Activation energy of a catalysed reaction
- Total energy of an uncatalysed reaction.

7.2.2 Which of the energy changes would be the same in both the enzyme-catalysed and uncatalysed reactions? (1/2)

C – amount of free energy

QUESTION 8

[11]

8.1 Compare the reactants, products, and energy yield of the three (3) stages of cellular respiration by completing the following table (redraw table in your answer book).

(18 x 1/2 = 9)

First stage: _____	Glycolysis		
Second stage: _____	Citric acid cycle/ Kreb Cycle		
Third stage: _____	Oxidative phosphorylation/ Hydrogen transfer system		

- ❖ Some energy is then used to photophosphorylate ADP to generate ATP.
 - ❖ The hydrogen reduces NADP⁺ to NADPH
 - ❖ Oxygen is released as a byproduct – diffuse through stomata into atmosphere.
- $$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$$
- ❖ Firstly used to split water – into hydrogen & oxygen.

9.1 Explain in detail how potential energy is used during the light phase of photosynthesis (6)

QUESTION 9 [11]

- block the electron transport chain (for example, rotenone, cyanide, and carbon monoxide).
 - inhibit ATP synthase (for example, the antibiotic oligomycin), or make the membrane leaky to hydrogen ions (called uncouplers, examples include dinitrophenol).
- Any 2
- 8.2 Three (3) categories of cellular poisons obstruct the last phase of cellular respiration. Briefly explain the functioning of two (2) of these poisons and give a commercial example of each.
- (4 x 1/2 = 2)

Reactants	Products	Energy yield
Glucose	NADH	2 x ATP
Pyruvate	Pyruvate	ATP
	Carbon dioxide	NADH
	Water	ATP
	Oxygen	36 x ATP

9.2 What is another name for the dark phase of photosynthesis? (1)

• **Calvin cycle**

9.3 Plants are green because they contain chlorophyll. Where will one find the chlorophyll in the plant? (2)

In the mesophyll cells of the leaves in the thylakoid membrane of the chloroplasts

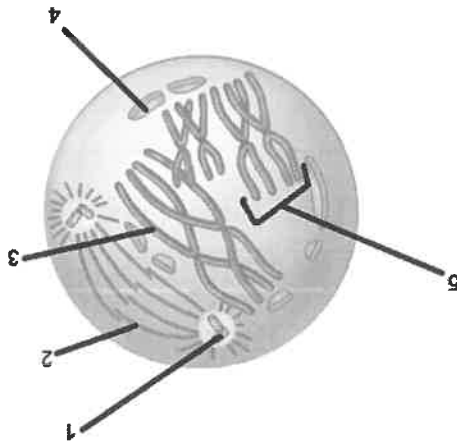
9.4 Why is photosynthesis vitally important to the human race survival? (2)

Enable plants to give us oxygen and food

QUESTION 10

[11]

10.1 Study the diagram below and answer the questions that follow.



10.1.1 What type of cell division is illustrated in the diagram above? Give a good, visual reason for your answer. (2)

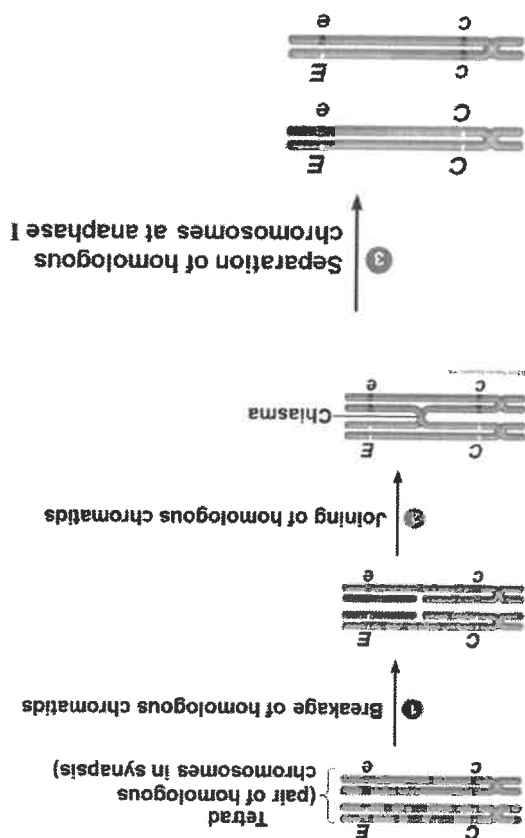
Meiosis – Homologous chromosomes lie next to one another.

10.1.2 What phase is illustrated in the diagram? (1)

Prophase I

10.1.3 Name and briefly discuss the process that occurs at the structures labeled 5? Draw diagrams to aid your explanation. (7)

- Crossing over
- is an exchange of corresponding segments between separate (nonsister) chromatids on homologous chromosomes.
- Nonsister chromatids join at a chiasma (plural, chiasmata), the site of attachment and crossing over.
- Corresponding amounts of genetic material are exchanged between maternal and paternal (nonsister) chromatids.



- 10.2 Chronic myelogenous leukemia (CML) is one of the most common leukemias and affects cells that give rise to white blood cells (leukocytes). What problem or mistake will result in CML?
- Results from part of chromosome 22 switching places with a small fragment from a tip of chromosome 9.
- (1)

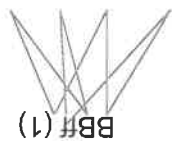
QUESTION 11

[11]

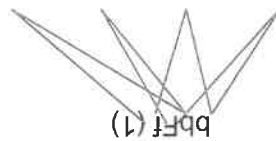
11.1 In humans, dark eye colour is dominant (B) while blue eyes are recessive (b). Having freckles is dominant (F), while a clear complexion (no freckles) is recessive (f). Show the dihybrid cross (using Punnett squares) between a blue-eyed mother with freckles (heterozygous for freckles) and a homozygous dark-eyed father without freckles.

$$(24/3 = 8)$$

Bf Bf Bf Bf (1)



Gametes(1) bF(1) bF(1) bF(1) bF(1)



Meiosis (1)

Fertilization (1)

F1-generation(1)

(1)

bF	BbFf	BbFf	BbFf	BbFf	BbFf	(1)
Bf	BbFf	BbFf	BbFf	BbFf	BbFf	(1)
bF	BbFf	BbFf	BbFf	BbFf	BbFf	(1)
Bf	BbFf	BbFf	BbFf	BbFf	BbFf	(1)
bF	BbFf	BbFf	BbFf	BbFf	BbFf	(1)
Bf	BbFf	BbFf	BbFf	BbFf	BbFf	(1)

Genotypes (1): 8 x BbFf (1); 8 x Bbff (1)

Phenotypes (1): 8 x Dark eyes with Freckles(1), 8 x Dark eyes without Freckles (1)

Ratio : 1:1 (1)

11.2 In guinea pigs, the allele for short hair is dominant (R).

11.2.1 What genotype would a heterozygous short haired guinea pig have? (1)

Rr

11.2.2 What genotype would a purebreeding short haired guinea pig have? (1)

RR

11.3 A dominant human disorder resulting in dwarfism. Achondroplasia (1)

QUESTION 12

[11]

12.1 How is the pre-m-RNA modified in Eukaryotic cells before translation can begin?

(6 x ½ = 3)

Each end of a pre-mRNA molecule is modified in a particular way:

- 5' end receives a modified nucleotide 5' cap
- 3' end gets a poly-A tail

○ RNA splicing

○ removes introns (non-coding RNA) &

○ joins exons (coding RNA).

○ creating an mRNA molecule with a continuous coding sequence.

12.2 tRNAs are specific to their function. By referring to this statement, how do t-RNA molecules differ?

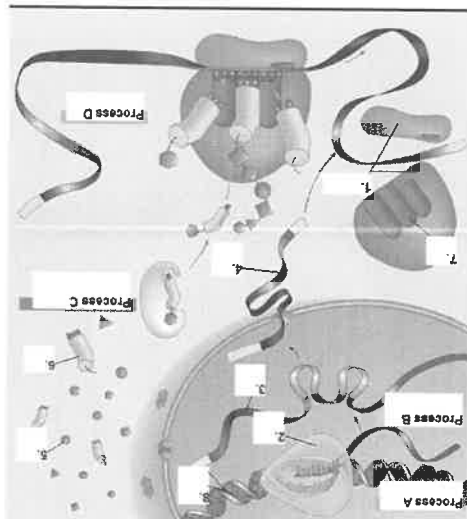
(3)

• Each carries a specific amino acid on 1 end.

• Each has an anticodon on the other end.

• the anticodon base-pairs with a complementary codon on mRNA

12.3 Study the diagram of protein synthesis and answer the questions that follow.



12.3.1 Label the processes A and D and label structures 1 – 8.

(10 x ½ = 5)

PROCESS A	PROCESS D
Transcription	Translation
1.	Ribosome units
2.	RNA polymerase
3.	Pre mRNA
4.	mRNA
5.	Amino Acid
6.	tRNA
7.	P site
8.	DNA

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