

Practice Test on Cell Biology (the REAL test is on Friday the 17th) – KEY

LO: Describe and explain the Central Dogma. SLE: Meet NGSS.

On the real test, you will be given this chart of the genetic code (from openstax.org/details/biology).

NOTES:

1. This practice test is most useful if you first attempt it on your own, then check your answers afterward.

2. Some answers below are far more thorough than I would expect you to write! I am giving you my full answer to be as clear as possible.

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

1. Translate the following DNA sequence into an amino acid sequence:

A-C-C-G-C-C-G-A-A-G-A-G-C-C-C

1st transcribe to RNA:

U-G-G, C-G-G, C-U-U, C-U-C, G-G-G

Then translate to amino acids:

Trp --- Arg ---- Leu --- Leu --- Gly

2. Complete this sentence:

Osmosis is the diffusion of WATER through a SEMI-PERMEABLE membrane.

3a. Complete this chemical equation:

C₆H₁₂O₆ + 6O₂ → 6CO₂ + 6H₂O + energy (recaptured as ATP)

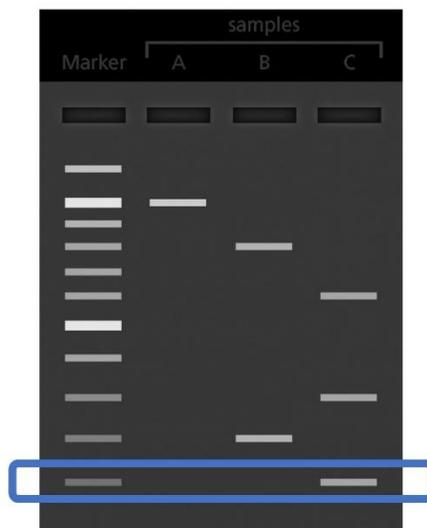
3b. What process does this chemical equation represent? Respiration

3c. Where in eukaryotic cells does this process take place?

- a. cell membrane b. chloroplasts c. mitochondria d. nucleus e. ribosome

4. DNA electrophoresis is the process of
- changing the charge of DNA by swapping out the phosphates for sulfates
 - digesting DNA into smaller pieces
 - mutating DNA with radiation
 - separating pieces of DNA based on size
5. Which is NOT an original part of the cell theory, as formulated in the 1800s?
- All living things are composed of cells.
 - Cells are the basic unit of structure and function of living things.
 - DNA runs the cell by telling it which proteins to make.
 - New cells come from existing cells.
6. What is the function of the endoplasmic reticulum (ER) and Golgi complex?
- hold the genetic material of the cell
 - process and package new proteins
 - protect the interior of the cell by keeping bad stuff out
 - transcribe DNA to RNA

7. At right is a diagram of a typical DNA gel. The dark slits near the top are the wells into which the DNA is pipetted. Circle the smallest piece (or pieces, if there is a tie) of DNA.
(Image from yourgenome.org.)



Smallest pieces are at bottom, farthest from the wells. (The smallest pieces travel the fastest and thus go the farthest.)

8. If a protein is 400 amino acids long, Olivia claims that the messenger RNA (mRNA) that gets translated into this protein must be at least 1203 bases long. Explain why she is right.

Each amino acid is coded for by a set of 3 bases, so $400 \times 3 = 1200$... plus 3 bases for the stop codon is a total of 1203.

9. If you give the artificial mRNA A-U-G-A-U-G-A-U-G-A-U-G... to a ribosome, the resulting protein contains only the amino acid methionine. Explain how this suggests that in the genetic code, 3 RNA bases (not 1 or 2 or 4) code for each amino acid.

- If every 3 bases coded for an amino acid, each A-U-G would code for the same amino acid, and you'd get a protein of one amino acid repeated over and over, which is what you get.
- If every 1 base coded for an amino acid, A, U, and G might each code for a different amino acid, leading to a protein made of 3 different amino acids, not just 1.
- If every pair of 2 bases code for an amino acid, the RNA would include 3 different 2-base sequences (A-U, G-A, and U-G), each of which might encode a different amino acid. So, again, the resulting protein would have more than 1 different amino acid.
- If every set of 4 bases code for an amino acid, the RNA would have 3 different 4-base sequences (A-U-G-A, U-G-A-U, G-A-U-G), which would, again, lead to a protein with multiple amino acids.

10. If a cell undergoing mitosis has 20 chromosomes, each of its daughter cells will have _____ chromosomes.

- a. 0 b. 5 c. 10 d. 20 e. 40 f. can't tell from the information given

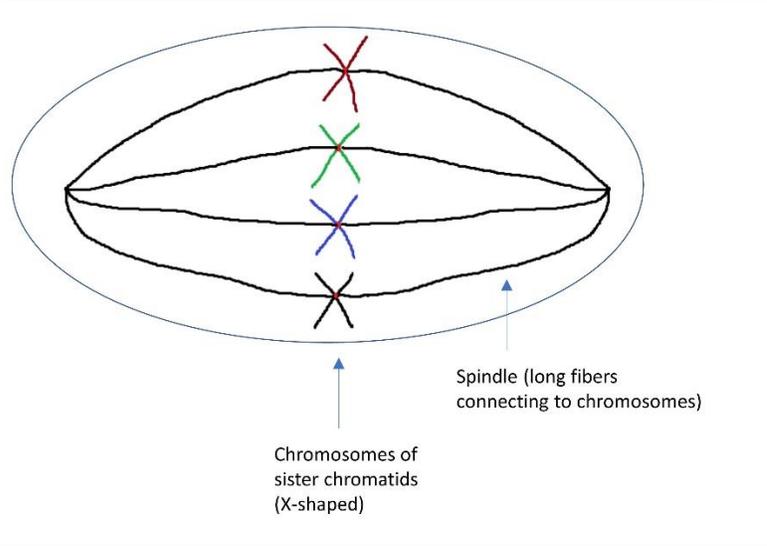
11. Ben Tice (previously introduced as Sven Tice's fictional fake brother) does experiments in which he attempts to get 3 different proteins (hemoglobin, RNA polymerase, and myosin) into human cells. He finds that these proteins are not able to cross the cell membrane. He concludes that cell membranes are impermeable to nutrients. Do you agree, disagree, or partly agree? Explain.

Partly agree.

- Some substances, like many proteins, cannot ordinarily pass through cell membranes, as Ben found.
- However, other substances CAN pass through the membranes, either by simple diffusion (some fats, CO₂, O₂, etc.) or with the help of carrier/transport proteins (water, glucose, sodium and chloride ions, etc.).
- Thus cell membranes are semi-permeable.

12. The fruit fly *Drosophila melanogaster* has been used in lots of important biology research. Most of its cells have 4 pairs of chromosomes (8 chromosomes total). Draw a cell at metaphase 2 of meiosis 2. Show and label the chromosomes and spindle.

(image adapted from <https://datbootcamp.com/biology-strategy/chromosome-and-chromatid-numbers-during-mitosis-and-meiosis/>)



13a. In genes like BRCA1 and BRCA1, substitution mutations are _____ pathogenic.

- a. never b. sometimes c. usually d. always

13b. What is a substitution mutation?

One DNA base replaces another. For example, AAA becomes ACA if a C gets substituted for the middle A.

14. Sex-linked traits are controlled by genes on the X chromosome. Why are males more likely than females to display recessive traits such as red-green colorblindness?

- You will display the dominant trait if you have at least 1 dominant allele.
- Females have 2 X chromosomes, and thus 2 alleles of each X-chromosome gene.
- Males only have 1 X chromosome, and thus 1 allele of each X-chromosome gene.
- Thus, for genes on the X chromosome, females have 2 “chances” to get a dominant allele, while males only have 1 chance.

15. Say whether each statement is true of DNA, RNA, both, or neither.

- a. a type of nucleic acid: both
- b. a product (end result) of translation: neither
- c. includes the base guanine (G): both
- d. can move from the nucleus to ribosomes: RNA
- e. different forms include a “messenger” (m) form and a “transfer” (t) form RNA

16. As we have seen, there is a gene controlling earlobe appearance (either attached or unattached). This trait is NOT sex-linked; that is, the relevant gene is not on the X chromosome. Unattached lobes are dominant over attached ones.

a. If the two possible alleles are E and e, what genotype(s) result(s) in a phenotype of unattached earlobes?

both EE and Ee

b. Two people who both have genotypes of Ee have children together. What are their children's possible genotypes, with what odds (percentages)?

I recommend drawing a Punnett Square. Parents' genotypes are in italics.

	<i>E</i>	<i>e</i>
<i>E</i>	EE	Ee
<i>e</i>	Ee	ee

Children's genotypes: 25% EE, 25% ee, 50% Ee

c. What are their children's possible phenotypes, with what odds (percentages)?

Children's phenotypes: 75% unattached, 25% attached