Biology 150: 4th in-class examination
April 17, 2019

Name Answers

Indicate the lab you are registered in:

Tuesday, 9:00-10:50 _____; Tuesday, 11:00-12:50 _____; Tuesday, 1:00-2:50 _____

Answer the questions in the space provided and you may also use the back of the page to complete your response. There are 17 questions worth a total of 50 points. There are also plus two bonus questions worth a total of 5 points. The point value of individual questions appears in parentheses.

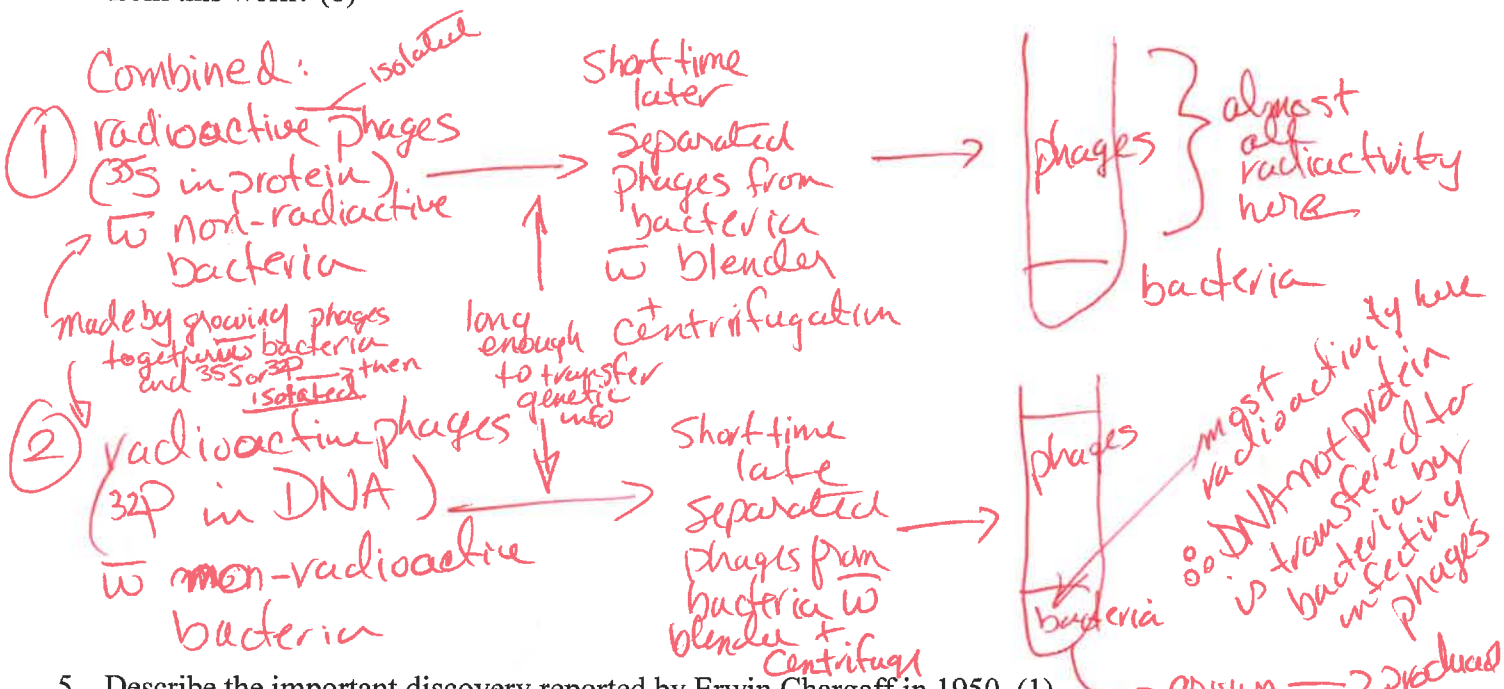
Note: a copy of the genetic code is printed on the last page.

1. Discovery of nucleic acids (DNA and RNA) is credited to Friedrich Miescher who, in 1870, isolated a substance from white blood cells that was acidic and rich in phosphate. (3)

2. In 1928, Fred Griffiths discover bacterial transformation. What is "bacterial transformation"? (1)
   the ability of bacteria to take up and use DNA from their environment

3. In 1944 Avery, Macleod, and McCarty found that bacterial transformation required DNA but did not require protein. (2)

4. Outline the famous Hershey and Chase experiment of 1952. What was the important conclusion from this work? (6)



5. Describe the important discovery reported by Erwin Chargaff in 1950. (1)
   - In all samples of DNA the relative content of Adenosine (A) is the same as the thymidine (T) and Guanosine (G) = Cytodine (C)

6. Rosalind Franklin used X-ray crystolography (methodology) to determine that DNA was 2 nm wide, had the sugars and phosphates on the outside and had repeating units of 3.4 and 0.34 nm (later determined to be length of each turn of the helix and the distance between base pairs). (2)

7. The Nobel Prize in Physiology or Medicine 1962 was awarded jointly to James Watson, Francis Crick, and Maurice Wilkins "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material." (1)

8. Describe and/or diagram eukaryotic DNA replication. Mention the role of each major enzyme complex (e.g. DNA polymerase I and III, DNA ligase, DNA helicase, topoisomerase, RNA primase, single strand binding proteins), okazaki fragments, and the differences between leading and lagging strand synthesis. (6)

- DNA binding proteins binding to origins of replication allow Helicase to bind. Helicase, moving in both directions separates strands
- topoisomerase releases tension in advance of helicase by cutting one strand and reattaching
- Single strand binding proteins stabilize the strands
- Primase synthesizes ~10 bp primers of RNA
- DNA Polymerase III binds to 3' end of each primer synthesizing DNA
- Leading strand is synthesized continuously following helicase
- the lagging strand is ~~compl~~ repeatedly started w new primers as more DNA is separated — each new section is an Okazaki fragment.
- DNA polymerase I replaces the RNA of the primers w DNA
- DNA ligase joins the Okazaki fragments.

9. Describe transcription. Where does it start? What does it? Travelling which direction (i.e. 3' to 5' or 5' to 3')? How does it stop? (4)

- transcription starts at a promoter
- transcription is done by RNA polymerase travelling 3'→5' along a template strand.
- transcription stops when a

10. Processing of mRNA consists of intron removal as well as addition of a 5' cap and a poly-A-tail. ? (1)

11. Assume that the following, running 3' to 5', is the DNA (gene) sequence at the beginning of the coding sequence for a specific mRNA. Give (a) the sequence of the product of transcription and (b) the order of the first five amino acids in the resulting polypeptide.(3)

TACTTCCGTACGATCAGATGACAGCCTG
AUGAAGGCAUGCUAGUCUACUGUCGGAC

Met - Lys - Ala - Cys - stop

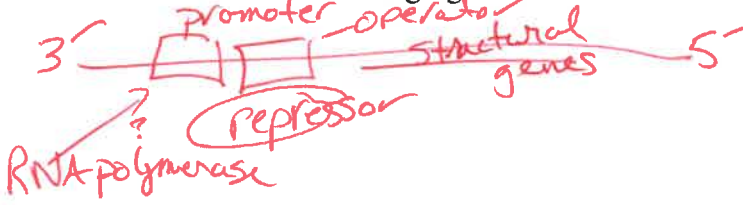
12. Some proteins end up in the endoplasmic reticulum. Describe how they get there? (3)

- beginning (NH2 end) of partially synthesized protein contains a "signal peptide"
- this binds a signal peptide recognition particle (SRP)
- the SRP then binds a SRP receptor in the RER membrane that channels the growing peptide into the ER or ER membrane

13. How do missense, nonsense, and silent mutations differ from each other? (3)

- missense mutations result in a changed amino acid
- nonsense " " " a premature stop
- silent " " " no change to the amino acid.

14. Describe and/or diagram the lac operon. Name and indicate the relative location of the different elements. Describe how changing lactose concentration alters function. (4)



- lactose (inducer) binds to the repressor removing it from the operator and allowing transcription

15. Describe how transcription activators work. Specifically, describe the role of CAP (Catabolic Activator Protein) in upregulating some genes and down regulating others. What is the role of cAMP? (5)

- transcription activators bind upstream of the promoter and increase RNA polymerase binding in already induced operons
- CAP binds cAMP (which rises when glucose is low) and then binds to the lac operon ... and loses binding affinity for the glucose uptake operon.

16. What gets acetylated to convert heterochromatin to euchromatin? (1)

histone tails

17. Gene induction in eukaryotes is dependent on distal and proximal control elements. What are these elements? Where are they located? How do they control gene expression? (4)

- transcription factors binding upstream of the promoter to "proximal elements (the DNA)
- distal elements (enhancers) bind activators and are positioned close to the promoter where they (along w mediator proteins) assist transcription factor binding.

Second Position

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

Bonus questions:

1) Compared to individual gene sequences, however, the genetic code is spectacularly evolutionarily conserved.

a) how might a mutation to an organisms DNA result in a change to the genetic code (1)

- a mutation to a aminoacyl-tRNA synthetase gene so that the resulting enzyme attaches a different amino acid to a given tRNA would effectively change the code.

b) explain why it might be that essentially never happens (2)

any change to the code would have the effect of changing the amino acid sequence of most of the cells proteins ——> certainly a fatal action.