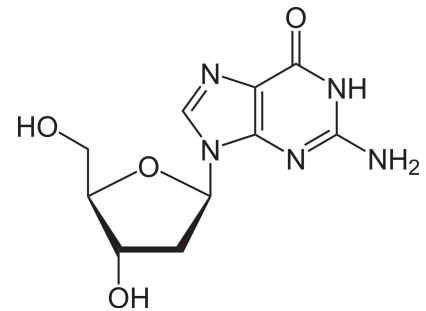


Introduction to Genetics
FALL 2023
EXAM I

1. A sample of normal double-stranded DNA was found to have a guanine content of 18%. What is the expected proportion of adenine?
A) 9% **B) 32%** C) 36% D) 68% E) 82%
2. In one strand of DNA, the nucleotide sequence is 5'AGCT3'. The complementary sequence in the other strand must be
A) 3'AGCT 3' B) 5'TCGA 3' C) 5'CTAG 3' D) 5'GATC 3' E) 5'ACGT 3'
3. The DNA content of an organism contains 50% GC basepairs. On average, how frequently would you expect to find the sequence 5'TCGA 3'?
A) once every 16 bases
B) once every 39 bases
C) once every 256 bases
D) once every 625 bases
E) once every 4096 bases
4. The DNA content of an organism contains 80% GC basepairs. On average, how frequently would you expect to find the sequence 5' TCGA 3'?
A) once every 16 bases
B) once every 39 bases
C) once every 256 bases
D) once every 625 bases
E) once every 4096 bases
5. The molecule shown to the right consists of
A) Ribose attached to the purine base, Adenine
B) Deoxyribose attached to the purine base, Adenine
C) Deoxyribose attached to the pyrimidine base, Cytosine
D) Deoxyribose attached to the purine base, Guanine
E) Ribose attached to the purine base, Guanine



6. A rapidly growing archaea has a circular genome that is 4 megabases in size and replicates using two *bidirectional* origins of replication. If the cells divide every 20 minutes, what is the minimum speed that the replication fork must be moving?
A) >200,000 bp/min B) >100,000 bp/min **C) >50,000 bp/min** D) >2,000 bp/min E) >1000bp/min
7. The replication machinery allows one error to slip through for each 1×10^{10} base pairs synthesized. Given that a human cell contains 6×10^9 base pairs of DNA, on average how many mutations are present in a 100 cell embryo?
A) <1 B) ~6 **C) ~60** D) ~560 E) >1000

8. The enzyme that polymerizes short stretches of RNA on the lagging strand during replication is called

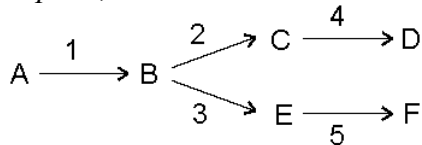
- A) DNA polymerase B) RNA Polymerase C) primase D) ligase E) helicase

9. The enzyme that joins Okazaki fragments on the lagging strand after the RNA primer is removed during replication is called

- A) polymerase B) telomerase C) primase D) ligase E) helicase

Questions 10-11 refer to the biochemical pathway below.

In *Neurospora*, a branched biochemical pathway synthesizes two essential amino acids, D & F



10. Which compound(s) will accumulate in null mutants lacking enzyme 1?

- A) A B) B C) C D) D and F E) B, C, D, E, and F

11. Null mutants lacking enzyme 3 gene will grow on minimal medium supplemented with which of the following compounds?

- A) A or B B) B only C) C or D D) E or F E) F only

12. Which of the following is not a component of the transcriptional system in cells?

- A) RNA polymerase
B) DNA
C) Promoter
D) Shine-Dalgarno sequence
E) Hairpin loop

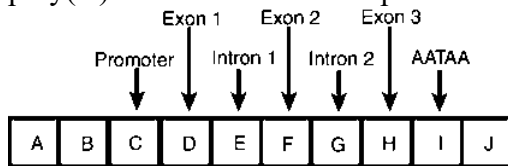
13. The order of events that occur during prokaryotic translation initiation is

- A) met-tRNA loads in the P site, peptide bond formation occurs, the 70S subunit translocates forward three bases
B) met-tRNA loads in the A site, peptide bond formation occurs, the 70S subunit translocates forward three bases
C) 50S subunit loads at a Shine Delgarno sequence, 30S subunit loads, met-tRNA loads in the A site
D) 30S subunit loads at a Shine Delgarno sequence, met-tRNA loads in the A site, 50S subunit loads
E) 30S subunit loads at a Shine Delgarno sequence, met-tRNA loads in the P site, 50S subunit loads

14. 5' capping refers to
- A) The addition of a poly-A tail to beginning of each transcript
 - B) The addition of a poly-A tail to the end of each transcript
 - C) The addition of methionine to the beginning of each transcript
 - D) The removal of the first methionine from proteins following translation
 - E) The addition of a 7-methyl guanine to the beginning of each transcript

Questions 15-18 refer to the diagram shown below.

The diagram represents the structure of a *Drosophila* gene, divided into 10 segments, designated A–J. The gene contains three exons, two introns, a promoter, and a site in I for poly(A) addition and transcriptional termination.



15. What segment or segments of the gene will be represented in the initial RNA transcript?
- A) BCDEFGHIJ
 - B) BCDEFGHI
 - C) CDEFGHI
 - D) CDFHI
 - E) CEGI
16. What segment or segments of the gene will be found in the completely processed transcript?
- A) BCDEFGHIJ
 - B) ABCDEFGHI
 - C) CDEFGHI
 - D) CDFHI
 - E) CEGI
17. What segment or segments of the gene in the processed transcript will have additional nucleotides added to them?
- A) D, F, and H
 - B) E and G
 - C) D and H
 - D) C and I
 - E) I
18. What segment or segments of the gene will possess the translation initiation codon?
- A) E or G depending upon splicing
 - B) B
 - C) C
 - D) D
 - E) E

19. A Sanger sequencing reaction that identifies where Cytosines occur in the single strand DNA **template** being sequenced would contain: a DNA polymerase, an oligo primer, a single strand DNA template and...

- A) a mixture of all the **deoxynucleotide** triphosphates, plus **dideoxyguanine** triphosphate
- B) a mixture of all the **deoxynucleotide** triphosphates, plus **dideoxycytosine** triphosphate
- C) a mixture of all the **dideoxynucleotide** triphosphates, plus **deoxycytosine** triphosphate
- D) a mixture of all the **ribonucleotide** triphosphates, plus **deoxyguanine** triphosphate
- E) a mixture of all the **ribonucleotide** triphosphates, plus **deoxycytosine** triphosphate

20. Which pair of pentamer primers could be used to amplify the DNA sequence shown below?

3' -AAAAAGATTACATCGGCATTACCGATTTAAAGCCCTGGGGG-5'
5' -TTTTTCTAATGTAGCCGTAATGGCTAAATTCGGGACCCCC-3'

- A) forward primer 5'-AAAAA-3' and reverse primer 5'-GGGGG-3'
- B) forward primer 5'-TTTTT-3' and reverse primer 5'-CCCCC-3'
- C) forward primer 5'-AAAAA-3' and reverse primer 5'-CCCCC-3'
- D) forward primer 5'-TTTTT-3' and reverse primer 5'-GGGGG-3'
- E) forward primer 5'-AAAAA-3' and reverse primer 5'-TTTTT-3'

Griffith had a pathogenic strain of bacteria (**type S**), which would kill mice that ingested them. However, if he heat inactivated the culture before feeding it to the mice, the **dead type S** bacteria were no longer pathogenic. Griffith also had a nonpathogenic strain of bacteria (**type R**) that did not kill the mice when they were ingested.

To his amazement, when he mixed two cultures of **dead type S** and **live type R** bacteria (neither of which is pathogenic) and fed this mixture to the mice, he found that all the mice died, and that the **live type R** bacteria had been transformed into **live type S** bacteria.

To determine whether the transforming material was made up of lipids, protein, or DNA, Avery extended Griffiths experiment. He again fed the mice a mixture of **dead type S** and **live type R** bacteria. However before mixing the two forms, Avery first treated the **dead type S** bacteria samples with either

- I. Proteinase II. DNase III. Lipase or IV. Proteinase and Lipase and DNase

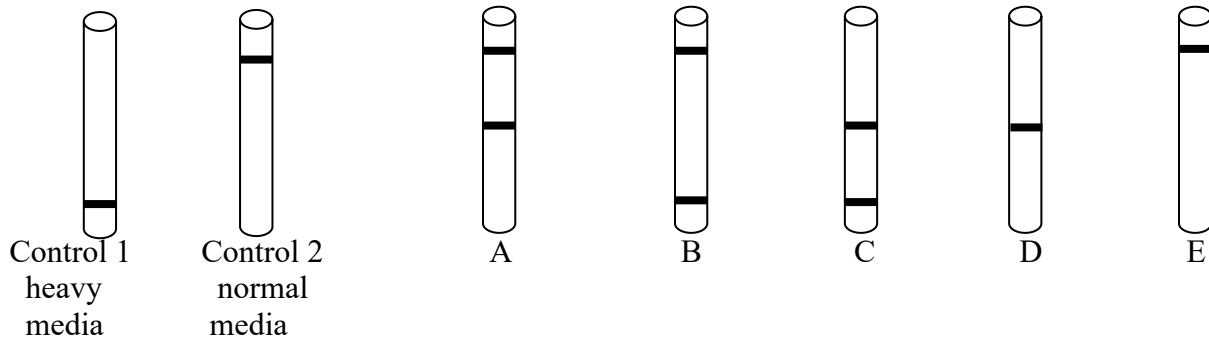
21. Which of the following outcomes would indicate that DNA is the transforming material?

- A) mice fed mixtures I and III both died
- B) mice fed mixtures II and IV both died
- C) mice fed mixtures I, III, and IV died
- D) mice fed mixture II died
- E) mice fed mixture IV died

Questions 22 and 23 refer to the following experiment

To differentiate between potential mechanisms for how DNA is duplicated, Meselson-Stahl set up an experiment to differentially label the strands of the DNA during replication. For this experimental analysis, a culture of *E. coli* was grown in media containing heavy isotopes of nitrogen (^{15}N) for several generations. Cells from this culture were then transferred into media containing normal nitrogen (^{14}N) and then samples were prepared 1) after one generation in the normal media, and 2) after two generations of growth in the normal media.

The DNA was then prepared from each sample and its boyant density was determined by centrifugation CsCl gradients. The results of two control cultures grown in only heavy (^{15}N) media, and only light (^{14}N) media are shown, along with five potential outcomes, labeled A-E.



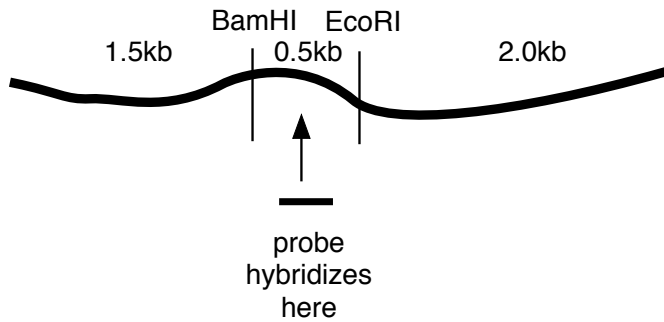
22. Considering the controls, which samples would support the idea that DNA replicated semiconservatively?

- A) D after one generation, E after two generations
- B) C after one generation, D after two generations
- C) D after one generation, B after two generations
- D) B after one generation, B after two generations
- E) D after one generation, A after two generations

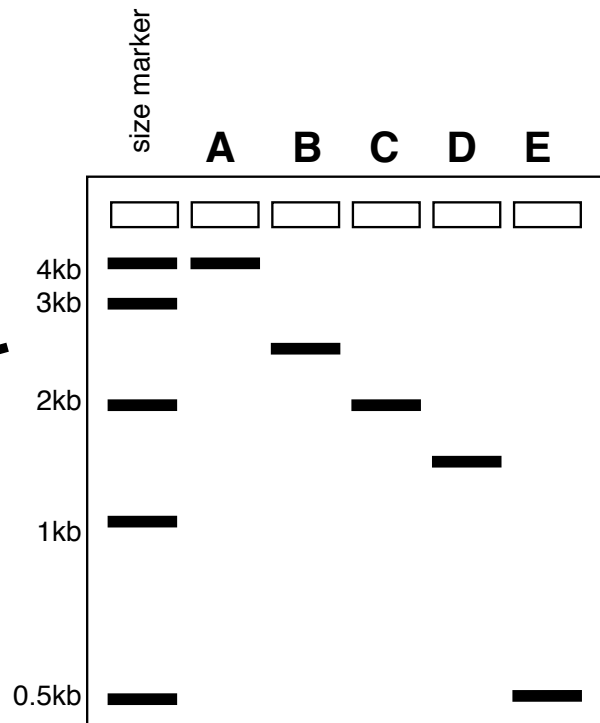
23. Considering the controls, which samples would support the idea that DNA replicated conservatively?

- A) D after one generation, E after two generations
- B) C after one generation, D after two generations
- C) D after one generation, B after two generations
- D) B after one generation, B after two generations
- E) D after one generation, A after two generations

A 4kb linear double stranded DNA virus has the following restriction sites in its genome.



The solid bar represents a short PCR fragment that was amplified, radioactively labeled, and used as a probe for the Southern Blot shown to the right. The probe hybridizes only to the region shown above on the viral genome. In each lane, the viral DNA was digested with a restriction endonuclease, and run through an agarose gel. The gel was transferred onto a nylon membrane and probed with the PCR fragment shown above, and the probe was then visualized after exposing the southern blot to film.



24. Which lane corresponds to the probe if the viral DNA was digested with **BamHI**?

- A) A **B) B** C) C D) D E) E

25. Which lane corresponds to the probe if the viral DNA was digested with both **EcoRI** and **BamHI**?

- A) A B) B C) C D) D **E) E**