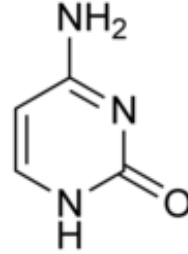


**Introduction to Genetics**  
**FALL 2010**  
**EXAM I**

1. The base shown at the right is

- A) Adenine
- B) Guanine
- C) Uracil
- D) Thymine
- E) Cytosine



2. When the base composition of double-stranded DNA from a new species of bacteria was determined, 30 percent of the bases were found to be adenine. What is the percentage of cytosine in the DNA of this organism?

- A) 20 %      B) 30 %      C) 40 %      D) 60 %      E) 70 %

3. A DNA molecule 6 bases long encodes 2 amino acids. How many different DNA sequences are theoretically possible?

- A) 24      B) 40      C) 400      D) 1296       E) 4096

4. A DNA molecule 6 bases long encodes 2 amino acids. How many different peptide sequences are theoretically possible?

- A) 24      B) 40       C) 400      D) 1296      E) 4096

5. The codon AUG, which is the "start" codon for polypeptide synthesis, also specifies amino acid

- A) Phe.      B) Gly.      C) Trp.       D) Met.      E) Asn.

6. The sequence of one strand of DNA is 5'-GCTTTAG-3'. The sequence of the complementary strand would be

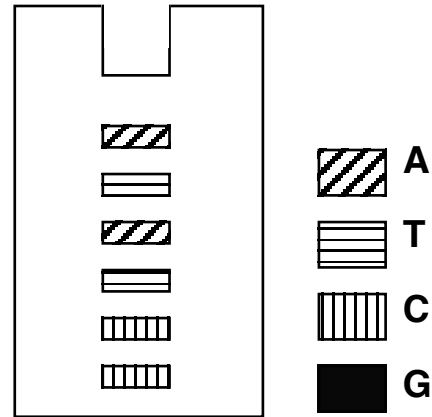
- A) 5'-GCTTTAG-3'.
- B) 3'-CTAAAGC-3'.
- C) 5'-GATTTTCG-3'.
- D) 5'-ATGGGCA-3'.
- E) 5'-CGAAATC-3'

7. Which chemical group is at the 5' end of a single polynucleotide strand?

- A) Hydroxyl group       B) Phosphate group      C) Diester group      D) Purine      E) Nitrogen group

8. The DNA sequence in the gel to the right reads

- A) 5'-CCTATA-3'
- B) 5'-ATATCC-3'
- C) 5'-GGATAT-3'
- D) 5'-TATAGG-3'
- E) 5'-UAUAGG-3'



9. The unique precursor that is used in DNA sequencing reactions to terminate DNA synthesis and identify the last base inserted is called a

- A) ribonucleoside triphosphate
- B) deoxyribonucleoside triphosphate
- C) dideoxyribonucleoside triphosphate
- D) deoxyuracil triphosphate
- E) pyrophosphate

10. 5'- ACG\_\_\_ - 3' is a half of a palindromic restriction site. What is the complete sequence?

- A) 5'- ACGACG- 3'
- B) 5'- ACGCGT- 3'
- C) 5'- ACGGCA - 3'
- D) 5'- ACGTGC - 3'
- E) 5'- ACGAGC - 3'

11. Pairing of homologous chromosomes occurs during

- A) prophase I
- B) prophase II
- C) anaphase I
- D) anaphase II
- E) metaphase I

12. In a plant in which  $2n = 24$ , what is the total number of chromosomes present in each gamete after *meiosis*?

- A) 6
- B) 12
- C) 24
- D) 48
- E) 96

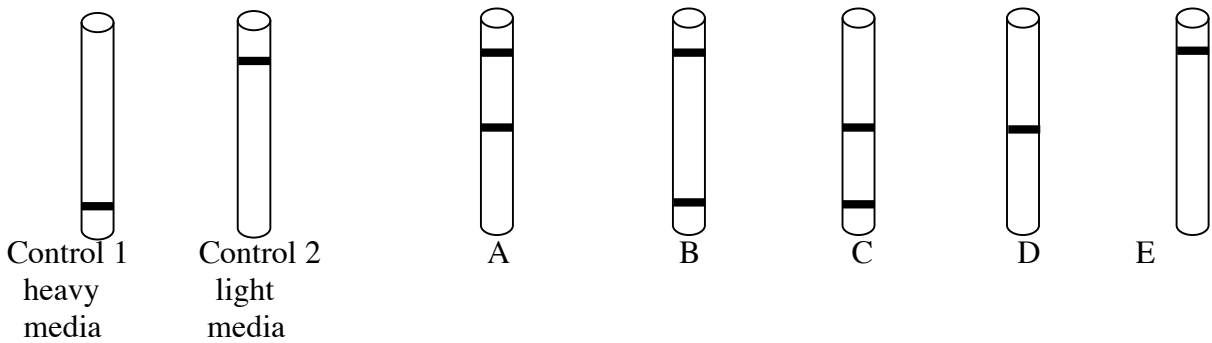
13. A rapidly growing bacteria has a genome that is 1 megabase in size and replicates from a single bidirectional origin of replication. If the cells divide every 20 minutes, what is the minimum speed (in basepairs/second) that the replication fork could be moving?

- A) >100,000 bp/s
- B) >1500 bp/sec
- C) >800bp/sec
- D) >400bp/sec
- E) >30bp/sec

Questions 14 and 15 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 ( $^{15}\text{N}$ ) for several generations. Cells from this culture were then transferred into media containing normal nitrogen ( $^{14}\text{N}$ ) and samples were prepared at after one generation in the normal media, and 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 ( $^{15}\text{N}$ ) media, and only light ( $^{14}\text{N}$ ) media are shown, along with five potential outcomes, labeled A-E.



14. If DNA replication occurred via a **semiconservative** mechanism, which outcome represents how the bacterial DNA would migrate after TWO generations of growth in the light media?

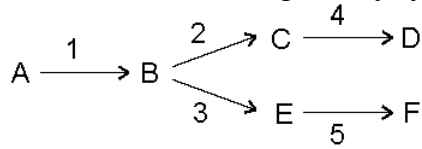
- A) A      B) B      C) C      D) D      E) E

15. If DNA replication occurred via a **conservative** mechanism, which outcome represents how the bacterial DNA would migrate after TWO generations of growth in the light media?

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

\*\*\*\*\*

16. A branched biochemical pathway synthesizes two related essential amino acids D & F



A mutant defective for enzyme 2 would grow on minimal medium supplemented with which of the following?

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

17. Avery observed that a nonpathogenic strain of bacteria (**type R**) could be genetically transformed into a pathogenic strain if they took up a cellular component of a related pathogenic strain (**type S**).

To determine which substance was the transforming material, Avery treated a solution of the heat killed **type S** bacteria with the following enzyme solutions, then mixed this with the nonpathogenic **type R** bacteria and fed these mixtures to mice.

I) Nothing    II) Proteinase    III) DNase    IV) RNase    V) Proteinase, RNase, and DNase

Assuming that ingestion of the pathogenic bacteria killed the mice, which of the following outcomes are consistent with the idea that DNA is the transforming material?

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

18. The enzyme that restores the ends of a DNA molecule on a human chromosome is called

- A) Telomerase**    B) Ligase    C) RNA Polymerase III    D) Primase    E) Helicase

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

5' -AAAAAGATTACATCGGCATTACCGATTTAAAGCCCTGGGG-3'  
3' -TTTTTCTAATGTAGCCGTAATGGCTAAATTTCTGGGACCCCC-5'

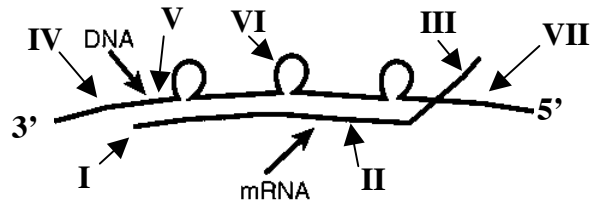
- A) forward primer 5'-AAAAA-3' and reverse primer 5'-GGGGG-3'  
B) forward primer 5'-TTTTT-3' and reverse primer 5'-CCCCC-3'  
**C) forward primer 5'-AAAAA-3' and reverse primer 5'-CCCCC-3'**  
D) forward primer 5'-TTTTT-3' and reverse primer 5'-GGGGG-3'  
E) forward primer 5'-AAAAA-3' and reverse primer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

20. Which of the following is found uniquely in prokaryotes?

- A) polycistronic mRNA**  
B) introns  
C) 3' polyadenylation  
D) mRNA capping  
E) Promoter sequences

Questions 21 22 and 23 refer to the following diagram:

An mRNA was isolated from mouse cells and hybridized to its corresponding piece of genomic DNA. The following electron micrograph was obtained:



21. The roman numerals on the diagram correspond to what component of the RNA molecule?

- A) I-polyA tail;      II-intron;      III-5' cap
- B) I-5' cap;          II-intron;      III-polyA tail
- C) I-polyA tail;      II-exon;        III-5' cap
- D) I-5' cap;          II exon;        III-polyA tail**
- E) I-3' cap;          II-intron;      III-polyA tail

22. The promoter region can be found in which segment?

- A) I      B) III      **C) IV**      D) V      E) VII

23. The region that contains the transcription termination signal can be found in which segment?

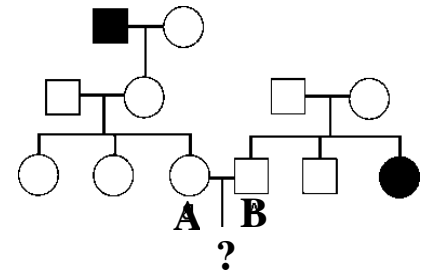
- A) I      B) II      C) III      D) IV      **E) VII**

\*\*\*\*\*

24. Regions on chromosomes where kinetocores attach are called

- A) euchromatin.
- B) centromeres.**
- C) heterochromatin.
- D) mid-repetitive sequences.
- E) nucleosomes.

Questions 25 26 and 27 refer to the following pedigree of the rare autosomal recessive disease phenylketonuria (PKU). The filled-in individuals have PKU. What is the probability of the first child having PKU?



25. If couple A and B have a child, what is the probability that the child will be affected?

- A) 1/16    **B) 1/12**    C) 1/4    D) 1/18    E) 1/9

26. If the couple is planning to have two children, what is the probability that both children will be affected?

- A) 1/16    B) 1/12    C) 1/4    D) 1/81    **E) 1/144**

27. If the couple's first child is affected and they decide to have a second child, what is the probability that their second child will be affected?

- A) 1/16    B) 1/12    **C) 1/4**    D) 1/81    E) 1/9

\*\*\*\*\*

28. A testcross with a dihybrid would be expected to produce progeny with a phenotypic ratio of

- A) 3:1  
 B) 1:1  
 C) 9:3:3:1  
**D) 1:1:1:1**  
 E) all progeny would be phenotypically identical

29. Mating of two organisms produces a 1:1 ratio of phenotypes in the progeny. The parental genotypes are

- A)  $Aa \times Aa$ .    **B)  $Aa \times aa$ .**    C)  $AA \times aa$ .    D)  $AA \times AA$ .    E)  $AA \times Aa$

30. In the cross  $Aa Bb Cc \times Aa Bb Cc$ , in which all genes undergo independent assortment, what proportion of offspring are expected to be homozygous recessive for all three genes?

- A) 1/4      B) 1/16      C) 1/8      D) 3/8      E) 1/64

31. In a testcross of  $Aa Bb Cc$  what is the expected frequency of  $aa bb Cc$  progeny?

- A) 1/4      B) 1/8      C) 1/32      D) 1/16      E) 3/16

32. A woman with keratosis, a skin condition caused by a rare dominant allele, marries a normal man, and they have two children. What is the probability that both children are normal?

- A) 0      B) 1/4      C) 1/2      D) 3/4      E) 1

33. Four mutants (labeled  $a$   $b$   $c$  and  $d$ ) are isolated in a mutant screen for genes affecting vulval development in the nematode worm *Caenorhabditis elegans*. Complementation tests are carried out, and the results are shown below. How many different genes do the four mutants represent?

- A) 0  
B) 1  
C) 2  
D) 3  
E) 4

	a	b	c	d
a	-	+	+	+
b		-	+	+
c			-	+
d				-