There is always only one best answer.

1) Suppose you find an organism that switches between semiconservative and conservative DNA replication between each cell cycle. The cells are grown in N14 (light) media, synchronized and then released into N15 (heavy) media for 2 cell divisions (i.e. 2 S-phases). How many chromosome "bands" would you expect, and what is the expected density of each band if you isolated the DNA by ultracentrifugation as Meselson and Stahl did?

A) 3; one band is all heavy (HH), one band is all light (LL), and one band is intermediate (HL).
B) 2; one band is all heavy (HH), one band is all light (LL),
C) 1; the one band is intermediate (HL).
D) 2; one band is all heavy (HH), one band is intermediate (HL).
E) A or C depending upon whether semiconservative happened first, then conservative, or vice versa.

2) In class we went through a test cross with 3 traits that were linked. If the largest class of progeny represented the parental, what did the smallest class represent?

A) The combination of all 3 traits
B) The two most distantly linked genes
C) The two most closely linked genes
D) The product of double recombination
E) Both C and D

3) (2 pts) Which scientist- discovery- pair is CORRECT?

A) Meselson and Stahl - discovered viable *E.coli* mutant defective for polymerase I
B) Chargaff - inferred double helix structure of DNA from x-ray diffraction pattern
C) Rosalind Franklin - crystal structure of DNA using x-ray crystallography
D) Watson and Crick – determined the structure of RNA
E) Alexander Flemming and Howard Florey – isolated DNA polymerase I

4) An individual is heterozygous for 5 traits. What is the possible number of gametes that could be produced, relative to these 5 loci

A) Can't determine since we do not know linkage
B) 4 since a single meiosis produces 4 gametes)
C) 5
D) 25 (5^2)
E) 32 (2^5)

5) Ploidy can change only 2 times. Which two times?

A) During M-phase and Meiosis II
B) During S-phase and Meiosis I
C) During fertilization and Meiosis I
D) During fertilization and S-phase
E) During Meiosis I and II

6) In the rare cases of trisomy 21 where an individual inherits 1 chromosome 21 from dad and 2 from mom, which law is broken?

A) The second Law of Thermodynamics
B) Mendel's first law – law of segregation
C) Mendel's second law – law of independent assortment
D) Law of reciprocal exchange
E) Law of x-linked inheritance established by Morgan

7) (2 pts) UC Berkeley has played an important role in the elucidation of RNA polymerases. Which of the two following UCB scientists were involved.

A) Rao and Johnson
B) Tjian and Chamberlain
C) Watson and Crick
D) Jacob and Monod
E) Gilbert and Sullivan

8) The failure to initiate lagging strand synthesis of a 2N animal cell would result in?

A) A cell arrested in S-phase
B) A cell with unattached spindles
C) A cell with 1.5C
D) All of the above
E) Both A and B

9) In mitosis the tension required to initiate chromosome separation is due to ____ and in Meiosis I it is due to _______.

A)	Homologous chromosomes are aligned	bipolar spindle attachment
B)	Crossing over between sister chromatids	crossing over between homologous chromosomes
C)	Bipolar spindle attachment	unipolar spindle attachment with recombination between non-sister chromatids of homologous chromosomes
D)	Bipolar spindle attachment	unipolar spindle attachment with recombination between sister chromatids of homologous chromosomes
E)	Unreplicated DNA	non-homologous sister chromosome recombination √

10) The acquisition of antibiotic resistance in bacteria can arise from?

A) Transformation with an antibiotic resistant gene
B) Conjugation with a bacteria containing an F plasmid containing an antibiotic resistant gene
C) Duplication of an essential gene involved in mitosis.
D) All of the above
E) Both A and B

11) The <u>control</u> of the eukaryotic cell cycle is determined by?

A) Rising and falling levels of CDC28
B) E3 ubiquitin ligases dedicated to degrading cyclins
C) Constant synthesis of cyclins
D) Rising and falling levels of cyclins
E) Both B and D

12) In Rao and Johnson's experiments, G2 cells could not continue into Mitosis when fused with an S-phase cell because?

A) CDC28 levels were not high
B) The proteasome was not working
C) Cyclin A levels were high
D) Cyclin B levels were high
E) A and D

13) (0 pts) Mark A for question 12 as you have version A!

14) During DNA replication, the 5' phosphate of the growing strand attacks the ____

A) 2' hydroxyl of an RNA nucleotide
B) the nearest guanine nucleotide
C) the methyl PPG cap
D) 3' hydroxyl of an incoming DNA nucleotide
E) None of the above

15 & 16) Consider the following 3 factor test cross of the genes A, B and C and the resulting progeny:

Phenotype	Numbers
ABC	383
abc	382
Abc	63
aBC	62
AbC	50
aBc	50
abC	5
ABc	5

15) What is the gene order?

A) A-B-C
B) A-C-B
C) C-A-B
D) A-C, but B is not linked
E) Double crossovers cannot allow determination of gene order

16) What is the distance (in centimorgans cM) between the A and C genes?

A) 2.5 cM
B) 10 cM
C) 13.5 cM
D) 15.3 cM
E) 22.5 cM

17) Consider you have a device that can detect all of the mutations found within a colony of bacteria. Using this device, you find 10^9 TOTAL mutations in a colony containing 10^{12} cells. The error rate of DNA polymerase is 1 mutation/10^9 nucleotides formed. What is the approximate genome size (in base pairs) of the bacterium that makes up this colony of bacteria?

A) 0.5×10^6
B) 1×10^6
C) 1×10^9
D) 2×10^{18}
E) None of the above

18) With the lovely weather, you decide to have a picnic. The potato salad you bought was contaminated with 1,000 bacteria. Each bacterium divides every 20 minutes. After sitting out for three hours, how many bacteria are present in the salad?

A) ~9,000
B) ~90,000
C) ~250,00
D) ~500,000
E) ~1,000,000

19) Alkaptoneuria is a recessive inherited disease causing urine to have the color of maple syrup. People exhibiting alkaptoneuria make up 1/10^6 of the adult population. If 50,000 people are chosen randomly how many carriers do you expect in that population? (Hint: rounding numbers may make the math easier).

A) ~1
B) ~10
C) ~20
D) ~50
E) ~100

20) Which of the following is generally TRUE of mRNAs?

A) Prokaryote mRNAs usually encode several polypeptides of the same operon , but eukaryotic mRNAs do not.
B) Eukaryotic mRNAs are capped and polyadenylated but prokaryotic mRNAs are not.
C) Eukaryotic mRNA precursors are commonly subject to RNA splicing but prokaryotic mRNAs usually are not.
D) They are synthesized in a 5' to 3' direction.
E) All of the above.

21) Which of the following, if any, does NOT directly contribute to chromosome segregation?

A) + (positive) end directed microtubule motors
B) - (minus) end-directed microtubule motors
C) NADPH
D) Kinetochore proteins
E) All of the above contributes.

22) What is the phenotype of partially diploid bacterial cells of the following genotype when grown on medium containing ONLY glycerol? Lactose and glucose are NOT present.

I+ Oc Z+ Y- A+

I+ O+ Z- Y+ A-

A) The production of functional β -galactosidase but no production of functional lac permease.
B) The production of functional lac permease but no production of functional β –galactosidase.
C) The production of functional β -galactosidase and functional lac permease.
D) NO production of functional lac permease and no production of functional β –galactosidase.
E) Cannot be determined from the information provided.

23) Taxol is an anticancer drug that disrupts the mitotic spindle. How would the FACs profile of human cancer cells treated with taxol look? Please recall that somatic human cells are diploid.

A) the profile would be a flat line across all values of fluorescence
B) the result depends upon the phase of the cell cycle the cells are in when treated.
C) one peak of fluorescence coincident with 2C on the X axis
D) one peak of fluorescence coincident with 4C on the X axis
E) a peak of fluorescence at both 2C and 4C with few cells having intermediate fluorescence.

24) Enzyme A is encoded by DNA of the structure Exon1-Intron1-Exon2. A mutation occurs that causes the splicing machinery to be completely nonfunctional. Assuming there is nothing that prevents Enzyme A from being translated, how would the splicing defect most likely affect Enzyme A?

A) Enzyme A would have extra amino acids in the middle, corresponding to Intron 1, but would retain its function.
B) There would be no change in the structure or function of Enzyme A.
C) Enzyme A will be translated in reverse, with Exon2 encoding for the N terminal and Exon 1 encoding for the C terminal.
D) The N terminus of Enzyme A corresponding to Exon 1 will remain unchanged, but translation of Intron 1 and Exon 2 will result in a nonfunctional enzyme.
E) Two proteins will be synthesized. One corresponding to Exon1-Intron1, and the other corresponding to Exon2.

25) Which of the following, if any, regarding the lac operon is FALSE? If NONE are False select E.

A) The lac genes of a lacY mutant would be expressed efficiently until the lactose supply in the cell is exhausted.
B) The production of beta-galactosidase would be affected by a lacZ mutant, and all proteins would be affected
C) The lac genes of a lacI mutant would be expressed continuously, regardless of whether lactose is present
D) Translation results in the production of three separate protein products.
E) All of the above are true (there is no false statement).

26) A mutation in a eukaryotic cell has altered the enzyme that adds poly-A tails to RNA transcripts such that the enzyme adds only five A's. This would most likely have which of the following effects?

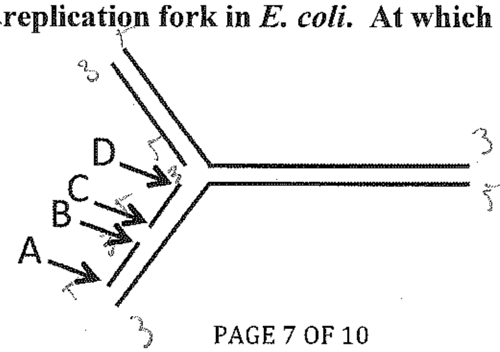
A) Translation will result in shorter polypeptides.
B) Silencing by miRNAs will no longer be effective.
C) mRNAs will not be sequestered to specific locations in the cell.
D) mRNAs will tend to be destroyed after only a short period of time in the cytosol.
E) An initiation complex will be slower to form.

27) Cyclic AMP-phosphodiesterase is an enzyme that catalyzes the reaction cAMP ---> AMP. The free energy change for this reaction is strongly exergonic. If a high concentration of cAMP-phosphodiesterase were introduced into the cytoplasm of *E. coli*, under which conditions, if any, would there be a *high* rate of transcription of the lac operon?

A) glucose present and lactose absent
B) glucose present and lactose present
C) glucose absent and lactose present
D) glucose absent and lactose absent
E) the operon will never be transcribed at a high rate

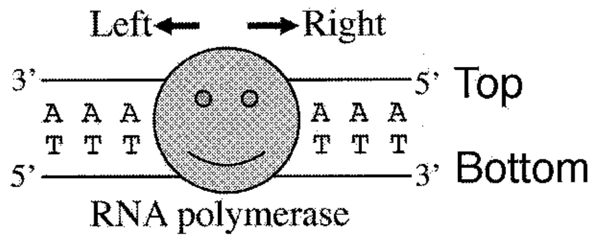
28) The figure below shows a replication fork in *E. coli*. At which of the indicated positions would you expect to see a 3'-OH?

A) A and B.
B) C and D.
C) A and C.
D) B and D.
E) A and D.



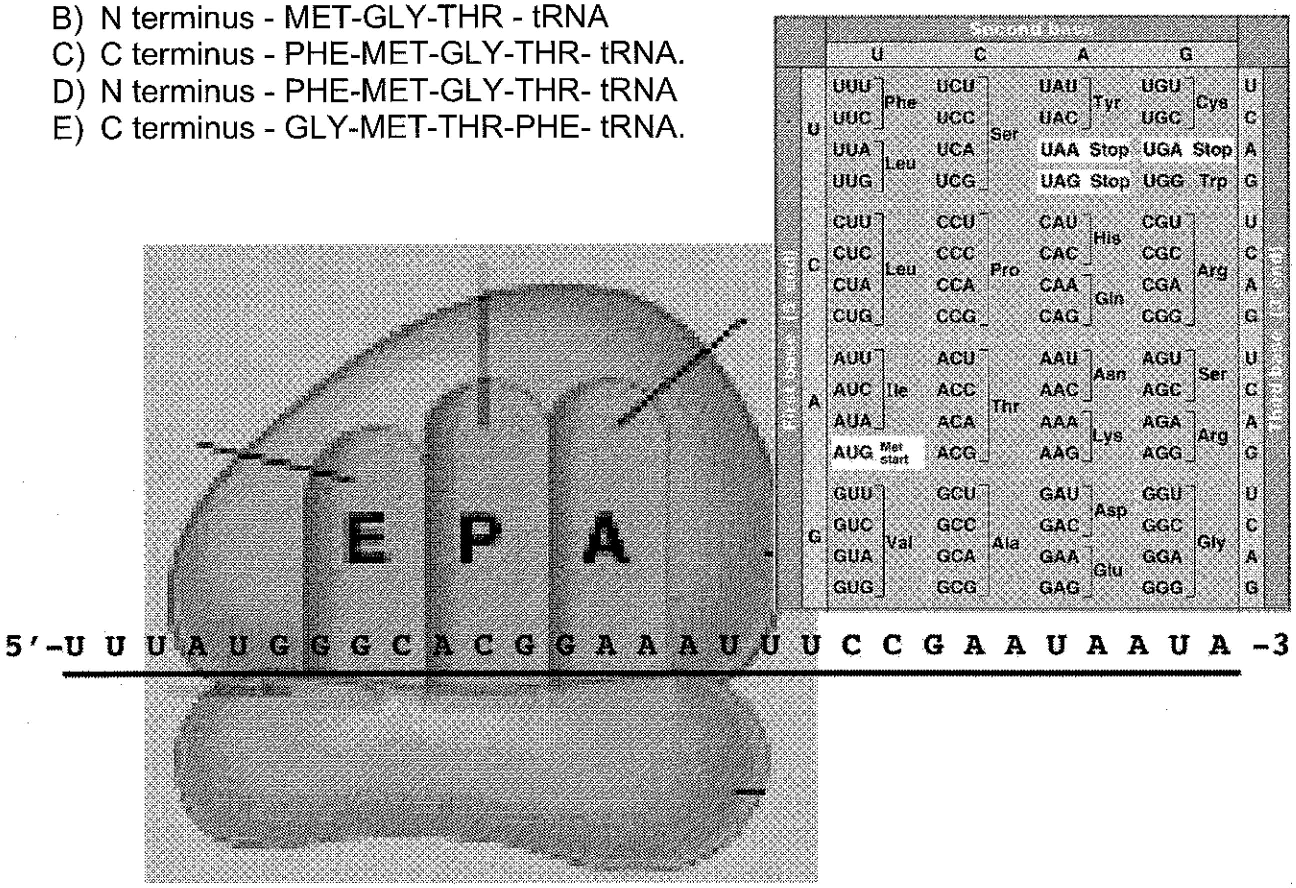
29) **The mRNA synthesized by the RNA polymerase in the figure is 5'-UUU, which direction (left or right) did the RNA polymerase go, and which strand of DNA (top or bottom) did the RNA polymerase use as a template strand?**

A) Right, Bottom.
B) Right, Top.
C) Left, Bottom.
D) Left, Top.



30) **Using the code on chart, what is the amino acid sequence of the polypeptide covalently bound to the tRNA in the P-site of the ribosome before peptide bond formation with the amino acid covalently bound to the tRNA in the A site.**

A) C terminus - MET-GLY-THR - tRNA.
B) N terminus - MET-GLY-THR - tRNA
C) C terminus - PHE-MET-GLY-THR- tRNA.
D) N terminus - PHE-MET-GLY-THR- tRNA
E) C terminus - GLY-MET-THR-PHE- tRNA.

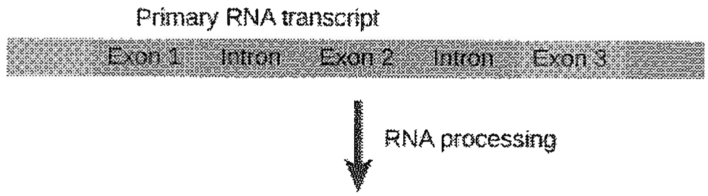


31) **Cis regulatory elements are generally encoded by:**

A) Protein
B) mRNA
C) DNA
D) Carbohydrates
E) DNA-binding proteins

32) The figure below shows a short stretch of DNA indicating there are 3 exons. With alternative splicing of exons 1 and 2 how many different mRNAs can be made? Note that Exon 3 is ALWAYS present in the mRNA.

A) 2
B) 3
C) 4
D) 6
E) 8



33) In *Drosophila*, the slo (slow walker) allele is recessive to the wild type slo$^+$ (normal walking speed) allele. Also, the big wing (bw) allele is recessive to the bw$^+$ (normal wing) allele. A slow walker, big wing female from a true breeding population was crossed to a true breeding wild type male. An F1 female was crossed to a slow walker and big winged male. The genetic distance between slo and bw is 8 Centimorgans. What numbers of progeny would you expect to detect if 1,000 progeny are analyzed?

	Slow walker, big wing	normal walker, normal wing	Slow walker, normal wing	Normal walker, big wing
A)	250	250	250	250
B)	80	80	420	420
C)	420	420	80	80
D)	40	40	460	460
E)	460	460	40	40

Work space.

EXAM CONTINUES ON THE NEXT PAGE

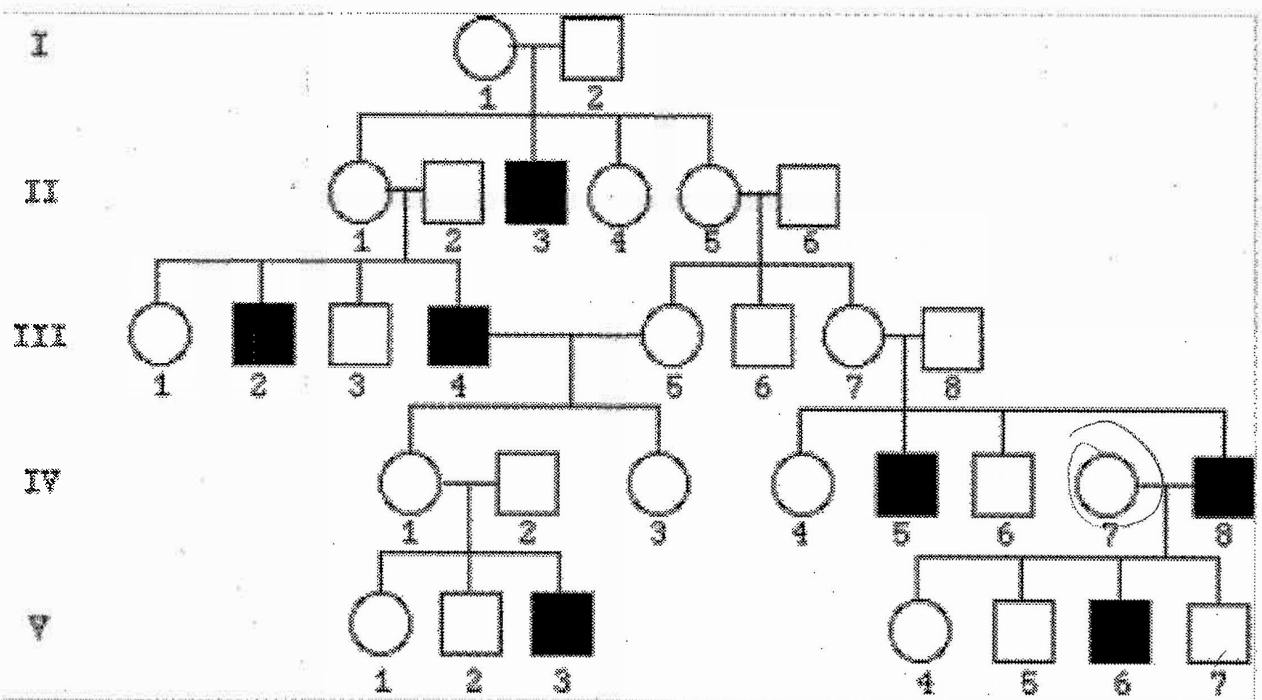
A pedigree is shown below. Use it to answer questions 34 & 35. Circles indicate females, squares indicate males.

34) Select the statement that best describes the disease allele.

A) autosomal linked, recessive to non-disease
B) autosomal linked, dominant to non-disease
C) X linked, recessive to non-disease √
D) X linked, dominant to non-disease
E) Y linked, recessive to non-disease

35) For individual 7 in generation IV select the best statement that describes their genotype.

A) hemizygous, non-disease allele
B) homozygous, non-disease allele
C) homozygous, disease allele
D) heterozygous
E) haplozygous



END OF THE EXAM