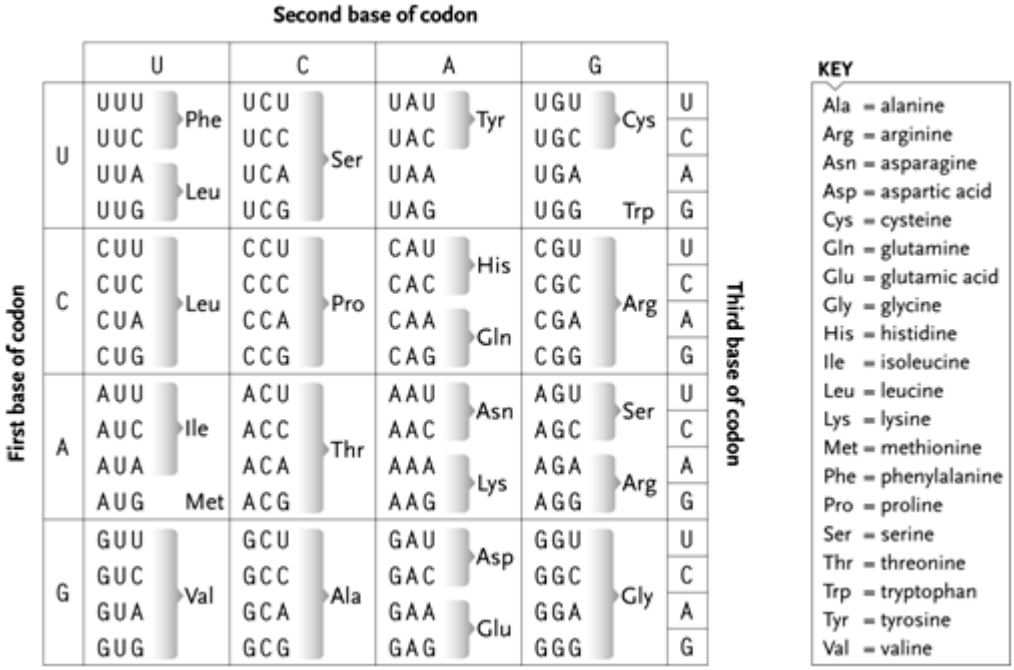
Part A: Please check that you have bubbled your student number correctly on the scantron. Choose one answer for each question.



1. The DNA of an organism is studied and found to contain 14% guanine. This organism should have ____% thymine and _____% cytosine in its DNA.

   A. 14; 36
   B. 36; 14
   C. 14; 86
   D. 36; 36

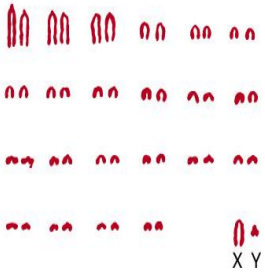
2. Which of the following probes would hybridize to the target sequence :

   5'....ATTCGACATT...3'

   A. 5'...ATTCGACATT....3'
   B. 5'...TTACAGCTTA....3'
   C. 5'...AATGTCGAAT...3'
   D. 5'...TAAGCTGTAA...3'

3. A colleague shows you the following karyotypes for two new recently discovered organisms. Which of the following predictions could you make?

Organism A

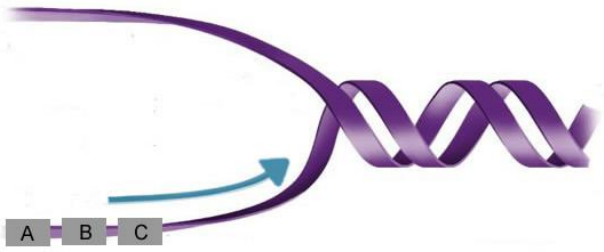


Organism B

A. Organism A's genome likely contains more nucleotides than that of organism B.
B. Organism B's genome likely contains more nucleotides than that of organism A.
C. Organism B is likely a male; Organism A is not male.
D. You can't make any firm predictions on the nucleotide content nor gender.

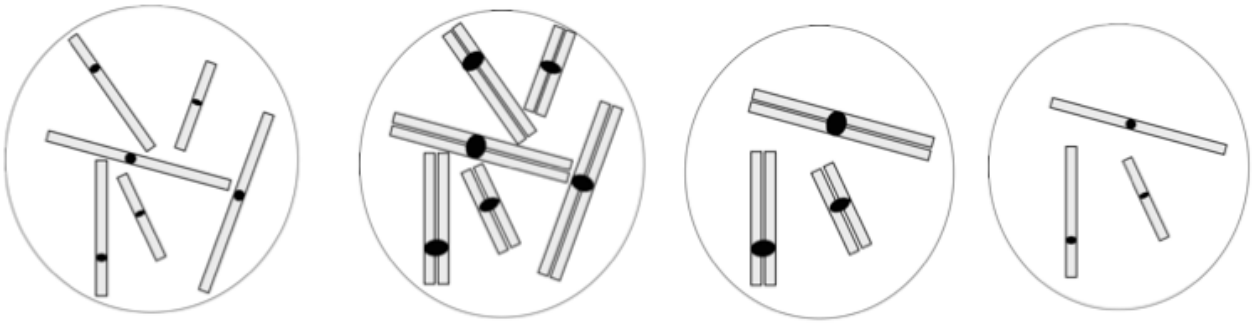
4. On the right is a double stand DNA helix. Transcription is occurring and the mRNA transcript is represented by the arrow. Box B is the promoter segment. The arrow at the end of the mRNA indicates the direction of the transcription. The DNA sequence encoding the start codon for this gene is located in:

A. Box A
B. Box B
C. Box C
D. Note located anywhere



5. A certain cell is diploid and has a total of six chromosomes. If we pretend that its chromosomes remain condensed throughout the cell cycle, which of the diagrams below correctly represents the chromosomes of this cell ***before*** DNA replication. (A)

a) b) c) d)



6. The object represented beside is composed of

A. four single-stranded DNA molecules
B. one double stranded DNA molecule
C. two double-stranded DNA molecules
D. two single-stranded DNA molecules

7. What are the total number of potential nucleotide sequences (combinations) that can be produced from a mRNA molecule containing 8 nucleotides.

   A. About 32 combinations
   B. About 4,000 combinations
   C. About 70,000 combinations
   D. About 300,000 combinations
   E. About 1 million combinations

8. The drug 5-bromouracil (5BU) is used to treat certain forms of cancer. This toxic compound is a base analog of thymine (T) and is incorporated into growing DNA chains. If 5BU is provided to a cancer cell entering the S (synthesis) phase, where will this drug be found in the chromosomes of newly formed daughter cells following mitosis?

   A. All of the chromosomes inherited by all daughter cells would contain 5BU.
   B. Only half of the chromosomes inherited by any given daughter cell would contain 5BU.
   C. Only half of the daughter cells would have 5BU in all of their chromosomes.
   D. Only half of the daughter cells would have no 5BU in their chromosomes.
   E. Both C and D will be seen.

9. Suppose the gene DKN1 is over 2000kb (kilobases) in length; however, the mRNA produced by this gene is only about 14 kb long. What is likely the cause of this discrepancy?

   A. The introns have been spliced out during mRNA processing and are not part of the mature mRNA.
   B. The DNA represents a double-stranded structure, while the RNA is single stranded.
   C. When the mRNA is produced, it is highly folded and therefore less long.
   D. There are more amino acids coded for by the DNA than the mRNA.
   E. The exons have been spliced out during mRNA processing and are not part of the mature mRNA.

10. A woman with no mutations in her X chromosomes has a daughter with a man whose X chromosome has a mutation in the Xist gene. The Xist gene produces a protein that when functional causes the inactivation of that particular chromosome (the chromosome does not get repressed as in the case of the Barr body example). This man also has the X-linked recessive disorder, haemophilia, which impairs the ability to stop bleeding through blood clotting. What are the effects on their daughter in terms of the inactivation of an X chromosome and the daughter's phenotype?

    A. There is no effect; the daughter's phenotype is normal (she does not have haemophilia).
    B. The paternal X chromosome is inactivated in all of the daughter's cells; she has a normal phenotype.
    C. Both the maternal & the paternal X chromosomes remain active in all the daughter's cells; she does not have haemophilia.
    D. The maternal and paternal X chromosomes are randomly inactivated in the daughter's cells; she may have haemophilia if her maternal chromosome is inactivated in blood system cells.
    E. The maternal X chromosome is inactivated in all of the daughter's cells; she therefore has haemophilia.

11. Assume that an mRNA molecule is synthesized using the following DNA template:

    3'-CTTACATGGCATCC-5"

    See the genetic code table. The second codon (counting the start codon as the first codon) directs the incorporation of which amino acid in the polypeptide?

    A. Asparagine
    B. Tyrosine
    C. Arginine
    D. Proline

12. Below are two DNA coding strand sequences. The 5' ATG encodes the "in-frame" start codon.

Hardeep's DNA sequence is: 5' ATG CGCTTA CCC TTA CTC CTA TAA 3'
Karen's DNA sequence is: 5' ATG CGCT**A**A CCC TTA CTC CTA TAA 3'

Karen's mutation causes the premature termination of:

A. Replication
B. Transcription
C. Translation
D. Both B and C

13. 13-deoxtedanolide is an antibiotic that binds to the E site of the ribosome. If 13-deoxytedanolide is added right before translation starts, which one of the statements is True?

A. Translation would not happen.
B. Translation would not be affected.
C. The end product carries a 13-deoxytedanolide before the first amino acid Met.
D. The end product has 2 amino-acids.

14. At the start of translation the initiator tRNA is base paired with the start codon at _____ in the ribosome.

a. the A site
b. first the A site, then the E site
c. the P site
d. first the A site, then the P site

15. Which of the following macromolecules is primarily responsible for the differences between a neuron and a muscle cell?

A. Carbohydrates
B. DNA
C. Lipids
D. mRNA
E. Proteins

16. A plant is homozygous for a mutation in gene *Bfr* (for this gene, the locus on both homologous chromosomes have the mutation). This plant produces a normal Bfr protein in normal amounts. More detailed analysis reveals that the *Bfr* mRNA produced by this plant is two nucleotides shorter than wild type plants (the locus for this gene on both homologous chromosomes of the wild-type plant do not possess the mutation). Where is it most likely that the two base pair deletion occurred?

A. Downstream of the stop codon in the last exon of gene *Bfr*.
B. In an intron of gene *Bfr* away from the splice sites
C. In the open reading frame of gene *Bfr*.
D. Within the promoter region of gene *Bfr*.

17. If a typical somatic cell has 64 chromosomes, how many chromosomes are expected in each gamete of that organism?

A. 8
B. 16
C. 32
D. 64
E. 128

18. Which parts of a eukaryotic gene are transcribed?

A. Only the introns
B. Exons, introns, promoter, and terminator sequence
C. Only the exons
D. It depends on the gene
E. Both the exons and introns

PART B – SHORT ANSWERS

- ANSWER QUESTIONS 19 TO 23 ON THE SCANTRON.
- ANSWER QURESTIONS 24 AND 25 IN THE SPACE PROVIDED.
- Write/print clearly and neatly in the space provided.

Two double-stranded 25 base-pair DNA fragments are heated in solution. Fragment A has 60% GC, and fragment B has 40% GC. Determine if the following statements are True or False. (5 points)

19. At a low enough temperature, both fragments will remain double-stranded.

    a. True
    b. False

20. Fragment A will separate into single strands at a lower temperature than fragment B.

    a. True
    b. False

21. Fragment B will separate into single strands at a lower temperature than fragment A.

    a. True
    b. False

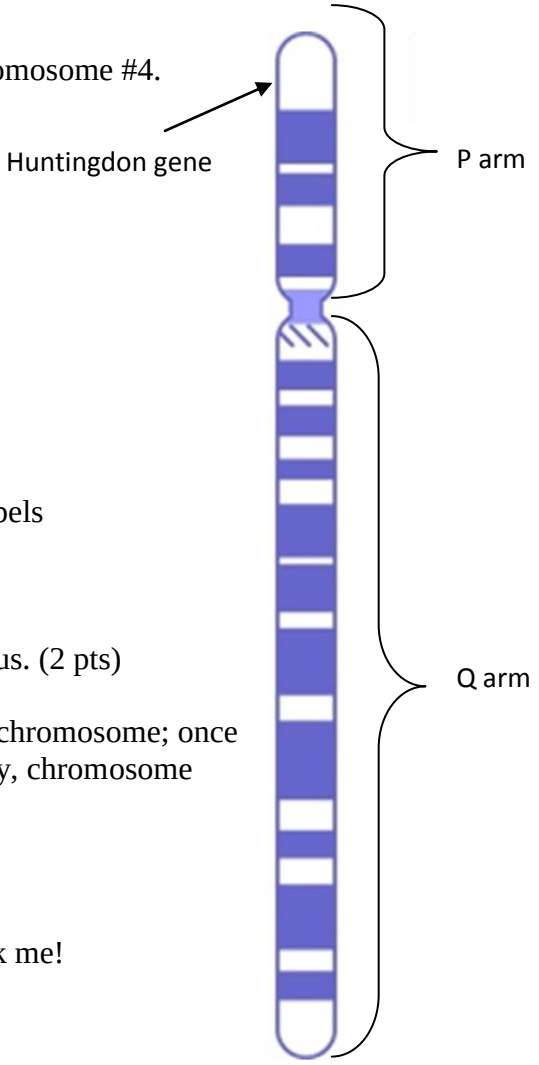
22. At a high enough temperature, both fragments A and B will separate into single strands.

    a. True
    b. False

23. At a high enough temperature, phosphodiester bonds will break before hydrogen bonds.

    a. True
    b. False

24. The ideogram on the right is a representation of the human chromosome #4.



a) On the diagram, label the Q arm and the P arm). (1 pt)

0.5 pts / correct labeling

b) The Huntingdon disease gene is located on this gene. Label the location of this gene if we suppose that its cytological address is 4p7. (1 pt)

1 pt for correct labeling; 0.5 pts for labeling something; 0 pts no labels

c) Explain two benefits that g-banding of chromosomes provides us. (2 pts)

Benefits include: Allows revealing the banding patterns along the chromosome; once Banding is achieved, we can perform a karyotype (thus asses ploidy, chromosome Abnormalities for examples);

1 pt/benefits

They may write something else. If in doubt please research it or ask me!