BROCK UNIVERSITY

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Course: BIOL 1F90
Date of Exam: Monday, December 12
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Instructor: Prof. Doug Bruce

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FHB III:9.1.2B.

Instructions

- **Part A.** Multiple Choice Questions. Use an HB pencil to record your answer to the multiple choice questions on the **Scantron sheet provided**. 1 mark each for a total of 60 marks.
- **Part B.** Short Answer Questions. 4 marks each for a total of 16 marks.
- **Use the last page for your calculations.**

NAME: _____ I.D.: _____

LAB DAY AND TIME: _____

PART A - Multiple Choice Section

1. Which of the following is an important feature of carbon and that makes life possible?
A. Carbon can form a maximum of 8 covalent bonds.
B. Carbon can form a maximum of 6 covalent bonds.
C. Carbon can form a maximum of 4 covalent bonds.
D. Carbon can form a maximum of 2 covalent bonds.
E. None of the choices are possible for carbon.

2. Water held behind a dam would best reflect _____.
A. potential energy
B. kinetic energy
C. chemical energy
D. heat energy
E. mechanical energy

3. A chemical reaction that has a positive ΔG is correctly described as
A. endergonic.
B. endothermic.
C. enthalpic.
D. spontaneous
E. exothermic.

4. Which of the following is NOT a product of the light reactions of photosynthesis?
A. NADPH
B. ATP
C. oxygen
D. carbon dioxide
E. energy intermediates

5. During noncyclic linear electron flow of the light reactions of photosynthesis, which molecule is the final acceptor of the high-energy electron?
A. oxygen
B. P700
C. NADP+
D. P680
E. ATP synthase

6. During photosynthesis, the energy given up by electrons as they move through the electron transport chain is used to
A. produce glucose.
B. fix CO_2.
C. generate an electrochemical H+ gradient across a membrane.
D. oxidize water.
E. boost energy levels of pigment electrons.

7. What is the main role of the pigment molecules within the antenna or light-harvesting complex?
A. Oxidize water and release oxygen to the reaction center chlorophyll.
B. Absorb photons and transfer light energy to the reaction center chlorophyll.
C. Synthesize NADPH.
D. Pass electrons to the electron transport chain and then to NADPH.
E. Increase H^+ concentration in the stroma.

8. What was the most significant conclusion that Gregor Mendel drew from his experiments with pea plants?
A. There is considerable genetic variation in garden peas.
B. Traits are inherited in discrete units, and are not the results of "blending."
C. Recessive genes occur more frequently in the F_1 than do dominant ones.
D. Genes are composed of DNA.
E. An organism that is homozygous for many recessive traits is at a disadvantage.

9. A cross between homozygous purple-flowered and homozygous white-flowered pea plants results in offspring with purple flowers. This demonstrates
A. the blending model of genetics.
B. true-breeding.
C. dominance.
D. a dihybrid cross.
E. the mistakes made by Mendel.

10. Mendel accounted for the observation that traits which had disappeared in the F_1 generation reappeared in the F_2 generation by proposing that
A. new mutations were frequently generated in the F_2 progeny, "reinventing" traits that had been lost in the F_1.
B. the mechanism controlling the appearance of traits was different between the F_1 and the F_2.
C. traits can be dominant or recessive, and the recessive traits were obscured by the dominant ones in the F_1.
D. the traits were lost in the F_1 due to blending of the parental traits.
E. members of the F_1 generation had only one allele for each character, but members of the F_2 had two alleles for each character.

11. In snapdragons, heterozygotes have pink flowers, whereas homozygotes have red or white flowers. When plants with red flowers are crossed with plants with white flowers, what proportion of the offspring will have pink flowers?
A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

The following statement pertains to the next two questions (#12 and #13). A tall plant is crossed with a short plant, and the progeny are all intermediate in size between the two parental plants.

12. This could be an example of
A. incomplete dominance.
B. polygenic inheritance.
C. complete dominance.
D. A or B
E. B or C

13. If the intermediate F_1 progeny were allowed to self-pollinate, and the F_2 progeny were also intermediate in size, but with some variation which followed a "normal" or "bell curve" distribution, this would suggest
A. incomplete dominance.
B. polygenic inheritance.
C. complete dominance.
D. a strong environmental influence.
E. codominance.

14. In certain plants, round seed shape is dominant to wrinkled seed shape. If a heterozygous plant is crossed with a homozygous round seed plant, what is the probability that the offspring will have wrinkled seeds?
A. 1/2
B. 1/4
C. 0
D. 1
E. 1/6

15. The fact that all seven of the pea plant traits studied by Mendel obeyed the principle of independent assortment means that
A. none of the traits obeyed the law of segregation.
B. the diploid number of chromosomes in the pea plants was 7.
C. all of the genes controlling the traits were located on the same chromosome.
D. all of the genes controlling the traits behaved as if they were on different chromosomes.
E. the formation of gametes in plants occurs by mitosis only.

16. In cats, black fur color is caused by an *X-linked* allele; the other allele at this locus causes orange color. The heterozygote is tortoiseshell. What kinds of offspring would you expect from the cross of a black female and an orange male?
A. tortoiseshell female; tortoiseshell male
B. black female; orange male
C. orange female; orange male
D. tortoiseshell female; black male
E. orange female; black male

17. What is genetic cross between an individual showing a dominant phenotype (but of unknown genotype) and a homozygous recessive individual called?
A. a self-cross
B. a testcross
C. a hybrid cross
D. an F_1 cross
E. a dihybrid cross

18. A recessive allele on the X chromosome is responsible for red-green color blindness in humans. A woman with normal vision whose father is color-blind marries a color-blind male. What is the probability that a son of this couple will be color-blind?
A. 0
B. 1/4
C. 1/2
D. 3/4
E. 1

19. How would one explain a testcross involving F_1 dihybrid flies in which more parental-type offspring than recombinant-type offspring are produced?
A. The two genes are linked.
B. The two genes are unlinked.
C. Recombination did not occur in the cell during meiosis.
D. The testcross was improperly performed.
E. Both of the characters are controlled by more than one gene.

20. What does a frequency of recombination of 50% indicate?
A. The two genes are likely located on different chromosomes.
B. All of the offspring have combinations of traits that match one of the two parents.
C. The genes are located on sex chromosomes.
D. Abnormal meiosis has occurred.
E. Independent assortment is hindered.

21. A sexually reproducing animal has two unlinked genes, one for head shape (*H*) and one for tail length (*T*). Its genotype is *HhTt*. Which of the following genotypes is possible in a gamete from this organism?
A. *HT*
B. *Hh*
C. *HhTt*
D. *T*
E. *tt*

22. When crossing a homozygous recessive with a heterozygote, what is the chance of getting an offspring with the homozygous recessive phenotype?
A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

23. *PP* = purple, *Pp* = purple, *pp* = white. The offspring of a cross between two heterozygous purple-flowering plants (*Pp* × *Pp*) results in
A. all purple-flowered plants.
B. purple-flowered plants and white-flowered plants.
C. two types of white-flowered plants: *PP* and *Pp*.
D. all white-flowered plants.
E. all pink-flowered plants

24. Black fur in mice (*B*) is dominant to brown fur (*b*). Short tails (*T*) are dominant to long tails (*t*). What fraction of the progeny of the cross BbTt × BBtt will have black fur and long tails?
A. 1/16
B. 3/16
C. 3/8
D. 1/2
E. 9/16

25. What is the mechanism for the production of genetic recombinants?
A. X inactivation
B. methylation of cytosine
C. crossing over and independent assortment
D. nondisjunction
E. deletions and duplications during meiosis

26. The frequency of crossing over between any two linked genes is
A. higher if they are recessive.
B. different between males and females.
C. determined by their relative dominance.
D. the same as if they were not linked.
E. proportional to the distance between them.

27. A man who carries an X-linked allele will pass it on to
A. all of his daughters.
B. half of his daughters.
C. all of his sons.
D. half of his sons.
E. all of his children.

28. Which of the following statements is *true regarding genomic imprinting?*
A. It explains cases in which the gender of the parent from whom an allele is inherited affects the expression of that allele.
B. It is greatest in females because of the larger maternal contribution of cytoplasm.
C. It may explain the transmission of Duchenne muscular dystrophy.
D. It involves an irreversible alteration in the DNA sequence of imprinted genes.
E. All of the above are correct.

29. The recombination frequency between gene *A* and gene *B is* 20%, the recombination frequency between gene *A* and gene *C* is 12%, and the recombination frequency between gene *B* and gene *C* is 8%. Which is the correct arrangement of these genes?
A. *ABC*
B. *ACB*
C. *BAC*
D. *CAB*
E. *CBA*

The following pertains to the next two questions (#30 and #31). In *Drosophila* the gene for wobbly leg, a recessive trait, has two alleles, "w" for wobbly leg and "W" for wild type leg. The gene for blue nose, a recessive trait, has two alleles, "b" for blue nose and "B" for wild type nose. To begin a mapping procedure, a cross between WWBB and wwbb was made and the resulting progeny WwBb were then test-crossed with wwbb. In this test cross the progeny were as follows; 465 wild type, 472 wobbly leg and blue nose, 35 wobbly leg and wild type nose, 28 wild type leg and blue nose.

30. In this example which one of the following genotypes would be described as recombinant?
A. wwbb
B. WWBB
C. Wwbb
D. WwBb
E. WWBb

31. The recombination frequency between the wobbly leg and blue nose genes is
A. 0.465
B. 0.035
C. 0.063
D. 0.028
E. 0.472

32. If a plant species exhibits maternal inheritance for leaf pigmentation, what is the phenotype of the parents of a variegated (green and white leaves) plant?
A. The maternal plant must be white and the paternal plant must be green.
B. The maternal plant must be green and the paternal plant must be white.
C. The maternal plant must be variegated and the paternal plant can be any color.
D. Both the maternal and paternal plant must be variegated.
E. The maternal plant must be variegated and the paternal plant must be white.

33. A man has a mutation in the ATP synthase gene encode by the mitochondrial genome. This results in an inability to synthesize ATP properly, causing extreme muscle weakness. If this man has children, what is the likelihood that they will inherit this disease from him?
A. 100%
B. 0%
C. 50%
D. 25%
E. 75%

34. It became apparent to Watson and Crick after completion of their model that the DNA molecule could carry a vast amount of hereditary information in its
A. sequence of bases.
B. phosphate-sugar backbones.
C. complementary pairing of bases.
D. side groups of nitrogenous bases.
E. different five-carbon sugars.

35. The strands that make up DNA are antiparallel. This means that
A. the twisting nature of DNA creates nonparallel strands.
B. the 5' to 3' direction of one strand runs counter to the 5' to 3' direction of the other strand.
C. base pairings create unequal spacing between the two DNA strands.
D. one strand is positively charged and the other is negatively charged.
E. one strand contains only purines and the other contains only pyrimidines.

36. What is the function of DNA polymerase?
A. to unwind the DNA helix during replication
B. to seal together the broken ends of DNA strands
C. to add nucleotides to the end of a growing DNA strand
D. to degrade damaged DNA molecules
E. to rejoin the two DNA strands (one new and one old) after replication

37. What kind of chemical bond is found between paired bases of the DNA double helix?
A. hydrogen
B. ionic
C. covalent
D. sulfhydryl
E. phosphate

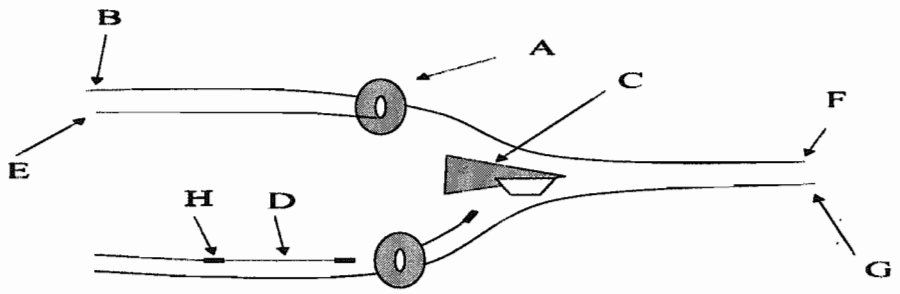
38. Cytosine makes up 38% of the nucleotides in a sample of DNA from an organism. Approximately, what percentage of the nucleotides in this sample will be thymine? Think about it!!!
A. 12
B. 24
C. 31
D. 38
E. It cannot be determined from the information provided.

39. **In his transformation experiments, Griffith observed that**
A. mutant mice were resistant to bacterial infections.
B. mixing a heat-killed pathogenic strain of bacteria with a living nonpathogenic strain can convert some of the living cells into the pathogenic form.
C. mixing a heat-killed nonpathogenic strain of bacteria with a living pathogenic strain makes the pathogenic strain nonpathogenic.
D. infecting mice with nonpathogenic strains of bacteria makes them resistant to pathogenic strains.
E. mice infected with a pathogenic strain of bacteria can spread the infection to other mice.

40. For a science fair project, two students repeat the Hershey and Chase experiment with viruses and bacteria, with the following modifications. They want to label the nitrogen of the DNA, rather than the phosphate. They reasoned that each nucleotide has only one phosphate and two to five nitrogens. Thus, labeling the nitrogens would provide a stronger signal than labeling the phosphates. Why won't this experiment work?
A. There is no radioactive isotope of nitrogen.
B. Radioactive nitrogen has a half-life of 100,000 years, and the material would be too dangerous
C. Meselson and Stahl already did this experiment.
D. Although there are more nitrogens in a nucleotide, labeled phosphates actually have 16 extra neutrons; therefore, they are more radioactive.
E. Amino acids (and thus proteins) also have nitrogen atoms; thus, the radioactivity would not distinguish between DNA and proteins.

41. Which of the following help to hold the DNA strands apart while they are being replicated?
A. primase
B. ligase
C. DNA polymerase
D. single-strand binding proteins
E. exonuclease

The following diagram pertains to the next three questions (#42, 43, 44)



42. In the above diagram which one of the following statements is true?

A) F and G are 3' ends
B) B and G are 5' ends
C) B and F are 5' ends
D) B and G are 3' ends
E) B and E are 3' ends

43. In the above diagram "A" is

A. DNA polymerase III
B. DNA polymerase I
C. Single strand stabilizing protein
D. Helicase
E. Primase

44. In the above diagram "D" is

A. Helicase
B. DNA ligase
C. Okazaki fragment
D. RNA primer
E. Single strand stabilizing protein

45. Using RNA as a template for protein synthesis instead of translating proteins directly from the DNA is advantageous for the cell because

A. RNA is much more stable than DNA.
B. RNA acts as an expendable copy of the genetic material, allowing the DNA to serve as a permanent, pristine repository of the genetic material.
C. many mRNA molecules can be transcribed from a single gene, increasing the potential rate of gene expression.
D. B and C only
E. A, B, and C

46. If the triplet CCC codes for the amino acid proline in bacteria, then in plants CCC should code for
A. leucine.
B. valine.
C. cystine.
D. phenylalanine.
E. proline.

47. What kind of molecule or substance is the primer that is used to initiate the synthesis of a new DNA strand?
A. RNA
B. DNA
C. protein
D. phosphate
E. sulfur

48. After DNA replication is completed,
A. each new DNA double helix consists of one old DNA strand and one new DNA strand.
B. each new DNA double helix consists of two new strands.
C. one DNA double helix consists of two old strands and one DNA double helix consists of two new strands.
D. each of the four DNA strands consists of some old strand parts and some new strand parts.
E. there are four double helices.

49. Once transcribed, eukaryotic mRNA typically undergoes substantial alteration that includes
A. excision of introns.
B. fusion into circular forms known as plasmids.
C. linkage to histone molecules.
D. union with ribosomes.
E. fusion with other newly transcribed mRNA.

50. The process that produces mRNA from DNA is called
A. transcription.
B. translation.
C. replication.
D. processing.
E. post-translational modification.

51. Transcription begins near a site in the DNA called the _____, while the terminator specifies the end of transcription.
A. promoter
B. enhancer
C. response element
D. transcription unit
E. regulatory sequence

52. If a DNA template strand has a sequence of 3′ TACAATGTAGCC 5′, then the RNA produced from it will be which sequence?
A. 3′TACAATGTAGCC5′
B. 5′ATGTTACATCGG3′
C. 5′AUGUUACAUCGG3′
D. 3′AUGUUACAUCGG5′
E. 3′ATGTTACATCGG5′

53. Intervening sequences that are transcribed, but not translated into protein are called
A. exons.
B. introns.
C. splicesomes.
D. transposons.
E. transcription factors.

54. Which of the following statements about RNA processing in eukaryotes is INCORRECT?
A. Introns are simply excised out of pre-mRNA to produce the mature mRNA.
B. A snRNP complex is used to remove introns from the pre-mRNA.
C. A poly A tail is added on to the 3′ end of the mRNA.
D. A 7-methylguanosine cap is added on to the 5′ end of the mRNA.
E. Processing occurs in the nucleus.

55. Which of the following statements about the mRNA start codon is INCORRECT?
A. The start codon is only a few nucleotides from the ribosomal binding site.
B. The start codon is usually GGA.
C. The start codon is usually AUG.
D. The start codon specifies the amino acid, methionine.
E. The start codon defines the reading frame.

56. What type of bonding is responsible for maintaining the shape of the tRNA molecule?
A. covalent bonding between sulfur atoms
B. ionic bonding between phosphates
C. hydrogen bonding between base pairs
D. van der Waals interactions between hydrogen atoms
E. peptide bonding between amino acids

57. Which of these correctly illustrates the pairing of DNA and RNA nucleotides?
A. GTTACG with CAATCG
B. GTTACG with CAAUGC
C. GTTACG with GTTACG
D. GTTACG with ACCGTA
E. GTTACG with UAACAU

58. What are polyribosomes?
A. groups of ribosomes reading a single mRNA simultaneously
B. ribosomes containing more than two subunits
C. multiple copies of ribosomes associated with giant chromosomes
D. aggregations of vesicles containing ribosomal RNA
E. ribosomes associated with more than one tRNA

59. During translation, chain elongation continues until what happens?
A. No further amino acids are needed by the cell.
B. All tRNAs are empty.
C. The polypeptide is long enough.
D. A stop codon is encountered.
E. The ribosomes run off the end of mRNA.

60. The term N-terminus refers to the presence of a(n) _____ at the 5′ end of a polypeptide.
A. oxygen atom
B. carboxyl group
C. amino group
D. carbonyl group
E. sulfate group

PART B. - Short Answer questions (4 marks each)

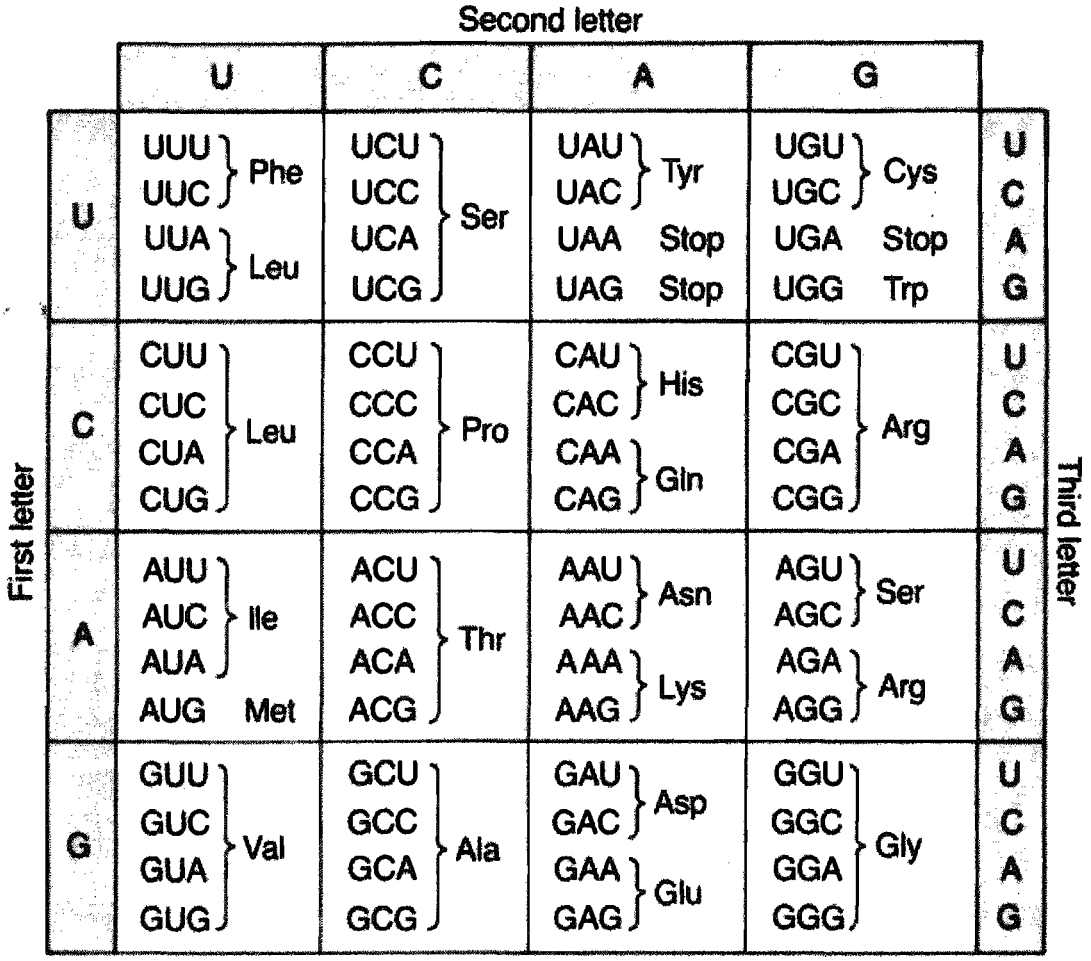
1. Draw the ring structure of glucose

2. Draw the structure of an amino acid of your choice, name it correctly for a bonus point

3. The following piece of mRNA codes for what sequence of amino acids? Make sure you label the "C" terminus and the "N" terminus of your oligopeptide. You can find the genetic code on the last page of the exam.

   5' UUGCCAUGCCGGUUAAGGCGUUUUAGCAA 3'

4. Dr. Bruce's telomeres are shorter than 97% of the students in BIOL 1F90. What does this say about him and why are his telomeres shorter?


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