CHERCHER PREPARATORY SCHOOL

Genetics Worksheet for Grade 12 Natural Science Students, 2012/2020

Section I: Genetic Crosses

1. What kind of gametes would be produced by organism having the following genotypes?
   a. AaBB b. AaBb
2. For pea plants with the following genotypes, list the possible gametes that the plant can make:
   a. TT Yy Rr b. Tt YY rr c. Tt Yy Rr d. tt Yy rr
3. For each genotype below, indicate whether it is heterozygous or homozygous.
   a. Ff b. QQ
4. If an organism produced the gametes DE and dE, what is its genotype?
5. If an organism produced the gametes TYR, Tyr, TyR and Tyr, what is its genotype?
6. Describe the difference between genotype and phenotype. Is it possible for two individuals to have the same phenotype but different genotypes?
7. Suppose you have a dog of the genotype FfHh, what are the possible gametes that it can produce if the genes are not linked?
8. What kind of gametes would be produced by an organism having the genotype PpQQRr?
9. Describe three advantages of using pea plants as an experimental organism.
10. Assume that genes A and B are not linked. If the probability of allele A in a gamete is 1/2 and the probability of allele B in a gamete is 1/2, then what is the probability that both A and B are in the same gamete?
11. BbCCDd is the genotype of an organism. How many different types of gametes can this organism produce?
12. Suppose you identify a new gene in mice. One of its alleles specifies white fur, another specifies brown. You want to see if the two interact in simple or incomplete dominance. What sorts of genetic crosses would give you the answer?
13. If a corn plant has a genotype of Ttyy, what are the possible genetic combinations that could be present in a single grain of pollen from this plant?

14. A single gene has three alleles. In a diploid organism, how many possible genotypes are there involving this gene?
15. If the parents of a family already have two boys, what is the probability that the next two offspring will be girls?
16. In all of Mendel's crosses, the F_2 plants displayed a 3:1 ratio of dominant to recessive traits. Of those showing the dominant character, what proportions were pure – breeding?
17. In garden peas the allele for being tall, T, is dominant to the allele for being short, t. How could you tell whether a tall garden pea was Tt or TT, given that you have short garden peas that you know are tt?
18. With regard to genotypes, what is a true-breeding organism?
19. How can you determine whether an organism is heterozygous or homozygous for a dominant trait?
20. In humans, brown eye color (B), is dominant over blue eye color (b). What is the phenotype of the Bb individuals?
21. In humans, the gene that allows you to roll your tongue is a dominant allele. Use a Punnett square to show how two 'roller' parents could have a child who is a 'non–roller'.
22. In Mendel's experiments, if the gene for tall (T) plants was incompletely dominant over the gene for short (t) plants, what would be the result of crossing two Tt plants?
23. In mice, agouti coat color is due to codominant alleles. Hairs, when viewed under a microscope are grey at the base and white at the tip. An agouti mouse will result from a cross between a black parent and a white parent. What will two agouti mice produce?
24. In monohybrid cross between pure tall and pure dwarf pea plant, how many types of genotypes are found in F_2 generation?
25. In pea plants, the long-stem trait (L) is dominant and the short-stem train (l) is recessive. Two pea plants were crossed, producing seeds that yielded 165 long-stem plants and 54 short-stem plants. What were the genotypes of the parent plants?
26. If, due to incomplete dominance, the F_1 plants from a cross of red flowered X white flowered parents are pink, what is the expected ratio in the F_2 generation?

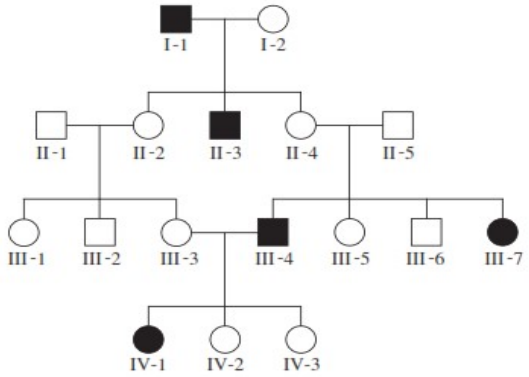
27. In raccoons, a dark face mask is dominant over a bleached face mask. Several crosses were made between raccoons that were heterozygous for dark face mask and raccoons that were homozygous for bleached face mask. What percentage of the offspring would be expected to have a dark face mask?
28. In sheep, eye color is controlled by a single gene with two alleles. When a homozygous brown-eyed sheep is crossed with a homozygous green-eyed sheep, blue-eyed offspring are produced. If the blue-eyed sheep are mated with each other, what percent of their offspring will most likely have brown eyes?
29. In a certain species of mouse, gray fur (G) is dominant over cream-colored fur (g). If a homozygous gray mouse is crossed with a cream-colored mouse, what will be the genotype of the F_1 generation?
30. Suppose 800 pea plants are produced from Tt x Tt cross, how many of them are expected to be pure tall?
31. Mendel crossed pure line pea plants with green pods, and pure line plants with yellow pods. All the F_1 plants had green pods. Out of 580 F_2 plants, 435 had green pods and 145 had yellow pods.
    a. Which characteristic is dominant and which is recessive?
    b. In the F_2 plants how many are homozygous recessive, homozygous dominant, and heterozygous?
32. Suppose in a monohybrid cross 80 F_2 plants were produced, what is the number of the plants that are expected to have the dominant and the recessive phenotypes?
33. Two parents of genotype Nn are cross-bred. The alleles show complete dominance. What proportion of the offspring will phenotypically look like their parents?
34. When round squash are crossed with long squash, all offspring are oval in shape. How many genotypes are produced when round squash are crossed with oval squash?
35. A man is brought to court in a paternity case. The alleged father has blood group AB. The mother has blood group A. What blood group of the child will exclude the alleged father from possible paternity?

36. The gene for no eyes in fruit flies is recessive; that for normal eyes is dominant. A male with no eyes is mated with a female who is pure for normal eyes. They produce 100 offspring, which are bred with one another and which produce 2000 offspring.
    a. How many of the F_1 generation are blind?
    b. How many of the F_1 generation carry the recessive allele for no eyes?
    c. How many of the F_2 generation have normal vision?
    d. How many of the F_2 generation are hybrid for normal vision?
37. The genotypes of a husband and wife are AB x AO. Among the blood types of their children, how many different genotypes and phenotypes are possible?
38. What percentage of tall plants results from a cross between hybrid tall and pure short pea plants?
39. When homozygous dominant parent is crossed with heterozygous parent, what is the percentage of offspring with different phenotype than either parent?
40. When Mendel selfed F_1 generation, he obtained 1064 offspring in F_2 generation. How many of them were dwarf out of these 1064 garden pea plants?
41. A man with blood group O married to a woman with blood group B had a child with blood group O. What is the genotype of the mother?
42. A man with blood type B marries a woman with blood type A. Their first child is blood type O. What is the probability their next child will be blood type AB?
43. A test cross is designed to determine the genotype of a parent with the dominant phenotype. A test cross produces progeny that are 1/2 tall and 1/2 dwarf. What is the genotype of the tall parent?
44. Dwarfism is due to a dominant allele that is also lethal in a homozygous state. If two dwarfs are married, what are the odds that their child will not be viable?
45. A woman is married for the second time. Her first husband was blood type B, and her child by that marriage was type AB. Her new husband is type A, and their child is type O. What is the woman's genotype?

46. Albinism (lack of pigment) in man is caused by recessive gene. If normal parents have an albino child, what is the probability that their next child will be normal?
47. An extra finger in man occurs rarely. It is due to a dominant gene. Suppose one parent is normal and the other parent has an extra finger, but is heterozygous for the trait. What is the probability that their next child will be normal?
48. As was shown by Gregor Mendel in garden pea, what percentage of the F_2 generation of a monohybrid cross has the recessive phenotype?
49. Assume that E (gene for brown eye) is dominant over e (gene for blue eyes) and that the father and the mother have both genes in their sex cells, what would be the proportion of homozygous children for eye colour?
50. A couple has 5 children, all boys. If the woman gives birth to a sixth child, what is the probability that the sixth child will be a girl?
51. Ato Chala and W/ro Chaltu have a little boy who has cystic fibrosis. Cystic fibrosis is caused by an autosomal recessive allele. What is the probability of their next child also having cystic fibrosis? Neither Ato Ali nor W/ro Fatuma have the condition.
52. A human disease known as cystic fibrosis is inherited as a recessive trait. Two unaffected individuals have a first child with the disease. What is the probability that their next two children will not have the disease?
53. A genetic cross between two F_1 hybrid pea plants having yellow seeds (dominant) will yield what percent green–seeded (recessive) plants in the F_2 generation?
54. Chaltu is short. Her parents are both tall. If tallness (T) is dominant over shortness (t), what were the genotypes of the parents?
55. Would it be possible to deduce the law of independent assortment from a monohybrid experiment? Explain your answer.
56. Coat color in a certain species of animal is governed by multiple alleles. The order of decreasing dominance for these alleles is as follows: black (B), buff, (f), brown (r) and albino (b). What phenotypic ratios are observed from Bb X rb cross?

57. If a person is Wwtt is married to a person who is wwTt, what proportion of their offspring will have a widow's peak and can twist their tongue provided that widow's peak is dominant and tongue twisting is recessive.

58. For the following pedigree, describe what you think is the most likely inheritance pattern (dominant versus recessive). Explain your reasoning. Filled (black) symbols indicate affected individuals.



59. Three babies were recently mixed up at Chiro hospital. The blood types of the parents and babies are shown below. Determine which baby belongs to which parents.

Parents	Blood type
I	A and B
II	A and A
III	AB and O

Baby	Blood type
1	B
2	O
3	AB

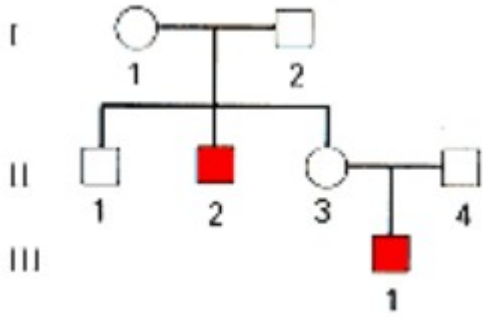
60. In a testcross of AaBb, where the genes show independent assortment, what is the expected frequency of aabb progeny?

61. A tall pea plant with axial flowers was crossed to a dwarf plant with terminal flowers. Tall plants and axial flowers are dominant traits. The following offspring were obtained: 27 tall, axial flowers; 23 tall, terminal flowers; 28 dwarf, axial flowers; and 25 dwarf, terminal flowers. What are the genotypes of the parents?

62. In squirrels, the gene for gray fur (G) is dominant over the gene for black fur (g). If 50% of a large litter of squirrels are gray, what was the most likely parental cross that produced this litter?

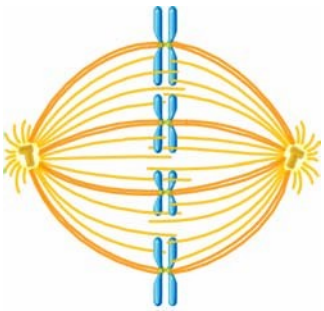
63. In the genetic cross, RrYy x RrYy, what is the probability of the offspring possessing at least one recessive trait in their phenotype?
64. Normal skin is dominant over albino skin. The ability to taste PTC (Phenylthiocarbamide) is dominant over the inability to taste. A normally pigmented woman who is a taster has a father who is an albino non-taster. She marries a normal man who is heterozygous for both traits.
    a. What is the genotype of the woman?
    b. What is the genotype of the man?
    c. What fraction of the children will be taster albinos?
    d. What fraction will be normally pigmented tasters?
    e. What fraction will be non-taster albinos?
65. How many genotype classes are possible from a dihybrid cross of two heterozygotes in which genes involved show complete dominance?
66. Red fruit is dominant to yellow fruit in tomatoes. Tallness is dominant to shortness in these plants. What phenotype and genotype ratios would you predict for the offspring of parent plants, one of which is red homozygous and tall homozygous, and the other of which is red heterozygous and tall heterozygous?
67. Regarding seed characteristics, suppose a heterozygous round yellow pea plant of RrYy genotype is selfed and produced 128 seeds, how many of the seeds are expected to be round yellow?
68. Two true-breeding stocks of garden peas are crossed. One parent had red, axial flowers, and the other had white, terminal flowers; all F_1 individuals had red, axial flowers. If 1,600 F_2 offspring resulted from the cross, how many of them would you expect to have red, terminal flowers?
69. Determine the probability that a plant of genotype CcWw will be produced from parental plants of the genotypes CcWw and Ccww.
70. A male beetle has the genotype Ttbb. If this beetle mates with a female with genotype TTBb, what is the chance their offspring will have the genotype TtBb?

71. A tall pea plant with terminal flowers (flowers on the ends of the stems) is crossed with a short plant that has axial flowers. All 72 offspring are tall with axial flowers. This is a dihybrid cross with the height and flower position traits showing independent assortment.
    a. Name the dominant and recessive alleles.
    b. Give the genotypes of the parents and offspring in this cross.
    c. Predict the F_2 offspring when the tall-axial F_1's are allowed to self pollinate.
72. In the pedigree illustrated, the shaded symbols represent persons affected with an X-linked recessive form of mental retardation. What are the genotypes of all the persons in this pedigree?



73. Both Chala and Chaltu are heterozygous for both freckles and white forelock, both dominant traits. What is the probability that their child will not have freckles and will not have a white forelock?
74. A dog with the hypothetical genotype DDEE is crossed to a dog that is ddee, and then the F_1 progeny are test crossed. What percent of the progeny of the test cross will be ddee if the two genes are unlinked?
75. If a woman who is not a carrier for hemophilia is married to a man who is a hemophiliac. What percentage of their male offspring could be expected to be hemophiliacs?
76. In cats, the gene for calico coat color is both codominant and X-linked. If a black and yellow cat are mated, what will be the result?
77. A heterozygous pea plant that is tall with yellow seeds, TtYy, is allowed to self-fertilize. What is the probability that an offspring will be either tall with yellow seeds, tall with green seeds, or dwarf with yellow seeds?

78. If a plant cell having 16 chromosomes undergoes meiotic cell division, how many chromosomes would the resulting daughter cells have?
79. If we cross AaBbCcDd X AaBbCcDd, what is the probability of obtaining the genotype AaBbCcDd? [Use multiplication rule.[1] No need for Punnett square!]
80. If we cross RrYyTtss X RryyttSs, what is the probability of obtaining the genotype RrYyTtSs?
81. What happens to chromosomes during interphase?
82. During which stage of a cell's cycle does DNA replication occur?
83. A diploid cell has eight chromosomes, four per set. For the following diagram, in what phase of mitosis, meiosis I or meiosis II, is this cell?



84. Why is it impossible for synapsis to occur during meiosis II?
85. Can a haploid cell undergo meiosis? Why or why not?
86. What are the major sources of variation in the process of meiosis?
87. Somatic cells of individuals with Down syndrome usually have an extra chromosome21; they contain forty-seven chromosomes. At which stages of meiosis I and II could a mistake alter the chromosome number?
88. How much variation as a result of independent assortment can occur in cells with the following diploid numbers: 2, 4, 6, 8, and 22?
89. Theoretically, if a female haemophiliac married a normal male, what percentage of their male offspring would be expected to have haemophilia?

[1] The probability of two independent events, A and B, being realized simultaneously is given by the product of their separate probabilities.

90. In humans colorblindness is an example of a sex-linked recessive trait. In this problem, a male with colorblindness marries a female who is not colorblind but carries the allele. Using a Punnett square, determine the genotypic and phenotypic probabilities for their potential offspring.
91. Colour blindness is due to an X – linked recessive gene. Suppose a woman heterozygous for color blindness marries a normal visioned man, what proportion of their children will be color blind?
92. A man with hemophilia lives a full life through modern medicine. He eventually marries a normal woman and wants to have children, but his wife is worried that their children will have the disease. What phenotypes are likely in their children?
93. In the human population, mutation of two genes on the X chromosome causes two types of X-linked hemophilia (A and B). In a few cases, a woman is heterozygous for both mutated alleles (one on each of the X chromosomes). All of her sons should have either hemophilia A or B. However, on very rare occasions, one of these women gives birth to a son who does not have hemophilia, and his one X chromosome does not have either mutated allele. Explain how such an X chromosome could arise.
94. An unaffected woman (i.e., without disease symptoms) who is heterozygous for the X-linked allele causing Duchenne muscular dystrophy has children with a man with a normal allele. What are the probabilities of the following combinations of offspring?
    a. An unaffected son
    b. An unaffected son or daughter
    c. A family of three children, all of whom are affected
95. Red kernel color in wheat results from the presence of at least one dominant allele of each of two independently segregating genes (in other words, R_ B_ genotypes have red kernels). Kernels on rrbb plants are white, and the genotypes R_ bb and rrB_ result in brown kernel color. Suppose that plants of a variety that is true breeding for red kernels are crossed with plants true breeding for white kernels. What are the expected phenotypic classes in the F_2 progeny and their relative proportions?

96. A type of muscular dystrophy is sex linked. If a woman is a carrier for the disease, what proportion of her sons will have the disease?
97. With respect to X-linked alleles, how many different types of gametes can a male produce?
98. If a female is homozygous for an X-linked allele, how many types of gametes can she produce with respect to that allele?
99. If a female is heterozygous for an X-linked allele, how many types of gametes might she produce with respect to that allele?

Section II: Molecular Genetics

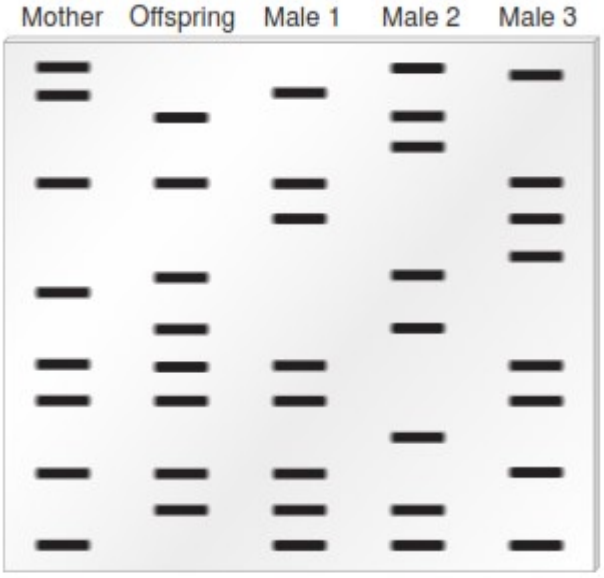
1. Describe the physical and chemical characteristics of DNA.
2. Explain why DNA fragments can be separated using an electrical current.
3. What is the significance of DNA replication in your body?
4. Write a short overview, in paragraph form, of the process of DNA replication.
5. The below table (Table 1) shows the distribution of nucleotides that originated from analysis of single-stranded DNA and double-stranded DNA. Identify which of the samples A, B, and C are most likely double stranded and which are single stranded.

Sample	Adenine	Guanine	Thymine	Cytosine
A	10%	40%	10%	40%
B	35%	10%	35%	20%
C	15%	25%	20%	40%

6. A molecule of DNA was analyzed and found to contain 20% thymine. Calculate the percentage of adenine, guanine, and cytosine in this molecule.
7. An organism has a G+C content of 64% in its DNA. What are the percentages of A, T, G, and C?
8. A double-stranded DNA molecule is separated into its constituent strands, and the strands are separated in an ultracentrifuge. In one of the strands the base composition is 24 percent A, 28 percent T, 22 percent G, and 26 percent C. What is the base composition of the other strand?
9. The base composition of an RNA virus was analyzed and found to be 14.1% A, 14.0% U, 36.2% G, and 35.7% C. Would you conclude that the viral genetic material is single-stranded RNA or double-stranded RNA?
10. Bacterial chromosomes have one origin of replication, where as eukaryotic chromosomes have several. Would you expect viral chromosomes to have an origin of replication? Why or why not?

11. Explain why it is necessary for eukaryotic DNA to have multiple replication origin sites.
12. When Watson and Crick built their model of DNA, they immediately proposed a semiconservative mode of replication. Provide justification for their initial hypothesis.
13. A cell's DNA is always maintained in the nucleus. Provide the rationale for why this is optimal for a cell's long-term survival.
14. In what ways are the structures of an α helix in proteins and the DNA double helix similar, and in what ways are they different?
15. Place the major steps in the cloning of DNA in the correct order by numbering them from 1 to 4.
    a. Construction of a recombinant DNA molecule
    b. Selection of cells containing recombinant molecule
    c. Introduction of the recombinant DNA into a host cell
    d. Generation of DNA fragments using restriction endonucleases
16. Outline the process of PCR. Be sure to describe the characteristics of a PCR cycle.
17. PCR is based on the natural process of DNA replication that occurs in the cell. In a comparative format, list the steps of DNA replication and PCR. Indicate how the steps of DNA replication are accomplished outside of a cell using PCR.
18. The following fragments were obtained after digestion of a sequence using restriction enzymes: 5.3 kb, 2.1 kb, 6.8 kb, 3.6 kb, 1.1 kb, 2.2 kb. Order the fragments, moving from the fastest migration to the slowest migration on a gel.
19. Which of the following DNA double helices would be more difficult to separate into single-stranded molecules by treatment with heat, which breaks hydrogen bonds? Explain your choice.
    a. GGCGTACCAGCGCAT
       CCGCATGGTCGCGTA
    b. ATACGATTTACGAGA
       TATGCTAAATGCTCT
20. What is DNA fingerprinting? How can it be used in human identification?

21. Here are DNA fingerprints of five people: a child, mother, and three potential fathers. Which males can be ruled out as being the father? Explain your answer.



Section III: Protein Synthesis

1. Describe the relationship between genes and proteins. How might an error in a gene result in a change in protein sequence?
2. State the central dogma of molecular genetics.
3. Place the following steps of translation in the correct order by numbering them from 1 to 9.
   a. A tRNA molecule carrying the amino acid methionine binds at its anticodon site to the mRNA start codon.
   b. The ribosome links the first amino acid to the second amino acid to begin the amino acid chain.
   c. The ribosome continues to link each amino acid to the growing amino acid chain.
   d. The ribosome reaches a stop codon.
   e. An mRNA binds to a ribosome.
   f. The mRNA and the completed amino acid chain separate from the ribosome.
   g. The first tRNA, separated from its amino acid, releases from the mRNA.
   h. A tRNA molecule carrying the second amino acid binds to the second mRNA codon.
   i. Each tRNA releases from the mRNA after it is separated from its amino acid.
4. For each of the following, identify the type of RNA involved (mRNA, rRNA, or tRNA).
   a. Transports the correct amino acid to the ribosome, using the information encoded in the mRNA.
   b. Is a major component of ribosomes.
   c. Specfies the order of amino acids in a protein, using a series of three-base codons, where different amino acids are specified by particular codons.
   d. Contains a three-base anticodon that pairs with a complementary codon revealed in the mRNA.
   e. Assists in making the bonds that link amino acids together to make a protein.
5. Transcribe the sequence of a fragment of DNA shown below into mRNA.

GGATCAGGTCCAGGCAATTTAGCATGCCCCAA

6. Using the genetic code given below, decipher the following mRNA sequence:

5′ – GGCAUGGGACAUUAUUUUGCCCGUUGUGGUGGGGCGUGA – 3′

1st Base	2nd (middle) Base of a Codon				3rd Base
	U	C	A	G	
U	UUU Phe UUC Phe UUA Leu UUG Leu	UCU Phe UCC Phe UCA Leu UCG Leu	UAU Tyr UAC Tyr UAA STOP UAG STOP	UGU Cys UGC Cys UGA STOP UGG Trp	U C A G
C	CUU Leu CUC Leu CUA Leu CUG Leu	CCU Pro CCC Pro CCA Pro CCG Pro	CAU His CAC His CAA Gln CAG Gln	CGU Arg CGC Arg CGA Arg CGG Arg	U C A G
A	AUU Ile AUC Ile AUA Ile **AUG Met***	ACU Thr ACC Thr ACA Thr ACG Thr	AAU Asn AAC Asn AAA Lys AAG Lys	AGU Ser AGC Ser AGA Arg AGG Arg	U C A G
G	GUU Val GUC Val GUA Val GUG Val	GCU Ala GCC Ala GCA Ala GCG Ala	GAU Asp GAC Asp GAA Glu GAG Glu	GGU Gly GGC Gly GGA Gly GGG Gly	U C A G

Table 2 The genetic code comprises 64 triplet nucleotides. Sixty-one of the codons specify 20 different amino acids and three codons signal termination. The start codon, AUG, also codes for methionine (Met).

***** The codon AUG codes for methionine (Met) and is the (almost) universal start codon. Occasionally GUG or UUG act as start codons.

7. A tRNA has the anticodon sequence 3′–CAG–5′. What amino acid does it carry?
8. How many different sequences of mRNA could encode a peptide with the sequence proline-glycine-methionine-serine?
9. If a tRNA molecule carries a glutamic acid, what are the two possible anticodon sequences that it could contain?
10. The amino acid sequence for a certain peptide is Leu–Tyr–Arg–Trp–Ser. How many nucleotides are necessary in the DNA to code for this peptide?

11. What amino acid sequence will be generated during translation from the following small mRNA: …CCC-AUG-UCU-UCG-UUA-UGA-UUG…? (Hint: Remember where translation starts and stops.)
12. The following nucleic acid is an entire primary transcript (pre-mRNA not yet processed): ACGCAUGCGaugaugccccucagGUCUguuuccgugaUGCCGUUGACCUGA. The nucleotides in capitals are exons; and the nucleotides in lowercase type are introns. Appropriately splice this primary transcript.
13. In a hypothetical situation, 85 amino acids exist and there are still only 4 nucleotides found in nucleic acid. Calculate the minimum number of nucleotides required to code for this large number of amino acids. What is the maximum number of amino acids your answer would code for?
14. Differentiate between transcription and translation in terms of their purpose and location.
15. Why can DNA in one organism be used to make the same protein in another organism?
16. The genetic code is universal. With the exception of a few organisms, all living things use the same code to build proteins. List possible ramifications (consequences) to the biotechnology industry and to the theory of evolution if this were not the case.
17. In eukaryotes, mRNA must be modified before it is allowed to exit the nucleus.
    a. Describe the modifications that are made to eukaryotic primary transcript.
    b. Explain how these modifications ensure that mRNA survives in the cytoplasm and is translated into a functioning protein.
18. Differentiate between the following:
    a. P site and A site
    b. codon and anticodon
    c. start codon and stop codon
    d. charged tRNA and uncharged tRNA
19. All incoming tRNAs must enter the A site first and then shift to the P site after peptide bond formation. Name the exception to this rule and explain this occurrence.

20. A mutation within a gene sequence changes the start codon to a stop codon. How will this mutation affect the transcription of this gene?
21. Outline the process of gel electrophoresis. List the properties of DNA that are used to achieve band separation.
22. Provide an example of why it is advantageous for a cell to control gene expression.
23. How is gene expression similar to DNA replication, and how is it different? Give at least one similarity and one difference.
24. Mutations that occur at the end of a gene may alter the sequence of the gene and prevent transcriptional termination. If a mutation prevented transcriptional termination at the end of a gene, where would gene transcription end? Or would it end?

Section IV: Mutations

1. What is a mutation? Explain why a mutation may be disadvantageous for the wellbeing of an organism. Provide examples of mutagens that may induce mutations.
2. Name three factors that can produce gene mutations.
3. Define the following terms: frameshift mutation, point mutation, nonsense mutation, missense mutation.
4. What is a silent mutation? Provide an example.
5. Both chromosomal and point mutations occur in DNA. In what ways do they differ?
6. Explain why mutations, such as nitrogen-base additions, are often much more harmful than nitrogen-base substitutions.
7. Which of two types of mutations, nonsense or missense, would be more harmful to an organism? Justify your answer using your knowledge of protein synthesis.
8. Using the genetic code, list all the codons that can possibly be altered to become a stop codon by substitution by one base.
9. Determine whether or not the following mutations would be harmful to an organism. Translate the mRNA sequence into protein to help you decide. The mutation is indicated in red.
   a. AUG UUU UUG CCU UAU CAU CGU
      AUG UUU UUG CCU UAC CAU CGU
   b. AUG UUU UUG CCU UAU CAU CGU
      AUG UUU UUG CCU UAA CAU CGU
   c. AUG UUU UUG CCU UAU CAU CGU
      AUG UUU CUU GCC UUA UCA UCG U
   d. AUG UUU UUG CCU UAU CAU CGU
      AUG UUU UUG CCU AUC AUC GU
   e. AUG UUU UUG CCU UAU CAU CGU
      UGC UAC UAU UCC GUU UUU GUA