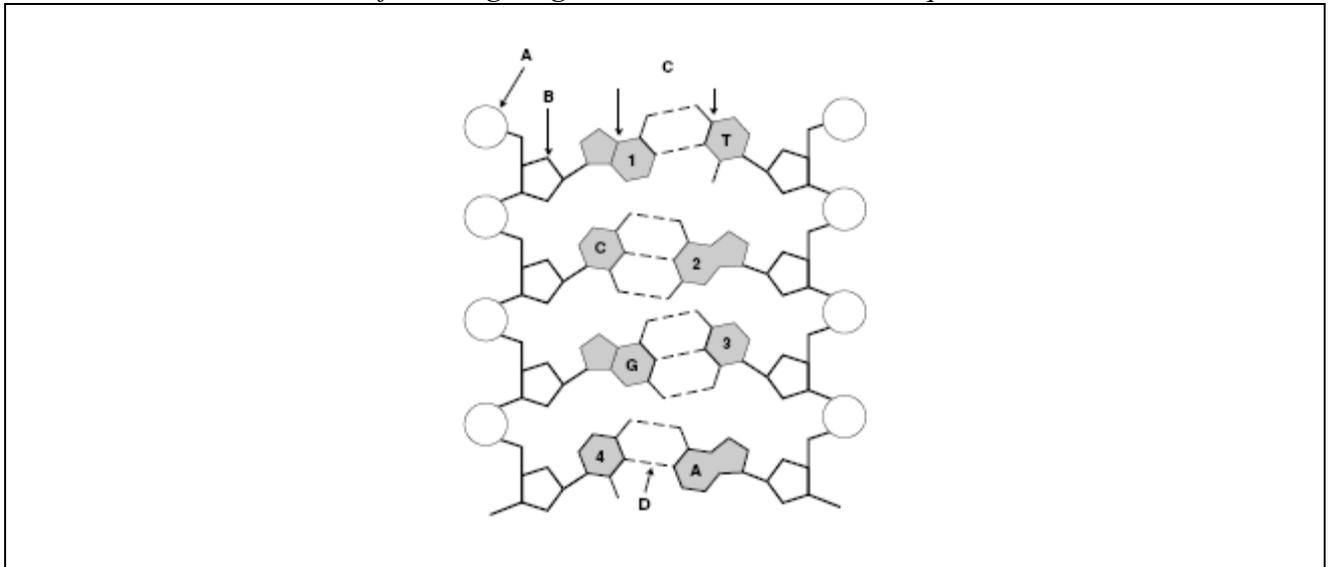


## Multiple Choice Questions

- Decide which of the choices best completes the statement or answers the question.
  - Locate that question number on the separate answer sheet provided.
  - Use the procedure described by your teacher to answer each question. For example, “fill in the circle that corresponds to your choice” or “make an X over the letter corresponding to your choice.”
- The double-helix model of DNA resembles a twisted ladder in which the “rungs” of the ladder are
    - a purine paired with a pyrimidine base.
    - A paired with G; C paired with T.
    - a sugar-phosphate paired with a sugar phosphate molecule.
    - two purine bases paired together; two pyrimidine bases paired together.
  - The two scientists credited with producing the first structural model of DNA were
    - Rosalind Franklin and Erwin Chargaff.
    - Phoebus Levene and Fredrick Griffith.
    - James Watson and Francis Crick.
    - Oswald Avery and Colin MacLeod.

Use the following diagram to answer the next two questions.



- Which row correctly identifies the structures labelled 1, 2, 3, and 4 respectively?

Row	Structure 1	Structure 2	Structure 3	Structure 4
a.	adenine	guanine	cytosine	uracil
b.	uracil	cytosine	guanine	thymine
c.	thymine	cytosine	guanine	adenine
d.	adenine	guanine	cytosine	thymine

<b>ASSESSMENT</b>	<h1>Chapter 18 Test</h1>	<b>BLM 18.5.1</b>
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4. The letter “D” on this diagram represents
- the deoxyribose molecule.
  - the ribose molecule.
  - hydrogen bonds between the complementary bases.
  - the covalent bonds between the sugar and phosphate groups.
5. Which row below completes the following statement? Statement: “A(n) *i* is defined as the functional sub-unit of DNA that directs the production of one or more *ii*. The *iii* of an organism is the sum of all the DNA that is carried in the cell of the organism.”

Row	<i>i</i>	<i>ii</i>	<i>iii</i>
a.	amino acid	polypeptides	protein
b.	gene	polypeptides	genome
c.	non-coding section	genes	genotype
d.	genome	RNA molecules	phenotype

6. The most widely accepted model for the replication of a DNA molecule is the
- conservative model.
  - liberal model.
  - dispersive model.
  - semi-conservative model.
7. The enzyme that is responsible for adding new nucleotides to the 3' end of a growing DNA chain during DNA replication is
- helicase.
  - RNA polymerase.
  - DNA polymerase.
  - DNA ligase.
8. The “central dogma” of gene expression proposes that
- the proteins pass by transcription to messenger RNA.
  - the genetic code has a greater influence on gene expression than the environment
  - genetic information passes from the DNA of genes to RNA to a protein.
  - genetic information passes from RNA to a protein
9. Which row does NOT correctly compare DNA and mRNA?

Row	DNA	mRNA
a.	contains the base thymine	contains the base uracil
b.	is double stranded	is double stranded
c.	stays in the nucleus	leaves the nucleus
d.	contains the sugar deoxyribose	contains the sugar ribose

<b>ASSESSMENT</b>	<h1>Chapter 18 Test</h1>	<b>BLM 18.5.1</b>
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Use the following table to answer the next three questions.  
 Messenger RNA Codons and Their Corresponding Amino Acids

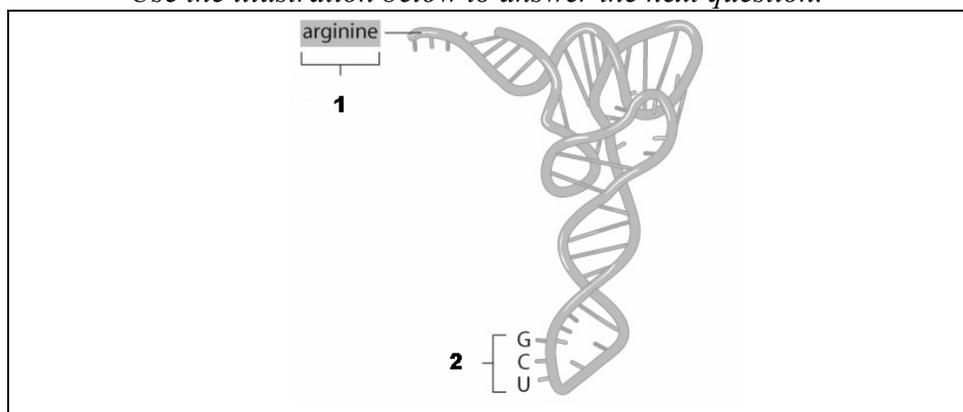
First base	Second base				Third base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop**	UGA stop**	A
	UUG leucine	UCG serine	UAG stop**	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine*	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

10. Identify the sequence of amino acids that would be formed from the following base pairs in a DNA molecule.

TACGGTCGT

- methionine-proline-alanine
- isoleucine-threonine-apspargine
- methionine-proline-stop
- start-glycine-stop

Use the illustration below to answer the next question.



11. Which row correctly identifies numbers 1 and 2 on the model shown in this illustration?

Row	Number 1	Number 2
a.	amino acid	ribosomal lobe
b.	amino acid	enzyme
c.	anticodon	amino acid
d.	amino acid	anticodon

<b>ASSESSMENT</b>	<b>Chapter 18 Test</b>	<b>BLM 18.5.1</b>
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12. The genetic codes in DNA for the three stop or terminator codons shown in the chart on the previous page are

- a. ATT; ATC; ACT
- b. UAA; UAG; UGA
- c. AUG; AAA; UUU
- d. AUU; AUC; ACU

13. Which of the following is not a characteristic of the genetic code?

- a. universal
- b. continuous
- c. frameshift
- d. redundant

14. The process of converting the information contained in the nucleotide sequence of mRNA into a sequence of amino acids is called

- a. transcription.
- b. translation.
- c. translocation.
- d. replication.

15. Which of the following is formed by transcription?

- a. mRNA
- b. tRNA
- c. rRNA
- d. cDNA

*Use the following information to answer the next two questions.*

The following matches the normal coding sequence, with the codons in the top row and the resulting amino acids in the bottom row.

mRNA codons:	–GUU	–CAU	–UUG	–ACU	–CCC	–GAA	–GAA
amino acids	–val	–his	–leu	–thr	–pro	–glu	–glu

16. Identify the type of mutation that would occur if the first codon was changed as shown below:  
GUU is changed to GUA

- a. frameshift mutation: this would cause the entire reading frame of a protein to be altered
- b. nonsense mutation: this would render the protein unable to code for a functional gene
- c. silent mutation: this would have no effect on the cell's metabolism
- d. mis-sense mutation: this would result in an altered DNA molecule

17. Identify the type of mutation that would occur if the third codon was changed as shown: UUG is changed to UAG

- a. frameshift mutation: this would cause the entire reading frame of the gene to be altered
- b. nonsense mutation: this would render the gene unable to code for a functional polypeptide
- c. silent mutation: this would have no effect on the cell's metabolism
- d. mis-sense mutation: this would result in an altered protein

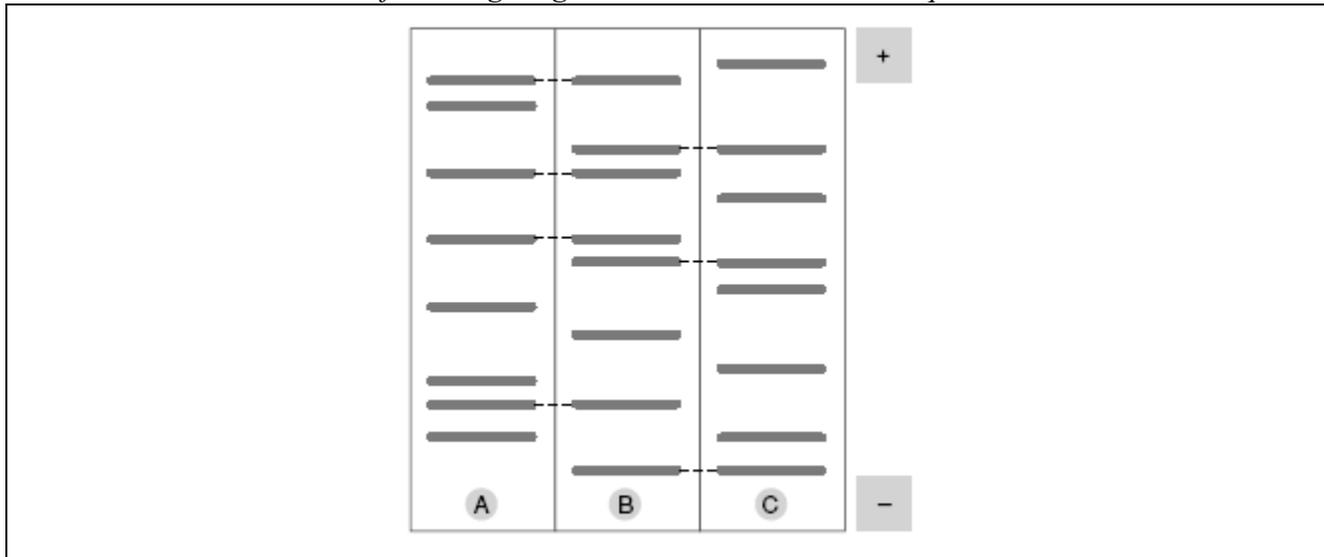
<b>ASSESSMENT</b>	<h1>Chapter 18 Test</h1>	<b>BLM 18.5.1</b>
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18. If the DNA codons are CAT CAT CAT, and a guanine base is added at the beginning, the result would be
- a new genetic code: CAT CAT CAT G.
  - a point mutation.
  - a silent mutation.
  - a frameshift mutation.
19. Why do you think you are covered with a heavy lead apron from your neck to your feet when you are getting an X ray at the dentist's office?
- If your gametes (sex cells) are damaged a germ line mutation may occur and these types of mutations are passed on from one generation to the next.
  - If your gametes (sex cells) are damaged a somatic cell mutation may occur and these types of mutations are passed on from one generation to the next.
  - If your skin cells in your checks are damaged a germ line mutation may occur and these types of mutations are passed on from one generation to another.
  - If your skin cells in your checks are damaged a somatic cell mutation may occur and these types of mutations are passed on from one generation to another.
20. Mutations that are caused by agents outside of the cell are said to be
- continuous mutations.
  - redundant mutations.
  - spontaneous mutations.
  - induced mutations.
21. Which of the following would be more accurate in determining the biological identity of your mother?
- the combined DNA of your biological mother and your biological father
  - the mtDNA of your biological mother
  - the mtDNA of your biological father
  - the combined mRNA of your biological mother and your biological father
22. Which of the following is NOT considered to be a clone?
- a colony of identical bacterial cells growing in a petri dish
  - fraternal twins
  - a clump of identical aspen trees
  - copies of a gene made through polymerase chain reaction (PCR) techniques
23. Restriction enzymes found in bacterial cells are ordinarily used
- during the replication of the bacterial DNA.
  - to degrade the bacterial cell's DNA.
  - to degrade viral DNA that enters the bacterial cell.
  - to attach pieces of DNA together.

<b>ASSESSMENT</b>	<h1>Chapter 18 Test</h1>	<b>BLM 18.5.1</b>
-------------------	--------------------------	-------------------

24. Recombinant DNA technology is used for all but one of the following procedures. Identify the procedure that is not the direct result of this form of biotechnology.
- cloning mammals such as Dolly the sheep
  - for gene therapy
  - to make a specific protein
  - clone a specific piece of DNA (gene)
25. The advantage of using a DNA microarray is that it allows scientists to
- produce transgenic plants.
  - rapidly replicate small segments of DNA nucleotides.
  - sort and analyze DNA samples.
  - analyze the activity of thousands of genes at once.

*Use the following diagram to answer the next two questions.*



26. This DNA fingerprint is from a biological father, a biological mother, and one of their children. Based on the fingerprint, the DNA from the child is in column
- A.
  - B.
  - C.
  - either A or C.
27. Based on the DNA fingerprint above, the percentage of the mother's DNA that matches the child's DNA is
- 100 percent.
  - 25 percent.
  - 50 percent.
  - 10 percent.

<b>ASSESSMENT</b>	<h1>Chapter 18 Test</h1>	<b>BLM 18.5.1</b>
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28. Which of the following is an **INCORRECT** statement?
- Bacteria can be altered to secrete the biotechnology product into a medium.
  - Plants are being engineered to have a human protein in their seeds.
  - Animals are being genetically engineered to have a human protein in their milk.
  - Animals can be cloned, but not plants or bacteria.
29. Which of the following is **NOT** required in order to clone a mammal such as a sheep?
- sperm from a donor animal
  - the nucleus from an adult animal
  - enucleated egg from a donor animal
  - surrogate mother to develop the embryo
30. Which of the following prenatal technologies would most likely be used to determine if a fetus might have a non-disjunction disorder such as Down's syndrome?
- ultrasound
  - amniocentesis
  - fetoscopy
  - gene therapy

### Numerical Response Questions

- Record your answer on the answer sheet provided.
  - If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
1. Use Chargaff's rule to determine proportions of the nucleotides. Assume that the characteristic proportions are exactly equal. Record the **percentage** of each nucleotide in the numerical response section on the answer sheet.

Nucleotide	Proportion (%)
A	
C	35
G	
T	

Nucleotide

\_\_\_\_\_

**A**

\_\_\_\_\_

**C**

\_\_\_\_\_

**G**

\_\_\_\_\_

**T**



Use the following information to answer the next question.

### The four stages of a Genetic Engineering Experiment

Like the experiment of Cohen and Boyer, most genetic engineering experiments consist of four stages. These stages are summarized below but note that they are not in the correct order.

1. Screening: The clones containing a specific DNA fragment of interest, often a fragment that includes a particular gene, are identified from the clone library.
2. Cloning: The plasmids or viruses serve as vectors that can introduce the DNA fragments into cells (usually bacteria). As each cell reproduces, it forms a clone of cells that all contain the fragment-bearing vector.
3. Production of Recombinant DNA: The fragments of DNA are inserted into plasmids or viral vectors, which have been cleaved with the same restriction endonuclease as the source DNA.
4. DNA Cleavage: A restriction endonuclease is used to cleave the source DNA into fragments. A different set of fragments will be obtained by employing endonucleases that recognize the different sequences.

4. The correct order of the stages of a genetic engineering experiment are \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. Record all **four digits** of your answer in the numerical response section on the answer sheet.

### Written Response Question

Answer each question in the space provided. Use complete sentences, show problem-solving methods, and include diagrams (with labels) when required.

Use the following information to answer the next question.

### Biotechnology in Agriculture

A major area of genetic engineering activity is manipulation of genes of key crops. In plants, the primary experimental difficulty has been identifying a suitable vector for introducing recombinant DNA. Plant cells do not possess the many plasmids that bacteria do, so the choice of potential vectors is limited. The most successful results so far have been obtained with the Ti (tumour-inducing) plasmid of the plant bacterium *Agrobacterium tumefaciens*, which infects broadleaf plants such as tomato and soybeans. Part of the Ti plasmid integrates into the plant DNA, and researchers have succeeded in attaching other genes to this portion of the plasmid. The characteristics of a number of plants have been altered using this technique to improve crops and forests.

Among the features scientists would like to affect are resistance to disease, frost, and other forms of stress; nutritional balance and protein content; and herbicide resistance. Unfortunately, *Agrobacterium* generally does not infect cereals such as corn, rice, and wheat, but alternative methods can be used to introduce new genes into these crops.

<b>ASSESSMENT</b>	<b>Chapter 18 Test</b>	<b>BLM 18.5.1</b>
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1. a) **Identify** the primary vector used to introduce genes into plant cells. (1 mark)

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b) **Identify** the types of plants that are generally infected by this vector. (1 mark)

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c) **List** the steps in the procedure that would be used to genetically engineer a tomato plant that was more resistant to frost. (4 marks)

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d) **Identify** three examples of where you think this vector might be used for genetic engineering of plants, and **explain** the potential benefits of each example (6 marks)

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e) **Identify** three potential risks associated with genetically modified food, and **explain** why some groups of people are concerned about this form of biotechnology. (6 marks)

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<b>ASSESSMENT</b>	<b>Chapter 18 Test</b>	<b>BLM 18.5.1</b>
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*Use the following information to answer the next question.*

### **The Human Genome Project**

A genome is all the genetic information of an individual or species. The goals of the Human Genome Project are to map the human chromosomes in two ways: (1) to construct a map that shows the sequence of base pairs along our chromosomes and (2) to construct a map that shows the sequence of genes along the human chromosome.

Researchers now know the sequence of the base pairs along the length of the human chromosomes. So far researchers have found only 30 000 genes that code for proteins; the rest of our DNA consists of nucleotide repeats that do not code for a protein. These non-coding regions of DNA are often referred to as “junk DNA.” Little difference seems to exist between the sequence of our bases and other organisms whose DNA sequences are also known. It’s possible that we will discover that our uniqueness is due to the regulation of our genes.

2. Write a unified response question that addresses The Human Genome Project. (10 marks)

- **Identify** and **discuss** four potential benefits that this project might have in terms of the needs, interests, and financial support of society.
- There are many ethical questions regarding how our knowledge of the human genome should be used. **Identify** and **describe** two social issues that are directly related to The Human Genome Project. Explain, using an example, the implications of each issue.

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