1) The type of molecule represented below is found in organisms.

Which statement correctly describes the sequence of bases found in this type of molecule?

A) It determines the characteristics that will be inherited.  
B) It changes every time it replicates.  
C) It directly controls the synthesis of starch within a cell.  
D) It is exactly the same in all organisms.

2) A medical test indicates that a patient has a defective protein. This condition is most likely due to a change in the directions coded in the

A) number of hydrogen atoms in starch molecules  
B) sequence of subunits in DNA  
C) sequence of inorganic molecules  
D) number of carbon atoms in sugar molecules

3) The diagram below represents the organization of genetic information within a cell nucleus.

The circle labeled Z most likely represents

A) vacuoles  
B) chromosomes  
C) molecular bases  
D) amino acids

4) The diagrams below represent portions of the genes that code for wing structure in two organisms of the same species. Gene 1 was taken from the cells of a female with normal wings, and gene 2 was taken from the cells of a female with abnormal wings.

The abnormal wing structure was most likely due to

A) an insertion  
B) normal replication  
C) a substitution  
D) a deletion

5) The presence of DNA is important for the cellular metabolic activities because DNA

A) is a structural component of cell membranes  
B) is the major component of cytoplasm  
C) directly increases the solubility of nutrients  
D) directs the production of enzymes
Questions 6 and 7 refer to the following:

The diagram below represents a DNA molecule.

6) What occurs in the process of replication?
   A) Proteins are formed in region 2.         C) Structure 1 is hydrolyzed.
   B) Chemical bonds are broken in region 2.  D) Structure 3 is synthesized.

7) What is the base sequence of strand X?

8) Molecule 1 represents a segment of hereditary information, and molecule 2 represents the portion of a molecule that is determined by information from molecule 1.

What will most likely happen if there is a change in the first three subunits on the upper strand of molecule 1?
   A) Molecule 1 will split apart, triggering an immune response.
   B) The remaining subunits in molecule 1 will also change.
   C) A portion of molecule 2 may be different.
   D) Molecule 2 may form two strands rather than one.
9) Which DNA strand represents the complementary base (letter) sequence to the portion of a DNA strand represented in the diagram below?

A) 
B) 
C) 
D) 

10) Which statement best describes the result of some of the processes involved in genetic engineering?
A) They are necessary for normal gamete formation.
B) They reduce variation in organisms that reproduce asexually.
C) They alter the arrangement of hereditary material.
D) They provide energy for mitosis and meiosis.

11) A woman has a gene that causes a visual disorder. To prevent the disorder from appearing in future generations, the defective gene would have to be repaired in the mother's
A) eye  B) uterus  C) reproductive cells  D) nervous system

12) The insertion of a human DNA fragment into a bacterial cell might make it possible for
A) the cloning of the human that donated that DNA fragment
B) humans to become immune to an infection by this type of bacteria
C) the cloning of this type of bacteria
D) the bacterial cell to produce a human protein

13) Many diabetics are now using insulin that was made by certain bacteria. The ability of these bacteria to produce insulin was most likely the result of
A) using radiation to trigger mutations
B) genetic mapping of bacterial DNA to activate the gene for insulin production
C) inserting a portion of human DNA into the ring-shaped DNA of bacteria
D) deleting many DNA segments from bacterial DNA

14) The gene for the production of human insulin is inserted into certain bacterial cells. The offspring of these bacterial cells will most likely be able to
A) reproduce sexually  C) synthesize this hormone
B) destroy pathogens  D) form human tissue
15) The diagram below illustrates some key steps of a procedure in one area of biotechnology.

The letter X most likely represents
A) human cells that are able to synthesize antibodies
B) bacterial cells that are unable to synthesize insulin
C) bacterial cells that are able to synthesize insulin
D) human cells that are unable to resist antibiotics

16) One way to produce large numbers of genetically identical offspring is by
A) fertilization
B) inserting a DNA segment into a different DNA molecule
C) cloning
D) changing genes by agents such as radiation or chemicals

17) The nucleus is removed from a body cell of one organism and is placed in an egg cell that has had its nucleus removed. This process, which results in the production of organisms that are genetically alike, is known as
A) DNA production
B) biological adaptation
C) fertilization
D) cloning

18) "Dolly" is a sheep developed from an egg cell of her mother that had its nucleus replaced by a nucleus from a body cell of her mother. As a result of this technique, Dolly is
A) able to have a longer lifespan
B) genetically identical to her mother
C) no longer able to reproduce
D) unable to mate

19) A crop of white potatoes is grown by placing pieces of potato in the ground. This method of reproduction is most similar to
A) sexual reproduction
B) cloning
C) genetic engineering
D) zygote

20) A small amount of DNA was taken from a fossil of a mammoth found frozen in glacial ice. Genetic technology can be used to produce a large quantity of identical DNA from this mammoth's DNA. In this technology, the original DNA sample is used to
A) stimulate differentiation in other mammoth cells
B) act as a template for repeated replication
C) trigger mitosis to obtain new base sequences
D) provide fragments to replace certain human body chemicals

21) Scientists have cloned sheep, but have not yet cloned a human. The best explanation for this situation is that
A) the technology to clone humans has not been explored
B) there are many ethical problems involved in cloning humans
C) human reproduction is very different from that of other mammals
D) cloning humans would take too long

22) Using one or more complete sentences, state two specific ways that applications of our knowledge of DNA and genetics is improving the field of medicine and health care for humans.

23) Although human muscle cells and nerve cells have the same genetic information, they perform different functions. Explain how this is possible.

24) Hemoglobin is a complex protein molecule found in red blood cells. Hemoglobin with the normal sequence of amino acids is able to carry oxygen to body cells effectively. In the disorder known as sickle-cell anemia, one amino acid is substituted for another in the hemoglobin. One characteristic of this disorder is poor distribution of oxygen to the body cells. Explain how the change in amino acid sequence of this protein could cause the results described.
25) Using one or more complete sentences, explain how a baby's DNA sequence compares to the DNA sequences of its mother?

26) A family has three daughters with the same parents. Using one or more complete sentences, state whether the three girls would all look alike or be different, then state at least one scientific fact that helps to support your answer.

Questions 27 and 28 refer to the following:

The diagram below provides information related to heredity.

![Diagram of hereditary information]

27) Which molecules are represented by box B?
   A) proteins  B) amino acids  C) bases  D) simple sugars

28) The type of molecule in box A serves as a template. Explain what this means.

29) Give three examples of how the technology of genetic engineering allows humans to alter the genetic makeup of organisms.

30) For many years, humans have used a variety of techniques that have influenced the genetic makeup of organisms. These techniques have led to the production of new varieties of organisms that possess characteristics that are useful to humans. Identify one technique presently being used to alter the genetic makeup of an organism, and explain how humans can benefit from this change.

   Your answer must include at least:
   (1) the name of the technique used to alter the genetic makeup
   (2) a brief description of what is involved in this technique
   (3) one specific example of how this technique has been used
   (4) a statement of how humans have benefited from the production of this new variety of organism
31) A portion of a molecule is shown in the diagram below.

Which statement best describes the main function of this type of molecule?

A) It determines what traits may be inherited.  
B) It is a structural part of the cell wall.  
C) It transports materials across the cell membrane.  
D) It stores energy for metabolic processes.

Questions 32 and 33 refer to the following:

The diagram below provides information related to heredity.

32) Which molecules are represented by box B?

A) bases  
B) proteins  
C) amino acids  
D) simple sugars

33) The type of molecule in box A serves as a template. Explain what this means.

34) The cells that make up the skin of an individual have some functions different from the cells that make up the liver because

A) different cells have different genetic material  
B) environment and past history have no influence on cell function  
C) different parts of genetic instructions are used in different types of cells  
D) all cells have a common ancestor

35) In an experiment, DNA from dead pathogenic bacteria was transferred into living bacteria that do not cause disease. These altered bacteria were then injected into healthy mice. These mice died of the same disease caused by the original pathogens. Based on this information, which statement would be a valid conclusion?

A) DNA changes the organism receiving the injection into the original organism.  
B) DNA is present only in living organisms.  
C) DNA from a dead organism can become active in another organism.  
D) DNA functions only in the original organism of which it was a part.
36) During the warm temperatures of summer, the arctic fox produces enzymes that cause its fur to become reddish brown. During the cold temperatures of winter, these enzymes do not function. As a result, the fox has a white coat that blends into the snowy background. This change in fur color shows that
A) the expression of certain genes is affected by temperature
B) random alteration of DNA can occur on certain chromosomes
C) mutations can be caused by temperature extremes
D) the genes of a fox are made of unstable DNA

37) Scientists have cloned sheep, but have not yet cloned a human. The best explanation for this situation is that
A) human reproduction is very different from that of other mammals
B) there are many ethical problems involved in cloning humans
C) cloning humans would take too long
D) the technology to clone humans has not been explored

38) The diagrams below represent some steps in a procedure used in biotechnology.

Letters X and Y represent the
A) gases needed to produce the energy required for gene manipulation
B) hormones that trigger rapid mutation of genetic information
C) hormones that stimulate the replication of bacterial DNA
D) biochemical catalysts involved in the insertion of genes into other organisms

Questions 39 through 41 refer to the following:

"Today I planted something new in my vegetable garden something very new, as a matter of fact. It's a potato called the New Leaf Superior, which has been genetically engineered by Monsanto, the chemical giant recently turned "life sciences" giant to produce its own insecticide. This it can do in every cell of every leaf, stem, flower, root, and (here's the creepy part) spud [the potato]." 

39) State one possible disadvantage of the synthesis of an insecticide by potatoes.

40) State two reasons that a gardener might choose to grow this new variety of plant.

41) Explain why every cell in the New Leaf Superior potato plant is able to produce its own insecticide.

Questions 42 and 43 refer to the following:
42) Describe how structures 1 and 2 in the given diagram interact in the process of protein synthesis.

43) Choose either structure 3 or structure 4 in the given diagram, write the number of the structure, and describe how it aids the process of protein synthesis.

44) A change in the order of DNA bases that code for a respiratory protein will most likely cause
   A) the production of a starch that has a similar function
   B) the digestion of the altered gene by enzymes
   C) a change in the sequence of amino acids determined by the gene
   D) the release of antibodies by certain cells to correct the error

45) Scientific studies show that identical twins who were separated at birth and raised in different homes may vary in height, weight, and intelligence. The most probable explanation for these differences is that
   A) one twin received genes only from the mother while the other twin received genes only from the father
   B) environments in which they were raised were different enough to affect the expression of their genes
   C) environments in which they were raised were different enough to change the genetic makeup of both individuals
   D) original genes of each twin increased in number as they developed

46) The ozone layer of Earth's atmosphere helps to filter ultraviolet radiation. As the ozone layer is depleted, more ultraviolet radiation reaches Earth's surface. This increase in ultraviolet radiation may be harmful because it can directly cause
   A) photosynthesis to stop in all marine organisms
   B) sterility in most species of mammals and birds
   C) abnormal migration patterns in waterfowl
   D) mutations in the DNA of organisms

47) Give three examples of how the technology of genetic engineering allows humans to alter the genetic makeup of organisms.

48) In Siamese cats, the fur on the ears, paws, tail, and face is usually black or brown, while the rest of the body fur is almost white. If a Siamese cat is kept indoors where it is warm, it may grow fur that is almost white on the ears, paws, tail, and face, while a Siamese cat that stays outside where it is cold, will grow fur that is quite dark on these areas. The best explanation for these changes in fur color is that
   A) the location of pigment-producing cells determines the DNA code of the genes
   B) the gene for fur color is modified by interactions with the environment
   C) an environmental factor influences the expression of this inherited trait
   D) skin cells that produce pigments have a higher mutation rate than other cells

Questions 49 through 51 refer to the following:

THEY SURE DO LOOK LIKE DINOSAURS
When making movies about dinosaurs, film producers often use ordinary lizards and enlarge their images thousands of times (1). We all know, however, that while they look like dinosaurs and are related to dinosaurs, lizards are not actually dinosaurs (2).

Recently, some scientists have developed a hypothesis that challenges this view (3). These scientists believe that some dinosaurs were actually the same species as some modern lizards that had grown to unbelievable sizes (4). They think that such growth might be due to a special type of DNA called repetitive DNA, often referred to as "junk" DNA because scientists do not understand its functions (5). These scientists studied pumpkins that can reach sizes of nearly 1,000 pounds and found them to contain large amounts of repetitive DNA (6). Other pumpkins that grow to only a few ounces in weight have very little of this kind of DNA (7). In addition, cells that reproduce uncontrollably have almost always been found to contain large amounts of this type of DNA (8).

49) Which kind of cells would most likely contain large amounts of repetitive DNA?
   A) cancer cells
   B) cells that are unable to reproduce
   C) red blood cells
   D) nerve cells
50) Write the number of a sentence that provides evidence which supports the hypothesis that increasing amounts of repetitive DNA are responsible for increased sizes of organisms.

51) State one reason why scientists formerly thought of repetitive DNA as "junk."

52) The data table below summarizes the results of an investigation in which seeds from the same plant were grown under different conditions of temperature and relative humidity.

<table>
<thead>
<tr>
<th>Temperature: 20°C</th>
<th>Temperature: 31°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Humidity: 20%</td>
<td>Relative Humidity: 95%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Genes Present in Cells of Organism</th>
<th>Appearance of Organism</th>
<th>Genes Present in Cells of Organism</th>
<th>Appearance of Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>red</td>
<td>AA</td>
<td>white</td>
</tr>
<tr>
<td>Aa</td>
<td>red</td>
<td>Aa</td>
<td>white</td>
</tr>
<tr>
<td>aa</td>
<td>white</td>
<td>aa</td>
<td>white</td>
</tr>
</tbody>
</table>

Which conclusion can be drawn from the information in the data table?
A) Many characteristics are not inherited.
B) There is an interaction between environment and heredity.
C) Mutations occur only when plants are grown at low temperatures.
D) Color in this species is determined by genes, only.

53) Using one or more complete sentences, explain how a baby's DNA sequence compares to the DNA sequences of its mother?

54) The instructions for the traits of an organism are coded in the arrangement of
A) glucose units in carbohydrate molecules
B) fat molecules in the cell membrane
C) bases in DNA in the nucleus
D) energy-rich bonds in starch molecules

55) A characteristic of mutations is that they usually
A) occur to meet the needs of a species
B) result in different genetic sequences
C) are caused only by the events of mitosis
D) do not occur at random

56) Two different types of cells from an organism are shown below.

Explain how these two different types of cells can function differently in the same organism even though they both contain the same genetic instructions.

57) Which statement is true regarding an alteration or change in DNA?
A) It is always detected by the process of chromatography.
B) It is always advantageous to an individual.
C) It is always known as a mutation.
D) It is always passed on to offspring.

58) A great deal of information can now be obtained about the future health of people by examining the genetic makeup of their cells. There are concerns that this information could be used to deny an individual health insurance or employment. These concerns best illustrate that
A) scientific explanations depend upon evidence collected from a single source
B) acquiring too much knowledge in human genetics will discourage future research in that area
C) scientific inquiry involves the collection of information from a large number of sources
D) while science provides knowledge, values are essential to making ethical decisions using this knowledge.
59) The nucleus is removed from a body cell of one organism and is placed in an egg cell that has had its nucleus removed. This process, which results in the production of organisms that are genetically alike, is known as
A) DNA production    B) cloning    C) biological adaptation    D) fertilization

60) The presence of DNA is important for the cellular metabolic activities because DNA
A) is a structural component of cell membranes    C) is the major component of the cytoplasm
B) directly increases the solubility of nutrients    D) directs the production of enzymes

61) The diagram below represents a technique used in biotechnology.

Name a specific substance that can be produced by this technique and state how humans have benefited from the production of this substance.

62) Which sentence does not describe cells cloned from a carrot?
A) They are genetically identical.    C) They are produced sexually.
B) They have identical chromosomes.    D) They have the same DNA codes.

63) A woman has a gene that causes a visual disorder. To prevent the disorder from appearing in future generations, the defective gene would have to be repaired in the mother's
A) uterus    B) nervous system    C) reproductive cells    D) eye

64) Molecule 1 represents a segment of hereditary information, and molecule 2 represents the portion of a molecule that is determined by information from molecule 1.

What will most likely happen if there is a change in the first three subunits on the upper strand of molecule 1?
A) Molecule 2 may form two strands rather than one.    C) Molecule 1 will split apart, triggering an immune response.
B) A portion of molecule 2 may be different.    D) The remaining subunits in molecule 1 will also change.
65) Cystic fibrosis is a genetic disease.

![Diagram of genetics problem]

According to the diagram, the mother's cells most likely contained

A) an abnormal number of chromosomes  
B) one normal gene and one abnormal gene  
C) two normal genes  
D) a disease-causing virus

66) The diagram below represents the organization of genetic information within a cell nucleus.

![Diagram of genetic information organization]

The circle labeled Z most likely represents

A) amino acids  
B) molecular bases  
C) vacuoles  
D) chromosomes

67) In the human pancreas, acinar cells produce digestive enzymes and beta cells produce insulin. The best explanation for this is that

A) a mutation occurs in the beta cells to produce insulin when the sugar level increases in the blood  
B) lowered sugar levels cause the production of insulin in acinar cells to help maintain homeostasis  
C) the genes in acinar cells came from one parent while the genes in beta cells came from the other parent  
D) different parts of an individual's DNA are used to direct the synthesis of different proteins in different types of cells

68) Using one or more complete sentences, state two specific ways that applications of our knowledge of DNA and genetics is improving the field of medicine and health care for humans.

69) Although human muscle cells and nerve cells have the same genetic information, they perform different functions. Explain how this is possible.

70) When a person's teeth are being x-rayed, other body parts of this person are covered with a protective lead blanket to prevent

A) changes in DNA molecules  
B) loss of hair  
C) increase in cell size  
D) changes in glucose structure

71) The sequence of subunits in a protein is most directly dependent on the

A) kinds of materials in the cell membrane  
B) region in the cell where enzymes are produced  
C) DNA in the chromosomes in a cell  
D) type of cell in which starch is found
72) The type of molecule represented below is found in organisms.

Which statement correctly describes the sequence of bases found in this type of molecule?

A) It directly controls the synthesis of starch within a cell.
B) It is exactly the same in all organisms.
C) It determines the characteristics that will be inherited.
D) It changes every time it replicates.

73) The diagrams below represent portions of the genes that code for wing structure in two organisms of the same species. Gene 1 was taken from the cells of a female with normal wings, and gene 2 was taken from the cells of a female with abnormal wings.

The abnormal wing structure was most likely due to

A) normal replication  B) a deletion  C) an insertion  D) a substitution

74) Hemoglobin is a complex protein molecule found in red blood cells. Hemoglobin with the normal sequence of amino acids is able to carry oxygen to body cells effectively. In the disorder known as sickle-cell anemia, one amino acid is substituted for another in the hemoglobin. One characteristic of this disorder is poor distribution of oxygen to the body cells. Explain how the change in amino acid sequence of this protein could cause the results described.

Questions 75 through 77 refer to the following:

In DNA, a sequence of three bases is a code for the placement of a certain amino acid in a protein chain. The table below shows some amino acids with their abbreviations and DNA codes.

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Abbreviation</th>
<th>DNA Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenylalanine</td>
<td>Phe</td>
<td>AAA, AAG</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>Try</td>
<td>ACC</td>
</tr>
<tr>
<td>Serine</td>
<td>Ser</td>
<td>AGA, AGG, AGT, AGC, TCA, TCG</td>
</tr>
<tr>
<td>Valine</td>
<td>Val</td>
<td>CAA, CAG, CAT, CAC</td>
</tr>
<tr>
<td>Proline</td>
<td>Pro</td>
<td>GGA, GGG, GGT, GGC</td>
</tr>
<tr>
<td>Glutamine</td>
<td>Glu</td>
<td>GGT, GTC</td>
</tr>
<tr>
<td>Threonine</td>
<td>Thr</td>
<td>TGA, TGG, TGT, TGC</td>
</tr>
<tr>
<td>Asparagine</td>
<td>Asp</td>
<td>TTA, TTG</td>
</tr>
</tbody>
</table>
75) Describe how a protein would be changed if a base sequence mutates from GGA to TGA.

76) According to the given table, which amino acid chain would be produced by the DNA base sequence below?


A) Val | Glu | Phe | Thr | Asp | Asp
B) Val | Glu | Phe | Asp | Asp | Thr
C) Val | Glu | Phe | Asp | Thr | Asp
D) Val | Pro | Phe | Asp | Asp | Thr

77) Identify one environmental factor that could cause a base sequence in DNA to be changed to a different base sequence.

78) A mutation occurs in a cell. Which sequence best represents the correct order of the events involved for this mutation to affect the traits expressed by this cell?

A) a change in the sequence of DNA bases, joining amino acids in sequence, appearance of characteristic
B) appearance of characteristic, joining amino acids in sequence, a change in the sequence of DNA bases
C) joining amino acids in sequence, a change in the sequence of DNA bases, appearance of characteristic
D) a change in the sequence of DNA bases, appearance of characteristic, joining amino acids in sequence

79) The gene for the production of human insulin is inserted into certain bacterial cells. The offspring of these bacterial cells will most likely be able to

A) destroy pathogens
B) reproduce sexually
C) synthesize this hormone
D) form human tissue

Questions 80 and 81 refer to the following:

The diagram below represents a DNA molecule.

![DNA diagram]

80) What is the base sequence of strand X in the given diagram?


81) Which of the following occurs during the process of replication in the given diagram?

A) Proteins are formed in region 2.
B) Structure 1 is hydrolyzed.
C) Chemical bonds are broken in region 2.
D) Structure 3 is synthesized.
82) From a single monkey, an animal breeder claims that he has successfully cloned two monkeys. He displays the two monkeys, a male and a female, to the public. The claim of the breeder should be rejected because the monkeys

A) are of two different sexes  
B) are twins  
C) developed from more than one sperm cell  
D) have the same parents

83) The production of certain human hormones by genetically engineered bacteria results from

A) crossing two different species of bacteria  
B) combining a portion of human DNA with bacterial DNA and inserting this into bacteria  
C) inserting a specific group of amino acids into the bacteria  
D) deleting a specific amino acid from human DNA and inserting it into bacterial DNA

84) Enzymes are used in moving sections of DNA that code for insulin from the pancreas cells of humans into a certain type of bacterial cell. This bacterial cell will reproduce, giving rise to offspring that are able to form

A) antibodies against insulin  
B) human insulin  
C) a new type of insulin  
D) enzymes that digest insulin

85) What determines the kind of genes an organism possesses?

A) sequence of the subunits A, T, C, and G in the DNA of the organism  
B) size of simple sugar molecules in the organs of the organism  
C) type of amino acids in the cells of the organism  
D) shape of the protein molecules in the organelles of the organism

86) Arrange the following structures from largest to smallest:

- d a chromosome
- d a nucleus
- d a gene

LARGEST __________  

SMALLEST __________

87) The genetic code of a DNA molecule is determined by a specific sequence of

A) ATP molecules  
B) chemical bonds  
C) molecular bases  
D) sugar molecules

88) The diagram below represents the chemical pathway of a process in a human liver cell.

```
<table>
<thead>
<tr>
<th>Substrate A</th>
<th>Substrate B</th>
<th>Substrate C</th>
</tr>
</thead>
<tbody>
<tr>
<td>enzyme X</td>
<td>enzyme Y</td>
<td></td>
</tr>
</tbody>
</table>
```

A particular liver cell is unable to make substance C. One possible explanation for the inability of this cell to make substance C is that

A) excess energy for step 2 prevented the conversion of substance B to substance C  
B) nuclear DNA was altered resulting in the cell being unable to make enzyme Y  
C) an excess of enzyme X was present, resulting in a decrease in the production of substance B  
D) a mutation occurred causing a change in the ability of the cell to use substance C
Questions 89 through 91 refer to the following:

The table below represents the DNA codes for several amino acids.

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>DNA Code Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cysteine</td>
<td>ACA or ACG</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>ACC</td>
</tr>
<tr>
<td>Valine</td>
<td>CAA or CAC or CAG or CAT</td>
</tr>
<tr>
<td>Proline</td>
<td>GGA or GGC or GGG or GGT</td>
</tr>
<tr>
<td>Asparagine</td>
<td>TTA or TTG</td>
</tr>
<tr>
<td>Methionine</td>
<td>TAC</td>
</tr>
</tbody>
</table>

89) A certain DNA strand has the base sequence: TACACACAAACGGGG. Based on the given information, write the sequence of amino acids synthesized from this code if it is read from left to right.

90) The DNA sequence below undergoes the following change:

TACACACAAACGGGG , TACACACAAACGGGT

State one reason this mutation produces no change in the action of the final molecule that will be synthesized from this code.

91) The DNA sequence below undergoes the following change:

TACACACAAACGGGG , TACACCCAAACGGGG

Based on the given information, how would the sequence of amino acids be changed as a result of this mutation?

92) A family has three daughters with the same parents. Using one or more complete sentences, state whether the three girls would all look alike or be different, then state at least one scientific fact that helps to support your answer.
93) The photographs below show some physical similarities between John Lennon and his son Julian.


Which conclusion can be drawn regarding these similarities?
A) The percentage of their proteins with the same molecular composition is high.
B) The base sequences of their genes are identical.
C) The DNA present in their body cells is identical.
D) The mutation rate is the same in their body cells.

94) For many years, humans have used a variety of techniques that have influenced the genetic makeup of organisms. These techniques have led to the production of new varieties of organisms that possess characteristics that are useful to humans. Identify one technique presently being used to alter the genetic makeup of an organism, and explain how humans can benefit from this change.

Your answer must include at least:
(1) the name of the technique used to alter the genetic makeup
(2) a brief description of what is involved in this technique
(3) one specific example of how this technique has been used
(4) a statement of how humans have benefited from the production of this new variety of organism

95) The loss of ozone in the upper atmosphere results in an increased amount of ultraviolet light reaching Earth from the Sun. Explain how this increase may be harmful, other than contributing in a small way to global warming, to life on Earth.

96) The diagram below represents the change in a sprouting onion bulb when sunlight is present and when sunlight is no longer available.

Which statement best explains this change?
A) Plants need oxygen to survive.
B) Environmental conditions do not alter characteristics.
C) The environment can influence the expression of certain genetic traits.
D) Plants produce hormones.
97) Biological research has generated knowledge used to diagnose genetic disorders in humans. Explain how a specific genetic disorder can be diagnosed. Your answer must include at least:
   d the name of a genetic disorder that can be diagnosed
   d the name or description of a technique used to diagnose the disorder
   d a description of one characteristic of the disorder

98) Which statement best describes the relationship between the number of genes and the number of chromosomes in human skin cells?
   A) There are more chromosomes than genes in skin cells.
   B) There are equal numbers of genes and chromosomes in skin cells.
   C) There are more genes than chromosomes in skin cells.

99) Research applications of the basic principles of genetics have contributed greatly to the rapid production of new varieties of plants and animals. Which activity is an example of such an application?
   A) selective breeding of plants and animals that exhibit high resistance to disease
   B) testing new fertilizers on food crops
   C) developing new irrigation methods to conserve water
   D) using natural predators to control insect pests

100) Which statements best describe the relationship between the terms "chromosomes", "genes", and "nuclei"?
    A) Genes are found on chromosomes. Chromosomes are found in nuclei.
    B) Chromosomes are found on genes. Genes are found in nuclei.
    C) Genes are found in nuclei. Nuclei are found in chromosomes.
    D) Chromosomes are found in nuclei. Nuclei are found in genes.

101) To determine the identity of their biological parents, adopted children sometimes request DNA tests. These tests involve comparing DNA samples from the child to DNA samples taken from the likely parents. Possible relationships may be determined from these tests because the
   A) base sequence of the father determines the base sequence of the offspring
   B) position of the genes on each chromosome is unique to each family
   C) DNA of parents and their offspring is more similar than the DNA of nonfamily members
   D) mutation rate is the same in closely related individuals

102) Individual cells can be isolated from a mature plant and grown with special mixtures of growth hormones to produce a number of genetically identical plants. This process is known as
   A) cloning
   B) meiotic division
   C) recombinant DNA technology
   D) selective breeding

103) Flower color in primrose plants is controlled by an individual gene. The sudden appearance of one white flowering primrose in a plant breeder's field of red primrose plants is most likely due to
   A) a change in the amount of glucose produced during photosynthesis
   B) rapid mitotic divisions within the developing seeds
   C) a random change in the structure of DNA during meiosis
   D) the use of a new natural fertilizer on the field

104) A crop of white potatoes is grown by placing pieces of potato in the ground. This method of reproduction is most similar to
   A) zygote
   B) cloning
   C) sexual reproduction
   D) genetic engineering

105) To produce large tomatoes that are resistant to cracking and splitting, some seed companies use the pollen from one variety of tomato plant to fertilize a different variety of tomato plant. This process is an example of
   A) direct harvesting
   B) cloning
   C) selective breeding
   D) DNA sequencing

106) A medical test indicates that a patient has a defective protein. This condition is most likely due to a change in the directions coded in the
   A) number of hydrogen atoms in starch molecules
   B) sequence of subunits in DNA
   C) sequence of inorganic molecules
   D) number of carbon atoms in sugar molecules

107) A certain mutant bacterial cell cannot produce substance X. The mutation was most likely the result of a change in the
   A) amino acid sequence of DNA
   B) gene that codes for a specific protein
   C) structure of the cell membrane
   D) ability of the DNA to replicate
The diagram below represents a change that occurred in a pair of chromosomes during the formation of an egg cell. The letters represent genes on the pair of chromosomes.

The alteration that occurred will most likely
A) be passed on to every cell that develops from the egg cell
B) change the chromosome number of the body cells that develop from the egg cell
C) convert sex cells into body cells
D) trigger the production of pathogens

Which statement best describes the term "theory" as used in the gene-chromosome theory?
A) A theory is an assumption made by scientists and implies a lack of certainty.
B) A theory is a hypothesis that has been supported by one experiment performed by two or more scientists.
C) A theory is never revised as new scientific evidence is presented.
D) A theory refers to a scientific explanation that is strongly supported by a variety of experimental data.

If a set of instructions that determines all of the characteristics of an organism is compared to a book, and a chromosome is compared to a chapter in the book, then what might be compared to a paragraph in the book?
A) a starch molecule
B) an amino acid
C) an egg
D) a DNA molecule

Which statement provides the best evidence that the environment interacts with genes in the development and expression of inherited traits?
A) Identical twins who have not been raised together show differences in height and weight.
B) Organisms produced asexually are genetically identical.
C) People who have cancer can pass the defective gene on to their offspring.
D) Mutations happen randomly and may be harmful or helpful to organisms.

Cloning an individual usually produces organisms that
A) are identical in appearance and behavior
B) contain dangerous mutations
C) produce enzymes different from the parent
D) contain identical genes

Many diabetics are now using insulin that was made by certain bacteria. The ability of these bacteria to produce insulin was most likely the result of
A) inserting a portion of human DNA into the ring-shaped DNA of bacteria
B) using radiation to trigger mutations
C) deleting many DNA segments from bacterial DNA
D) genetic mapping of bacterial DNA to activate the gene for insulin production

"Dolly" is a sheep developed from an egg cell of her mother that had its nucleus replaced by a nucleus from a body cell of her mother. As a result of this technique, Dolly is
A) able to have a longer lifespan
B) unable to mate
C) genetically identical to her mother
D) no longer able to reproduce

Questions 115 and 116 refer to the following:

**THE HUMAN GENOME PROJECT**

For a number of years, scientists at Cold Spring Harbor Laboratory have been attempting to map every known human gene. By mapping, scientists mean that they are trying to find out on which of the 46 chromosomes each gene is located and exactly where on the chromosome the gene is located. By locating the exact positions of defective genes, scientists hope to cure diseases by replacing defective genes with normal ones, a technique known as gene therapy. Scientists can use specific enzymes to cut out the defective genes and insert the normal genes. They must be careful to use the enzyme that will splice out only the target gene, since different enzymes will cut DNA at different locations.

While the human genome project should eventually improve the health of humans, many people are skeptical and apprehensive, believing that gene therapy would be working against nature and would have religious, moral, legal, and ethical implications.
115) Using *one* specific example, explain why the human genome project is considered important.

116) Explain why scientists must use only certain enzymes when inserting or removing a defective gene from a cell.

117) The chart below shows relationships between genes, the environment, and coloration of tomato plants.

<table>
<thead>
<tr>
<th>Inherited Gene</th>
<th>Environmental Condition</th>
<th>Final Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Light</td>
<td>Green</td>
</tr>
<tr>
<td>B</td>
<td>Light</td>
<td>White</td>
</tr>
<tr>
<td>A</td>
<td>Dark</td>
<td>White</td>
</tr>
<tr>
<td>B</td>
<td>Dark</td>
<td>White</td>
</tr>
</tbody>
</table>

Which statement *best* explains the final appearance of these tomato plants?
A) The expression of gene *B* varies with the presence of light.
B) Gene *B* is expressed only in darkness.
C) The expression of gene *A* varies with the environment.
D) The expression of gene *A* is not affected by light.

118) The diagram below represents a section of a molecule that carries genetic information.

The pattern of numbers represents
A) the order of proteins in a gene  
B) folds of an amino acid  
C) positions of gene mutations  
D) a sequence of paired bases

119) Which DNA strand represents the complementary base (letter) sequence to the portion of a DNA strand represented in the diagram below?

A)

B)

C)

D)

120) People with cystic fibrosis inherit defective genetic information and cannot produce normal CFTR proteins. Scientists have used gene therapy to insert normal DNA segments that code for the missing CFTR protein into the lung cells of people with cystic fibrosis. Which statement does *not* describe a result of this therapy?
A) Offspring of someone with altered lung cells will inherit the normal CFTR gene.
B) Altered lung cells can produce the normal CFTR protein.
C) Altered lung cells can divide to produce other lung cells with the normal CFTR gene.
D) The normal CFTR gene may be expressed in altered lung cells.
121) Fruit flies with the curly-wing trait will develop straight wings if kept at a temperature of 16°C during development and curly wings if kept at 25°C. The best explanation for this change in the shape of wings is that the
   A) type of genes present in the fruit fly is dependent on environmental temperature
   B) genes for curly wings and genes for straight wings are found on different chromosomes
   C) higher temperature produces a gene mutation
   D) environment affects the expression of the genes for this trait

122) Which statement best describes human insulin that is produced by genetically engineered bacteria?
   A) This insulin will not function normally in humans because it is produced by bacteria.
   B) This insulin is produced as a result of human insulin being inserted into bacteria cells.
   C) This insulin is produced as a result of exposing bacteria cells to radiation, which produces a mutation.
   D) This insulin may have fewer side effects than the insulin previously extracted from the pancreas of other animals.

123) In the diagram below, strands I and II represent portions of a DNA molecule.

   Strand II would normally include
   A) AGC  B) GAT  C) TCG  D) TAC

124) The insertion of a human DNA fragment into a bacterial cell might make it possible for
   A) the cloning of the human that donated that DNA fragment
   B) the bacterial cell to produce a human protein
   C) the cloning of this type of bacteria
   D) humans to become immune to an infection by this type of bacteria

125) The function of the coded instructions contained in the body cells of an organism is to
   A) form a variety of gametes that will pass on hereditary information
   B) produce the inorganic molecules needed for normal cell growth
   C) direct the synthesis of proteins necessary for proper cell function
   D) synthesize different kinds of amino acids in a specific sequence

126) When the bacterium *Serratia marcescens* is grown on a sterile culture medium in a petri dish at 30°C the bacterial colonies are cream colored. When this same bacterium is cultured under identical conditions, except at a temperature of 25°C, the colonies are brick red. This difference in color is most likely due to the
   A) effect of colony size on the synthesis of color pigments
   B) sterilization of the culture medium
   C) type of nutrients in the culture medium
   D) effect of temperature on the expression of the gene for color

127) Which statement best describes the result of some of the processes involved in genetic engineering?
   A) They are necessary for normal gamete formation.
   B) They alter the arrangement of hereditary material.
   C) They provide energy for mitosis and meiosis.
   D) They reduce variation in organisms that reproduce asexually.
128) After a series of cell divisions, an embryo develops different types of body cells such as muscle cells, nerve cells, and blood cells. This development occurs because
A) different genetic instructions are synthesized to meet the needs of new types of cells
B) different segments of the genetic instructions are used to produce different types of cells
C) some parts of the genetic materials are lost as a result of fertilization
D) the genetic code changes as the cells divide

129) In a particular variety of corn, the kernels turn red when exposed to sunlight. In the absence of sunlight, the kernels remain yellow. Based on this information, it can be concluded that the color of these corn kernels is due to
A) a different type of DNA that is produced when sunlight is present
B) a different species of corn that is produced in sunlight
C) the effect of environment on gene expression
D) the effect of sunlight on the number of chromosomes inherited

130) Which situation would most directly affect future generations naturally produced by a maple tree?
A) An increase in temperature reduces the number of cell divisions in the roots.
B) Ultraviolet radiation changes the DNA sequence within the gametes of some flowers of the tree.
C) Rapidly growing cells just under the bark are exposed to radiation, causing changes in genetic material.
D) Ultraviolet radiation changes the DNA sequence within some leaves of the tree.

131) The diagram below illustrates some key steps of a procedure in one area of biotechnology.

The letter X most likely represents
A) human cells that are able to synthesize antibodies
B) bacterial cells that are able to synthesize insulin
C) human cells that are unable to resist antibiotics
D) bacterial cells that are unable to synthesize insulin

132) The letters in the diagram below represent genes on a particular chromosome.

Gene B contains the code for an enzyme that cannot be synthesized unless gene A is also active. Which statement best explains why this can occur?
A) A hereditary trait can be determined by more than one gene.
B) Genes are made up of double-stranded segments of DNA.
C) The first gene on each chromosome controls all the other genes on the chromosome.
D) All the genes on a chromosome act to produce a single trait.

133) One way to produce large numbers of genetically identical offspring is by
A) fertilization
B) cloning
C) inserting a DNA segment into a different DNA molecule
D) changing genes by agents such as radiation or chemicals
A small amount of DNA was taken from a fossil of a mammoth found frozen in glacial ice. Genetic technology can be used to produce a large quantity of identical DNA from this mammoth's DNA. In this technology, the original DNA sample is used to
A) stimulate differentiation in other mammoth cells
B) provide fragments to replace certain human body chemicals
C) trigger mitosis to obtain new base sequences
D) act as a template for repeated replication

When DNA separates into two strands, the DNA would most likely be directly involved in
A) evolution
B) fertilization
C) differentiation
D) replication

A single gene mutation results from
A) the failure of chromosomes to separate
B) recombination of traits
C) a change in a base sequence in DNA
D) blocked nerve messages

Some mammals have genes for fur color that produce pigment only when the outside temperature is above a certain level. This pigment production is an example of how the environment of an organism can
A) stop the process of evolution
B) destroy certain genes
C) cause new mutations to occur
D) influence the expression of certain genes

The largest amount of DNA in a plant cell is contained in
A) a nucleus
B) a protein molecule
C) a chromosome
D) an enzyme molecule

The characteristics of a developing fetus are most influenced by
A) circulating levels of white blood cells in the placenta
B) hormone production by the father
C) gene combinations and their expression in the embryo
D) milk production in the mother

(a) Use appropriate letters to write a 9-base DNA sequence that could represent a portion of a gene.

(b) Show one example of what could happen to the 9-base DNA sequence you wrote in part (a) if a mutation occurred in that gene.

Genes involved in the production of abnormal red blood cells have an abnormal sequence of
A) bases
B) ATP molecules
C) sugars
D) amino acids

Research has shown that certain body cells, known as stem cells, can develop into a variety of specialized cells. Various factors can cause stem cells to develop into different types of mature cells. These different types of mature cells result from
A) identical genetic codes and meiotic cell division
B) different antibodies and mitotic cell division
C) similar steps in the development of the cells and a reduction in the number of chromosomes in each cell
D) different environments of the cells and the functioning of different parts of the genetic code

A gene that codes for resistance to glyphosate, a biodegradable weedkiller, has been inserted into certain plants. As a result, these plants will be more likely to
A) convert glyphosate into fertilizer
B) die when exposed to glyphosate
C) survive when glyphosate is applied to them
D) produce chemicals that kill weeds growing near them

Which statement best describes the relationship between cells, DNA, and proteins?
A) Cells contain DNA that controls the production of proteins.
B) DNA is composed of proteins that carry coded information for how cells function.
C) Proteins are used to produce cells that link amino acids together into DNA.
D) Cells are linked together by proteins to make different kinds of DNA molecules.

State one reason that mutations are often referred to as the "raw materials" of evolution.
One variety of strawberry is resistant to a damaging fungus, but produces small fruit. Another strawberry variety produces large fruit, but is not resistant to the same fungus. The two desirable qualities may be combined in a new variety of strawberry plant by

A) direct harvesting  
B) asexual reproduction  
C) cloning  
D) selective breeding

147) Down syndrome is a genetic disorder caused by the presence of an extra chromosome in the body cells of humans. This extra chromosome occurs in a gamete as a result of

A) a gene mutation  
B) replication of a single chromosome during mitosis  
C) an error in the process of cloning  
D) an error in meiotic cell division

148) Animal cells utilize many different proteins. Discuss the synthesis of proteins in an animal cell. Your answer must include at least:

(1) the identity of the building blocks required to synthesize these proteins
(2) the identity of the sites in the cell where the proteins are assembled
(3) an explanation of the role of DNA in the process of making proteins in the cell

149) A biotechnology firm has produced tobacco plants that synthesize human antibodies that prevent bacterial diseases. One of the first steps in the production of these plants required

A) using selective breeding to increase the number of antibody genes in tobacco plants
B) growing tobacco plants in soil containing a specific fertilizer
C) using natural selection to increase the survival of antibody-producing tobacco plants
D) inserting human DNA segments into the cells of tobacco plants

150) Plants inherit genes that enable them to produce chlorophyll, but this pigment is not produced unless the plants are exposed to light. This is an example of how the environment can

A) cause mutations to occur  
B) affect one plant species, but not another  
C) result in the appearance of a new species  
D) influence the expression of a genetic trait

151) The types of human cells shown below are different from one another, even though they all originated from the same fertilized egg and contain the same genetic information.

![Human cells](image)

Explain why these genetically identical cells can differ in structure and function.

152) A product of genetic engineering technology is represented below.

![Genetic engineering product](image)

Which substance was needed to join the insulin gene to the bacterial DNA as shown?

A) a specific enzyme  
B) a specific carbohydrate  
C) antibodies  
D) hormones
153) Synthesis of a defective protein may result from an alteration in
   A) cellular fat concentration
   B) a base sequence code
   C) vacuole shape
   D) the number of mitochondria