Molecular Genetics

Jan 96,34

Use the following information to answer the next two questions

Some Inherited Traits in House Cats

Dominant Trait	Allele	Recessive Trait	Allele
Pointed ears	P	Folded ears	p
Smooth hair	S	Curly hair	s
Polydactyly (more Than 5 digits on Paws)	D	Five digits on paws	d

Assume that all of the alleles shown above exhibit independent assortment

1. A folded-eared female mated with a male of unknown phenotype. All six of their offspring had pointed ears. What were the most probable genotypes of

   A. pp and PP
   B. Pp and Pp
   C. pp and Pp
   D. pp and pp

Jan 96, 7
Numerical Response

1. A curly-haired, five digited male was crossed with a female that was heterozygous for both hair type and the number of digits on the paws. What is the probability of this mating producing offspring that have curly hair and are heterozygous for the number of digits on the paws?

   (Record your **answer as a value from 0 to 1**, rounded to two significant digits, in the numerical-response section of the answer sheet.)

   Answer: _____

Jan 96,35

Use the following information to answer the next two questions

In *Drosophila*, ebony body colour is caused by the recessive allele *eb* and grey body colour by the dominant allele eb^+. Vestigial wings are produced by the recessive allele *vg* and long wings by the dominant allele vg^+.

When mated, a female with ebony body colour and vestigial wings produced the following offspring:

41 flies with ebony body and long wings
44 flies with grey body and long wings
39 flies with grey body and vestigial wings
46 flies with ebony body and vestigial wings

2. What was the genotype of the male parent in this cross?

A. $eb^+eb^+ \ vg^+vg^+$
B. $eb^+eb \ vg^+vg^+$
C. $eb^+eb \ vg^+vg$
D. $eb^+eb \ vgvg$

Jan 96,36

3. How many of the 44 offspring with grey bodies and long wings would be expected to be heterozygous for body colour?

A. 44
B. 33
C. 22
D. 11

Jan 96,37

Use the following information to answer the next two questions

An anemic condition in humans called thalassemia results from decreased production of hemoglobin. Three genes control the condition: *N* (normal hemoglobin), *Thal-1* (thelassemia 1), and *Thal-2* (thalassemia 2). Possible genotypes and phenotypes for the trait are shown below

Genotype	**Phenotype**
NN	No anemia
N Thal-1	Mild anemia
N Thal-2	Mild anemia
Thal-2 Thal-2	Mild anemia
Thal-2 Thal-1	Moderate anemia
Thal-1 Thal-1	Fatal—embryo or fetus dies before birth

4. Which statement is consistent with the information given?

A. *Thal-1*and *Thal-2* are codominant and *N* is dominant
B. *Thal-1* is dominant over both *N* and *Thal-2*
C. *N* is dominant over both *Thal-1* and *Thal-2*
D. *N, Thal-1* and *Thal-2* are codominant

Jan 96,38

5. If a male with the genotype *N Thal-1* and a female with the genotype *N Thal-2* have a child, the probability of that child having some degree of anemia (either mild or moderate) is

   A. 1.00
   B. 0.75
   C. 0.50
   D. 0.25

Jun 96,37

Use the following information to answer the next question

When a gene that directs cells of the human anterior pituitary to synthesize HGH is transplanted into bacteria, it will cause the bacteria also to synthesize HGH. This HGH can be used to treat slowed skeletal growth in children.

6. The phenomenon described illustrates that

   A. gene therapy can be used to cure inherited diseases in humans
   B. DNA is a universal language that can be read by all organisms
   C. bacteria, like humans, use insulin to regulate their sugar metabolism
   D. humans have acquired some bacterial genetical traits through symbiotic relationships

Jun 96,38

Use the following information to answer the next question

Some Events that Occur in a Cell during the Manufacture of Proteins

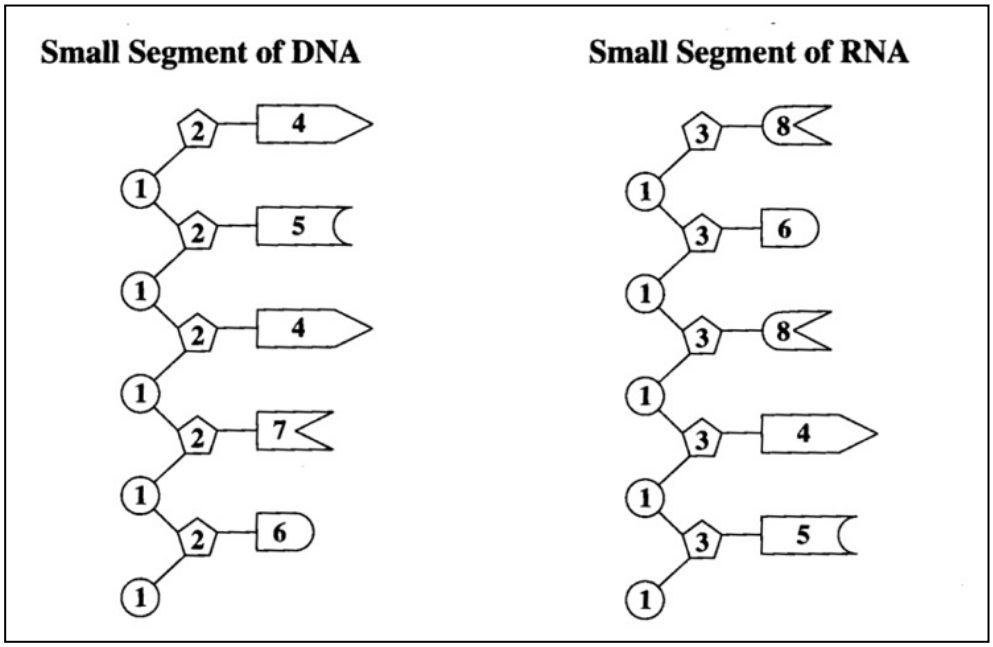
1 mRNA nucleotides are fused into a long chain
2 Amino acids join in a chain
3 Double helix of DNA uncoils
4 Polypeptide is released
5 tRNA anticodons match with mRNA codons
6 mRNA attaches to a ribosome

7. The sequence in which these events occur is

   A. 1,3,5,6,4,2
   B. 1,3,6,5,2,4
   C. 3,1,5,6,4,2
   D. 3,1,6,5,2,4

Jun 96,39

Use the following information to answer the next two questions.



8. If structure **1**, structure **3,** and structure **8** were combined to form a molecule, it would be

   A. an amino acid
   B. a nucleic acid
   C. a uracil nucleotide
   D. an adenine nucleotide

Jun 96,40

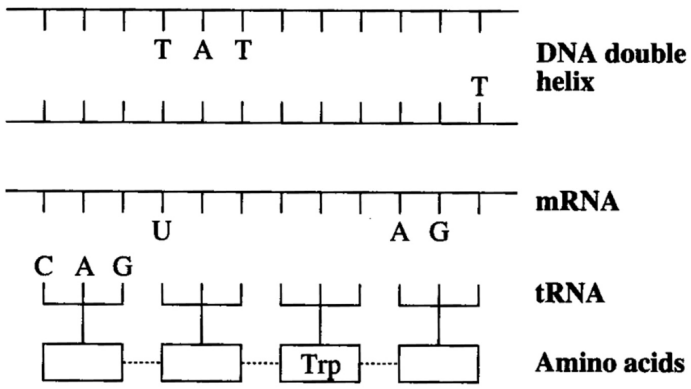
9. One likely result of a mutation could be the

   A. replication of the DNA segment
   B. transcription of the RNA segment
   C. replacement of structure 3 in the RNA segment with structure 2
   D. replacement of structure 4 in the DNA segment with structure 7

Jun 96, 41

Use the following information to answer the next two questions

In the following diagram, assume that the information is read from left to right and that the codons are aligned in the correct order. Some information has been omitted deliberately.



10. The first codon in the mRNA strand is

A. CAG
B. GTC
C. CUG
D. GUC

Jun 96,7

Use this additional information to answer the next question

Some Amino Acids

1 Alanine
2 Arginine
3 Cysteine
4 Glycine
5 Isoleucine
6 Lysine
7 Phenylalanine
8 Serine
9 Threonine

Numerical Response

2. The second codon in the DNA double helix is TAT. What is the amino acid coded by this triplet?

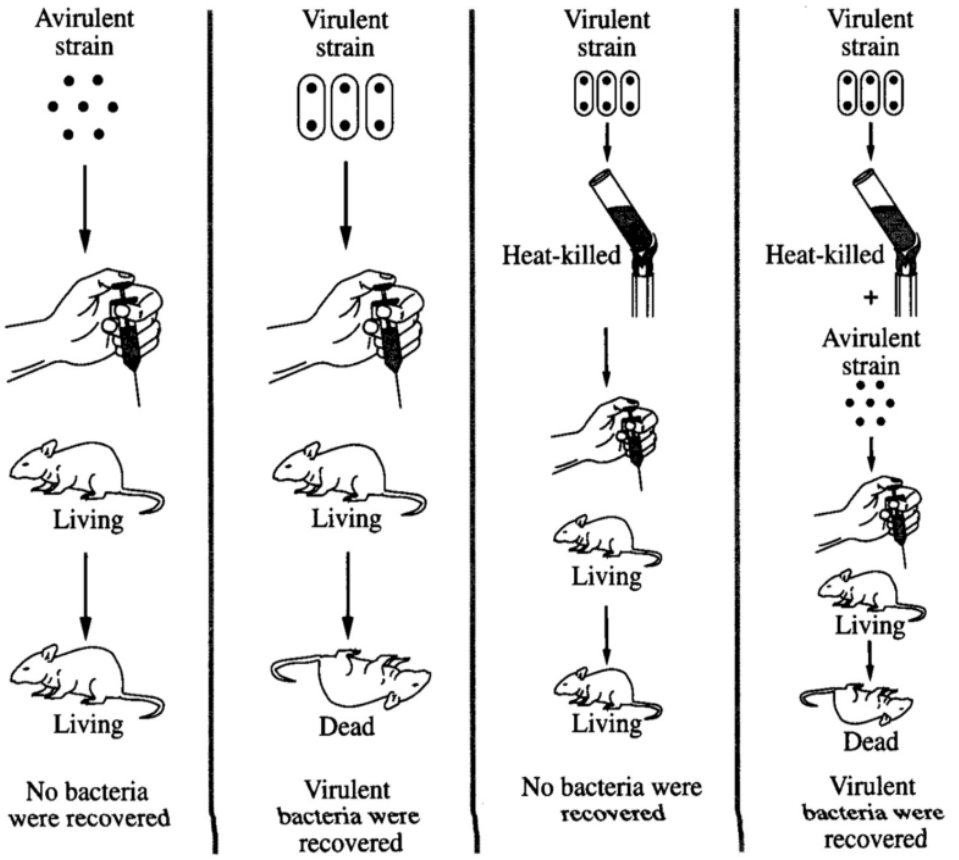
(Record your **answer** in the numerical-response section of the answer sheet.)

Answer: _____

Jun 97,29

Use the following information to answer the next question

In 1928, a British scientist, Frederick Griffith, performed an experiment by injecting mice with two strains of bacteria. The avirulent bacteria strain did not cause pneumonia, and the virulent bacteria strain caused pneumonia. Below is an illustration of his results.



From *Biology Directions*

11. The results illustrated can be **best** interpreted as showing that

A. the genetic material was deoxyribonucleic acid
B. some of the virulent bacteria had survived heat treatment
C. genetic material from the dead virulent bacteria had entered the living avirulent bacteria
D. genetic material from the avirulent strain caused the change to the virulent bacteria

Jun 97,30

Use the following information to answer the next two questions

The tables below represent a portion of a DNA molecule and its corresponding mRNA, tRNA, and polypeptide chain.

DNA:	C	G	T								
	G	C	A				T	G	A		
mRNA:			U	U			A			**Y**	
tRNA:							**X**			G	C	A
Amino acids:	**W**		Tryptophan								

12. The nitrogen bases for positions **X** and **Y** are, respectively

A. uracil and guanine
B. uracil and cytosine
C. adenine and cytosine
D. thymine and guanine

Jun 97,31

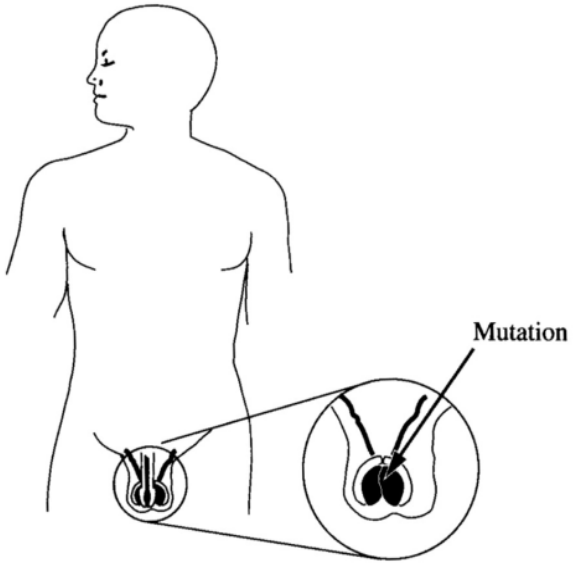
13. The amino acid labeled **W** is

A. methionine
B. tryptophan
C. arginine
D. alanine

Jun 97,32

Use the following information to answer the next two questions

Mutations occur in all organisms spontaneously. The natural rate of change is normally very low, but this rate can be increased by environmental factors such as ionizing radiation (e.g., ultraviolet light and X-rays) and mutagenic chemicals (e.g., benzene).



14. Which process would allow a mutation in the location shown to be passed on to the next generation?

    A. Mitosis
    B. Oogenesis
    C. Nondisjunction
    D. Spermatogenesis

Jun 97,33

15. By causing physical damage to a cellular component, ionizing radiation or chemicals can cause mutations. The site of this damage is

    A. the nuclear membrane
    B. the protein structure of the ribosome
    C. one or more amino acids in a crucial enzyme
    D. one or more nucleotides in the DNA molecule

Jun 97,34

Use the following information to answer the next question

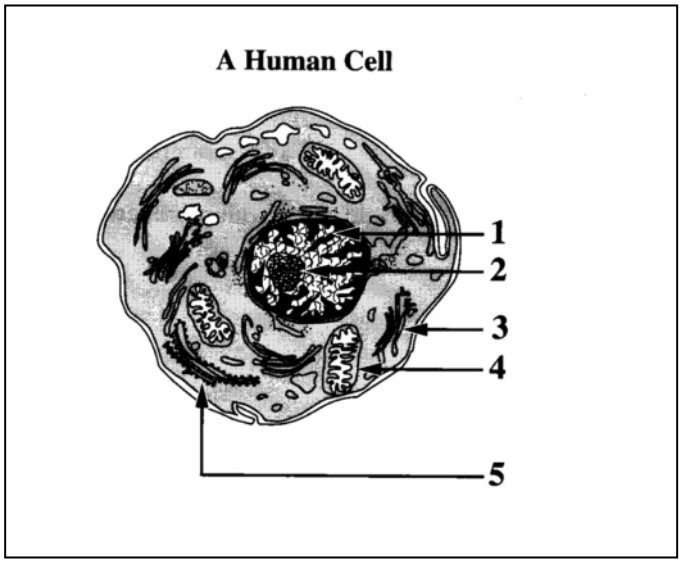
> A bacterium has been found that synthesizes a type of plastic called polyhydroxybutyrate (PHB). Researchers can remove genes from this bacterium, "cut" open the DNA in plant cells, and insert the bacterial genes. Plants grown from these transformed cells will synthesize PHB.
>
> -from *Science News*

16. The row that identifies the enzymes likely used by researchers to move the genes from the bacterium to a plant is

Row	Enzyme(s) Used on Bacterial DNA	Enzymes(s) Used on Plant DNA
A.	Ligase only	Ligase and restriction
B.	Restriction only	Ligase only
C.	Restriction only	Restriction and ligase
D.	Restriction and ligase	Restriction only

Jun 97,35

Use the following information to answer the next question

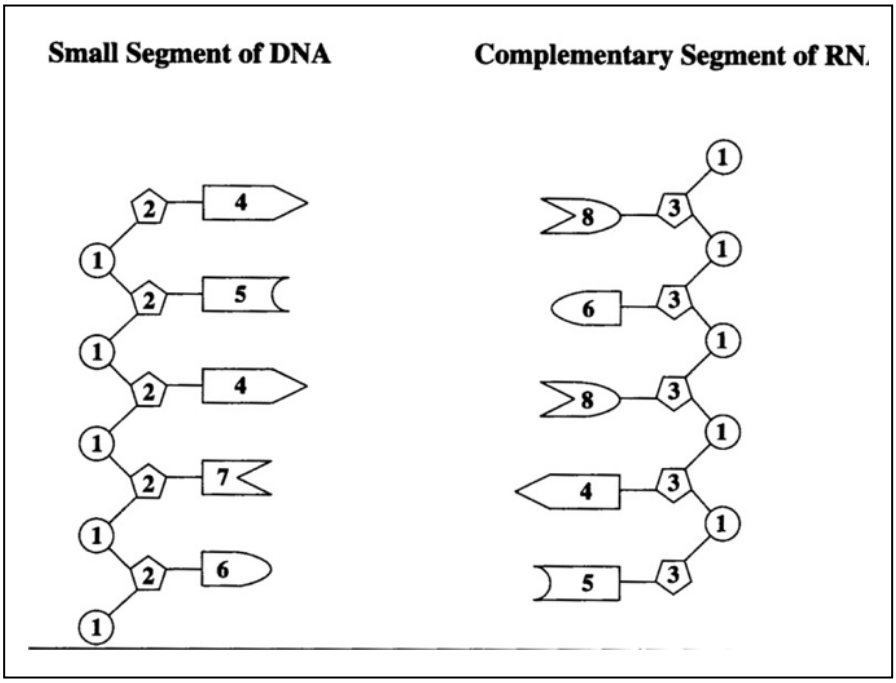


17. Which structures in the diagrammed human cell contain DNA?

A. Structures 1 and 3
B. Structures 1 and 4
C. Structures 2 and 3
D. Structures 3 and 5

Jun 98,37

Use the following information to answer the next question



18. If structure **4** is adenine, then structure **8** is

A. uracil
B. adenine
C. thymine
D. cytosine

Jun 98,38

Use the following information to answer the next question

The DNA sense strand shown below is thought to contain the genetic code for part of an enzyme that speeds up the breakdown of alcohol in the liver. (Read the DNA beginning at the left.)

- A – A – G – G – G – C – C – T – T – A – T – C -

19. Which amino acid sequence would be found in a polypeptide that is produced using the coded information in the above DNA sense strand?

A. Leucine – glycine – glutamate
B. Phenylalanine – proline – glutamate
C. Leucine – glcine – glutamate – tyrosine
D. Asparagine – proline – valine – methionine

Jun 98,39

Use the following information to answer the next question

> Between 50,000 and 100,000 genes are involved to build, run and maintain a human body. Any one of these genes can mutate.
>
> If geneticists locate a harmful mutation, there is hope that one day they will be able to repair the gene both in the affected individual and in his or her gametes.
>
> - from *Turner, 1996*

20. The technology to replace genes in cells of humans is called

    A. gene cloning
    B. gene therapy
    C. carrier screening
    D. DNA fingerprinting

Jun 98,40

Use the following information to answer the next three questions

> The polymerase chain reaction technique (PCR) makes it possible to produce a large number of copies of a specific DNA sequence in a relatively short time. When heated to 94oC, double-stranded DNA molecules separate completely, forming two single strands. Later, after the temperature is lowered and with DNA polymerase present, complementary DNA strands form. The process of heating and cooling can be repeated to produce as many copies of the DNA as is required.
>
> - from *Klug and Cummings, 1997*

21. If a DNA triplet is CTA, then the complementary DNA triplet is

    A. GAU
    B. GAT
    C. CUA
    D. CTA

Jun 98,41

22. PCR is similar to process that normally occurs in cells prior to cell division. The row that identifies the site and name of this process is

Row	Site	Process
A.	nucleus	replication
B.	nucleus	transcription
C.	cytoplasm	replication
D.	cytoplasm	transcription

Jun 98,42

23. Which enzymes would a geneticist use to cut DNA into fragments?

    A. Ligase enzyme
    B. RNA polymerases
    C. DNA polymerases
    D. Restriction enzymes

Jun 98,43

Use the following information to answer the next four questions

In some humans, the liver is unable to produce the enzyme called fumarylacetoacetate hydrolase (FAH). Without this enzyme, the liver is damaged over time because of the accumulation of the toxin succinylacetone. This toxin is produced through the improper metabolism of amino acids, it has been found that livers damaged by succinylacetone actually contain small patches of undamaged cells. These cells produce FAH.

Mice also suffer from liver damage caused by FAH deficiency. Researchers successfully used the following two methods to regenerate normal functioning livers in FAH-deficient mice.

I. Researchers transplanted some healthy liver cells into the unhealthy livers of the mice.
II. Researchers inserted normal genes into the damaged livers of the unhealthy mice.

-from *Travis, 1996*

24. The **most likely** explanation for the success following the transplant of healthy cells in mice is that the healthy cells

A. produced antibodies that repair the damaged cells
B. transferred FAH-producing genes to the damaged liver
C. underwent meiosis more rapidly than the damaged cells
D. produced enough FAH enzyme to restore the function of the liver

Jun 98,44

25. Which of the following statements about cells is demonstrated by this research?

A. Genes control cell division in liver cells
B. Genes control the production of the FAH enzyme in cells
C. Liver cells in an individual are genetically identical to each other
D. Liver cells cannot regenerate themselves by the process of mitosis

Jun 98,45

26. The presence of patches of healthy cells in the damaged human livers may indicate that

A. enzymes are not normally coded for by genes in liver cells
B. liver cells in an individual can undergo genetic change and cell division
C. liver cells migrated into the damaged livers from other places in the body
D. enzymes are produced in various places in the body and then migrate into the liver

Jun 98,8

Numerical Response

3. The sequence of events that produces the enzyme FAH (a protein) in liver cells is _____.

1. tRNA transports amino acids to the ribosome
2. information from DNA is used to form mRNA
3. mRNA carries the message to the ribosome
4. ribosome encounters a terminator (stop) codon

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____ _____ _____ _____

Jan 00,34

Use the following information to answer the next question

Portion of the Insulin Protein

Phenylalanine – Valine – Asparagine – Glutamate – Histidine

Assume that a mutation occurred in the strand DNA that codes for the portion of protein shown above. The protein was altered in structure and no longer performed its function.

-from *Campbell, 1987*

27. Which of the following effects would this mutation have on an individual's body?

    A. A chronic increase in blood sugar after meals
    B. A chronic decrease in blood sugar after meals
    C. A decrease in the body's metabolic rate after meals
    D. An increase in the body's metabolic rate after meals

Jan 00,35

Use the following information to answer the next question

Erwin Chargaff found that the relative amount of each of the base pairs that make up DNA varies from species to species. He analyzed a sample of DNA from *Escherichia coli* (a bacterium) and found that 23.6% of the nitrogen base molecules present in this sample were thymine.

-from *Curtis, 1983*

28. In this sample of Escherichia coli DNA, the percentage of the nitrogen base molecules that would be adenine is

    A. 76.4 %
    B. 38.2 %
    C. 23.6 %
    D. 11.8 %

Jan 00,36

Use the following information to answer the next two questions

A condition called "situs inversus" causes the internal organs of an animal to be reversed and end up on the wrong side of the body. Researchers have shown that insertion of a DNA fragment in one particular structural gene of mice may lead to this condition. Mice homozygous for this insertion are born with their organs reversed and die within a week of their birth. Mice heterozygous for this insertion are born with their organs in normal positions.

-from *Oliwenstein, 1993*

29. Which of the following statements is a **reasonable** conclusion based on this information?

    A. The gene with the inserted DNA fragment is recessive
    B. The gene with the inserted DNA fragment is dominant
    C. The affected gene produces a protein that influences embryonic development
    D. The affected gene cannot be transcribed after foreign DNA has been inserted

Jan 00,37

30. If two heterozygous mice were mated, what percentage of their offspring would be predicted to die?

    A. 0 %
    B. 25 %
    C. 50 %
    D. 75 %

Jan 00,38

Use the following information to answer the next two questions

> Although most strains of the bacterial species *Vibrio cholera* are harmless, the 01strain produces a toxin that binds to cells of the small intestine, causing rapid depletion of salts and water, which, if not replaced, can be lethal in humans. This disease is known as cholera.
>
> The transformation from harmless to harmful bacterial strains is thought to be caused by a virus that transfers the cholera toxin gene (CTX) from one bacterial strain and places it into another. Researchers can mimic this process by using current technologies.
>
> -from *Glausiusz, 1996*

31. The sequence of events that would enable researchers to incorporate the CTX gene into bacterial DNA would be to

    A. first open the bacterial DNA with ligase enzymes, then position the CTX gene in the DNA, and then join the DNA by restriction enzymes
    B. first open the bacterial DNA with restriction enzymes, then position the CTX gene in the DNA, and then join the DNA by ligase enzymes
    C. first position the CTX gene in the DNA, then open the DNA with the ligase enzymes, and then join the DNA by restriction enzymes
    D. first position the CTX gene in the DNA, then open the DNA with restriction enzymes, and then join the DNA by ligase enzymes

Jan 00,39

32. The overall effects of cholera toxin are opposite to the physiological effects of which of the following hormones?

    A. Oxytocin
    B. Thyroxine
    C. Aldosterone
    D. Epinephrine

Jan 00,40

Use the following information to answer the next two questions

> Some people have condemned the use of food preservatives because they may cause cancer. A researcher has found contradictory evidence that suggest that two widely used food preservatives actually increase levels of natural cancer-fighting agents in laboratory animals. The preservatives BHA and BHT increase the activity of a gene that controls the production of an enzyme. This enzyme helps destroy cancer-causing substances (carcinogens) before they trigger the development of tumours.
>
> -from *Pearson et al, 1983*

33. The most **direct** relationship between a gene and an enzyme is that

    A. an enzyme causes a gene to destroy carcinogens
    B. the sequence of nucleotides in a gene determines the structure of an enzyme
    C. each gene contains the code needed to construct many different types of enzymes
    D. the sequence of amino acids in an enzyme is unrelated to nucleotide sequence in a gene

Jan 00,5

Use the following additional information to answer the next question

> **Some Events that Occur Following BHA or BHT Exposure**
>
> **1** The polypeptide folds into an enzyme shape
> **2** tRNAs transport amino acids to the ribosome
> **3** A polypeptide is released from the ribosome
> **4** mRNA leaves the nucleus and attaches to ribosome in the cytoplasm

Numerical Response

4. The sequence of events that results in the production of the cancer-fighting enzyme is _____, _____, _____, and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Jan 01,35

Use the following information to answer the next three questions

> Researchers have found a gene known as p53. It codes for a protein that binds to specific areas of DNA and activates them. This causes the production of a set of proteins that halts cell division or, in some cells, activates the cell's suicide program (apoptosis). The p53 gene is activated when a cell is damaged and/or undergoes a DNA mutation.
>
> -from *Seachrist, 1996*

34. The normal function of the p53 gene is likely to

    A. encourage a cell to undergo mitosis
    B. encourage a cell to undergo meiosis
    C. prevent an abnormal cell from reproducing
    D. prevent the transcription of a cell suicide gene

Jan 01,36

Use the following additional information to answer the next two questions

Research on the p53 gene was initially done with cancer cells obtained from a laboratory animal. These cells were grown in a petri dish. A cell with two normal *p53* alleles was found to have normal cell division. Cells with one normal and one mutated *p53* allele were also found to have normal cell division. Cells that had mutations in both *p53* alleles were unable to control cell division and were associated with cancer.

35. The initial research findings described above

    A. demonstrate that the activated p53 gene causes cancer in lab animals
    B. demonstrate that the p53 protein causes the formation of cancer cells
    C. indicate that the normal p53 gene is responsible for preventing cancer in all mammals
    D. indicate that the normal p53 gene is responsible for preventing cancer under laboratory conditions

Jan 01,37

36. Gene therapy that might stop in controlled cell division due to the mutant *p53* allele would require

    A. one functional *p53* allele to be successfully inserted into cancer cells
    B. two functional *p53* alleles to be successfully inserted into cancer cells
    C. one functional *p53* allele to be successfully removed from cancer cells
    D. two functional *p53* alleles to be successfully removed from cancer cells

Jan 01,38

37. Which of the following rows correctly describes a DNA molecule?

Row	Components	Backbone	Molecules that form the links between two strands
A.	amino acids, sugars, and bases	sugars and bases	amino acids
B.	amino acids, sugars, and bases	sugars and amino acids	bases
C.	phosphates, sugars, and bases	sugars and bases	phosphates
D.	phosphates, sugars, and bases	sugars and phosphates	bases

Jan 01,39

Use the following information to answer the next question

A section of template DNA contains the following proportions of bases:

adenine – 20% thymine – 30% cytosine – 10% guanine – 40%

38. The proportions of three of the mRNA nucleotides produced from this DNA are

    A. 20% adenine, 30% uracil, and 10% cytosine
    B. 40% cytosine, 20% adenine, and 30% uracil
    C. 20% uracil, 40% cytosine, and 10% guanine
    D. 20% thymine, 30% adenine, and 10% guanine

Jan 02,22

Use the following information to answer the next six questions

> Mutated mitochondrial DNA has been linked with many disorders. For example, mitochondrial DNA mutations are believed to cause approximately 1.5% of all cases of diabetes mellitus. Type I diabetes mellitus is characterized by low insulin levels. In addition to insulin, blood glucose can be affected by glucagon.
>
> -from *Wallace, 1997*

39. Which of the following statements summarizes the effect of insulin and the effect of glucagon on blood glucose levels?

    A. Both insulin and glucagon tend to raise blood glucose levels.
    B. Both insulin and glucagon tend to lower blood glucose levels
    C. Insulin tends to raise blood glucose levels; whereas, glucagon tends to lower blood glucose levels
    D. Insulin tends to lower blood glucose levels; whereas, glucagon tends to raise blood glucose levels

Jan 02,23

Use the following additional information to answer the next four questions

> A deletion mutation in mitochondrial DNA cuases Kearns – Sayre syndrome (KSS). A large sample of different types of somatic cells was removed from a male with KSS, tested, and found to contain the deletion. The only type of mitochondrial DNA that was found in somatic cells from the man's mother was mitochondrial DNA that did not have the KSS deletion.

40. A reasonable hypothesis to explain these results is that the mutation in the mitochondrial DNA that caused KSS in the man first occurred in the

    A. mother's oocytes
    B. man's somatic cells
    C. man's spermatocytes
    D. mother's somatic cells

Jan 02,24

41. Both males and females can be affected by mitochondrial mutations, but only females can transmit genetic mutations to their offspring. For this inheritance pattern, which of the following rows gives the contributions to the zygote made by the sperm and by the egg?

Row	Sperm Contribution	Egg Contribution
A.	nuclear contents only	both nuclear and cytoplasmic contents
B.	both nuclear and cytoplasmic contents	nuclear contents only
C.	neither nuclear nor cytoplasmic contents	both nuclear and cytoplasmic contents
D.	both nuclear and cytoplasmic contents	neither nuclear nor cytoplasmic contents

Jan 02,25

42. Mitochondrial DNA and nuclear DNA both code for the formation of proteins. Which of the following statements about protein synthesis is **true**?

    A. A mRNA anticodon binds with an amino acid codon, which results in the placement of a specific tRNA molecule in the polypeptide chain.
    B. A mRNA anticodon binds with a tRNA codon, which results in the placement of a specific polypeptide molecule in the amino acid chain.
    C. A tRNA anticodon binds with an mRNA codon, which results in the placement of a specific amino acid molecule in the polypeptide chain.
    D. A tRNA anticodon binds with a polypeptide codon, which results in the placement of a specific mRNA molecule in the amino acid chain.

Jan 02,26

Use the following additional information to answer the next question

> In an individual with KSS, part of the coding strand of mitochondrial DNA that has been deleted has the following base sequence.
>
> ACC TCC CTC ACC AAA

43. The third amino acid coded for by this segment of mitochondrial DNA is

    A. lysine
    B. threonine
    C. glutamate
    D. phenylalanine

Jan 02,27

Use the following additional information to answer the next question

> Over time, mitochondrial DNA accumulates non-lethal mutations at a constant rate. There is a higher degree of variation in mitochondrial DNA in earlier populations than in more recent populations. Scientists have taken samples of mitochondrial DNA from people living on different continents and compared the number of mitochondrial DNA mutations in these samples. They used this data as evidence to determine the order in which Earth's continents were populated.

44. In this study, the manipulated variable was the

    A. amount of mitochondrial DNA tested
    B. time of migration from one continent to another
    C. amount of variation in mitochondrial DNA base sequences
    D. geographic location of subjects whose sample of mitochondrial DNA was tested