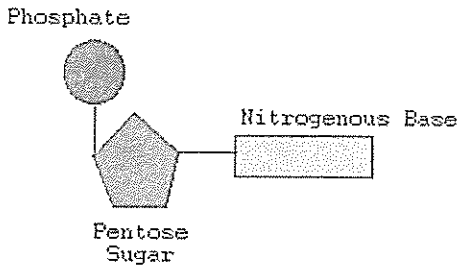
Topic 6: Genetics

Heredity and Genes:

1. Heredity	The passing of genetic information from one generation to the next through reproduction
2. Chromosome	Thick, threadlike structure that contains genetic information in the form of DNA
3. Gene	A segment of DNA (on a chromosome) that contains the code for a specific trait
4. Trait	A characteristic that is passed from parent to offspring through the genes

Nucleotides: Subunits of nucleic acids

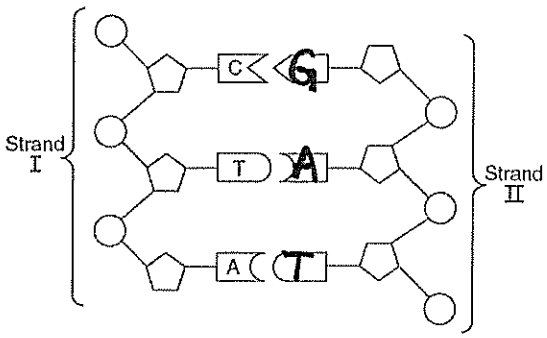
- 5-carbon sugar: ribose / deoxyribose
- phosphate group
- nitrogenous bases: A, T, G, C

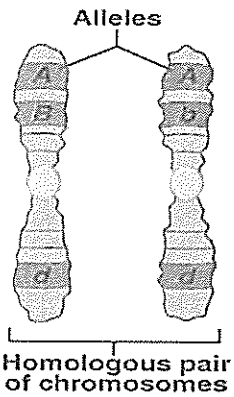


Base Pairing: (held together by weak hydrogen bonds)

a. A is always bonded to T in DNA
b. C is always bonded to G in DNA

Fill in appropriate bases below:



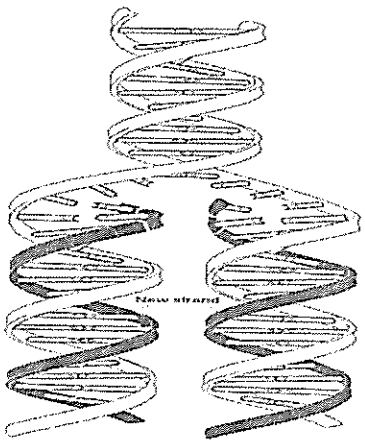


You get one chromosome in a homologous pair from each parent.

DNA Replication:

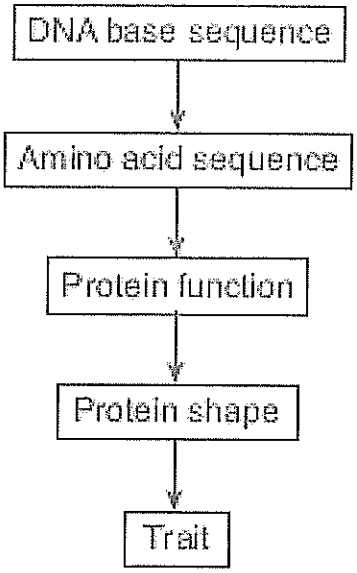
1. DNA untwists
2. Unzips between nitrogenous bases (H bonds break)
3. New nucleotides are added
4. Two identical strands are produced

When does DNA replication occur?
Replication occurs just before cell division
(Mitosis / Meiosis)

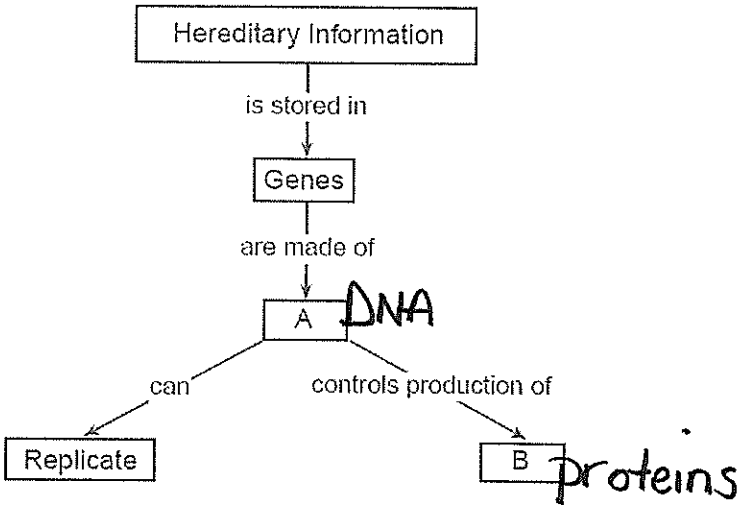


Protein Synthesis:

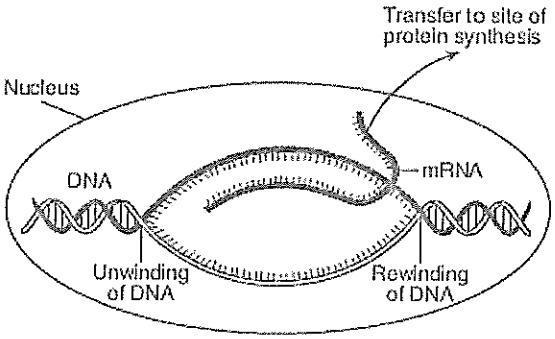
Transcription	Translation
• Writing the code • In the nucleus • mRNA is made from DNA template	• reading the code • At the ribosome • tRNA bring over amino acids • polypeptide chain is formed



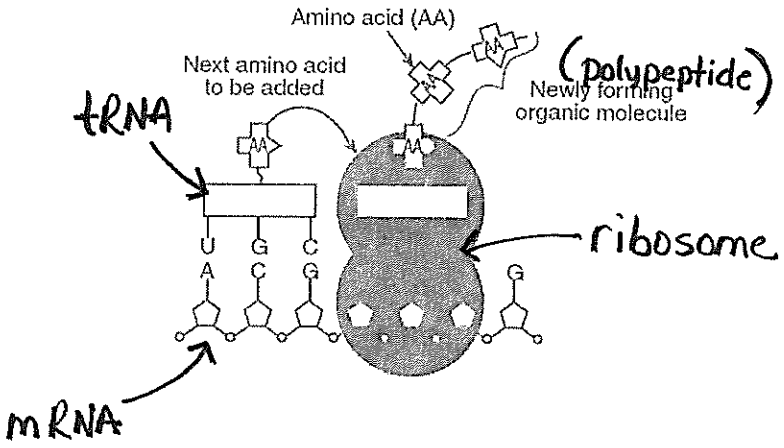
Fill in boxes A and B:



Transcription:



Translation:
Label mRNA, tRNA, and ribosome



Amino Acid Chart:

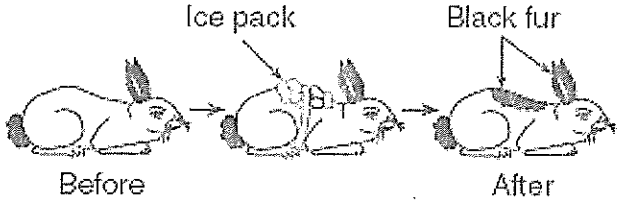
1st letter	Second Letter: U	C	A	G	3rd letter
U	UUU Phe UUC UUA Leu UUG	UCU UCC UCA Ser UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC CUA Leu CUG	CCU CCC CCA Pro CCG	CAU His CAC CAA Gln CAG	CGU CGC CGA Arg CGG	U C A G
A	AUU AUC AUA Ile AUG Met	ACU ACC ACA Thr ACG	AAU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

Fill out the chart below:

DNA STRAND	mRNA STRAND	Amino acid sequence
GATTCGGAATTA	CUA AGC CUU AAU	Leu, Ser, Leu, Asn
TAGGGCCCTGGC	AUC CCG GGA CCG	Ile, Pro, Gly, Pro

Gene Expression and Environment:

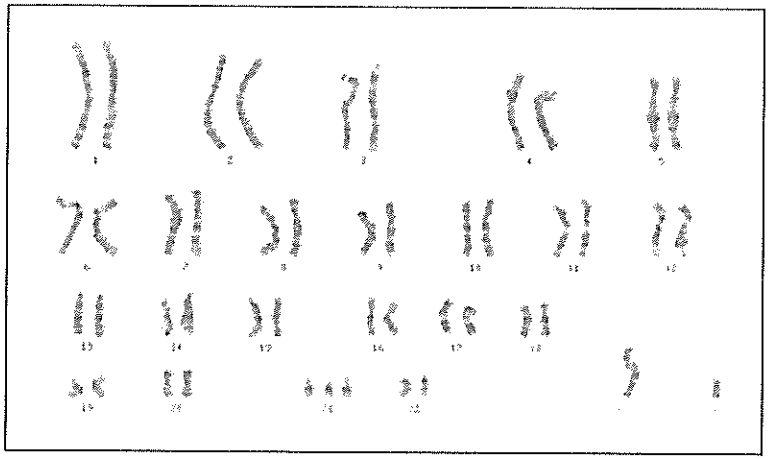
Organisms	Environmental factor	Expression
Himalayan Rabbit	Lower temperatures	Black fur (instead of white)
Green Plants	No light	White (no chlorophyll)



Mutations:

- Change in sequence of nucleotides (nitrogenous base sequence) → change in sequence of amino acids (different protein, can result in disease)
- There can also be chromosomal mutations where all or part of a chromosome has been added or deleted. (Downs Syndrome)

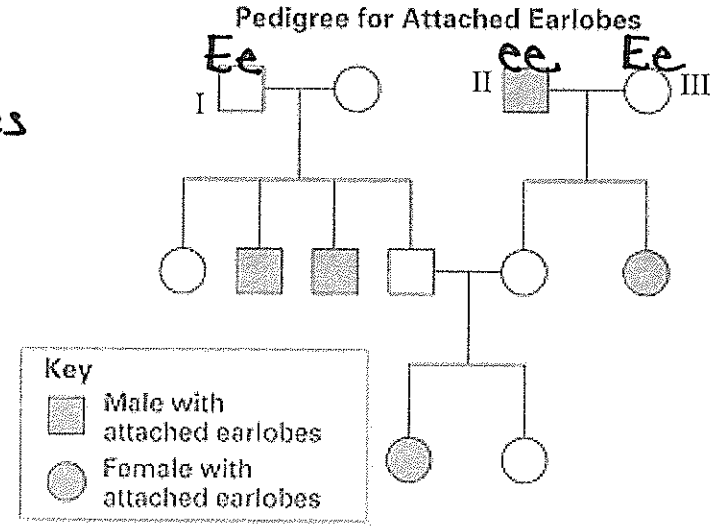
Karyotype: picture of chromosomes used to detect abnormalities



Pedigree:

- Family tree that records and traces the occurrence of a trait in a family
- Shaded = shows trait, Blank = does not show trait (genotype must be calculated using the chart)
- Boxes = males, Circles = females
- Attached earlobes is a recessive trait. Based on this information, create a chart of possible genotypes and phenotypes fore ear lobes. The first one has been done for you.
- Also, determine the genotypes for individuals I, II and III

Genotype	Phenotype
EE	Free earlobes
Ee	Free earlobes
ee	attached earlobes



Genetics

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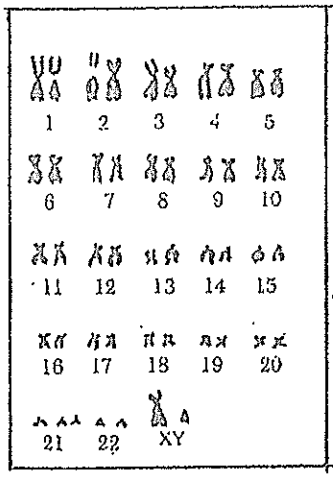
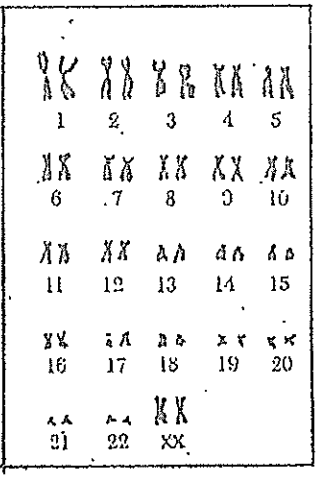
1. Base your answer to the following question on your knowledge of biology and on the charts below which show human chromosomes arranged in pairs.

Individual *A*



Individual *B*



The preparation of these charts for individuals *A* and *B* is known as

1) microsurgery
2) karyotyping
3) blood typing
4) chemical screening

2. According to the gene-chromosome theory, which statement is true?

1) Genes are present only on human chromosomes.
2) Genes are arranged in a linear sequence on a chromosome.
3) Alleles are located on nonhomologous chromosomes.
4) Mutations occur mainly in sex cells

3. When the bacterium *Serratia marcescens* is grown on a sterile culture medium in a petri dish at 30°C, the bacterial colonies will be cream colored. When this same bacterium is cultured under identical conditions, except at a temperature of 25°C, the colonies will be brick red. This difference in color is most likely due to the

1) type of nutrients in the culture medium
2) sterilization of the culture medium
3) effect of temperature on the expression of the gene for color
4) effect of colony size on the synthesis of color pigments

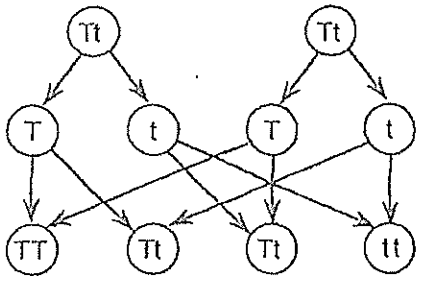
4. Mutations can be transmitted to the next generation only if they are present in

1) brain cells
2) sex cells
3) body cells
4) muscle cells

5. 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

1) different antibodies and mitotic cell division
2) identical genetic codes and meiotic cell division
3) different environments of the cells and the functioning of different parts of the genetic code
4) similar steps in the development of the cells and a reduction in the number of chromosomes in each cell

6. The diagram below represents the inheritance of stem height in garden peas.



The diagram best illustrates

1) intermediate inheritance
2) segregation and recombination
3) sex linkage and codominance
4) independent assortment

7. X-rays, formaldehyde, and asbestos fibers are all similar in that they are

1) animal preservatives
2) used to treat diseases
3) used to diagnose diseases
4) mutagenic agents

8. Changes in the genetic material in sex cells are mutations that

1) may be transmitted to the next generation
2) are always eliminated during meiosis
3) are always sex-linked
4) cannot affect the organism or its offspring

9. The genes for red hair and freckles are usually inherited together because these genes are

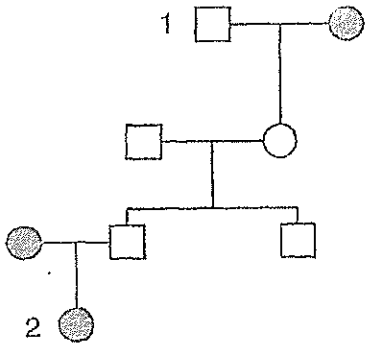
1) homologous
2) sorted independently
3) linked
4) hybrid traits

10. Genes for two different traits that are located next to each other on the same chromosome would most likely be

linked

1) inherited separately
2) codominant
3) recombined
4) inherited together

11. Base your answer to the following question on the pedigree chart below, which shows a history of ear lobe shape, and on your knowledge of biology.



KEY

E = Allele for free ear lobes (dominant)
e = Allele for attached ear lobes (recessive)

□ = Male with free ear lobes
○ = Female with free ear lobes
■ = Male with attached ear lobes
● = Female with attached ear lobes

The genotype of individual 1 could be
1) *EE*, only 2) *Ee*, only 3) *ee* (4) *EE* or *Ee*

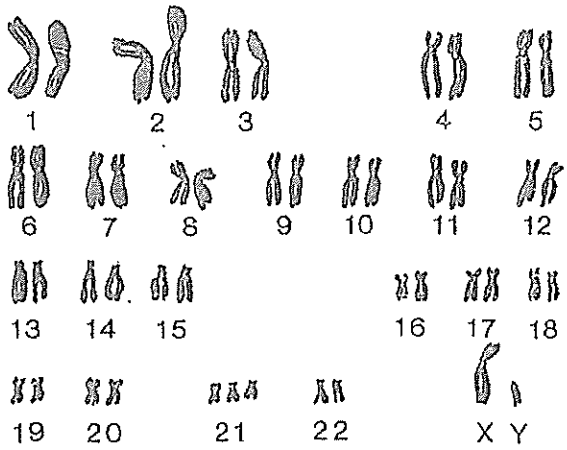
12. The cells that make up the skin of an individual have some functions different from the cells that make up the liver because
1) all cells have a common ancestor
2) different cells have different genetic material
3) environment and past history have no influence on cell function
(4) different parts of genetic instructions are used in different types of cells

13. Which statement best describes the relationship between the number of genes and the number of chromosomes in human skin cells?
(1) There are more genes than chromosomes in skin cells.
2) There are more chromosomes than genes in skin cells.
3) There are equal numbers of genes and chromosomes in skin cells.

14. What will happen if a base sequence of a strand of DNA is changed from A–T–G to A–T–C?
(1) The m-RNA will be changed from U–A–C to U–A–G.
2) The t-RNA will be changed from U–A–C to T–A–C.
3) The m-RNA will be changed from T–U–C to T–U–G.
4) The t-RNA will be changed from C–A–U to C–A–C.

15. A certain species of plant produces blue flowers when the soil pH is above 7.0. However, when the soil pH is below 7.0, the flowers are pink. Which statement best explains this color change?
1) Mutagenic agents can alter genotypes.
(2) The environment influences gene action.
3) Polyploidy produces 2n gametes.
4) Chromosomal mutations produce color effects.

16. Base your answer to the following question on the diagram below of the chromosomes from a human cell and on your knowledge of biology.



Which procedure can be performed during fetal development to detect the chromosomal disorder illustrated by the diagram?
1) genetic counseling 3) urine analysis
(2) amniocentesis 4) cloning

17. In a certain type of plant, tall is dominant over short, and green seed coat is dominant over yellow seed coat. When two plants heterozygous for both of these traits are crossed, the offspring produced are tall, with green seed coats; tall, with yellow seed coats; short, with green seed coats; and short, with yellow seed coats. The results of this cross illustrate
1) vegetative propagation
2) mutagenic agents
3) intermediate inheritance
(4) independent assortment

18. DNA controls cellular activities most directly by coding for the synthesis of
    1) inorganic compounds
    3) carbohydrates
    (2) enzymes (proteins)
    4) fatty acids

19. 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
    1) a change in the amount of glucose produced during photosynthesis
    2) the use of a new natural fertilizer on the field
    3) rapid mitotic divisions within the developing seeds
    (4) a random change in the structure of DNA during meiosis (mutation)

20. The genetic code for one amino acid molecule consists of
    1) five sugar molecules
    (3) three nucleotides
    2) two phosphates
    4) four hydrogen bonds

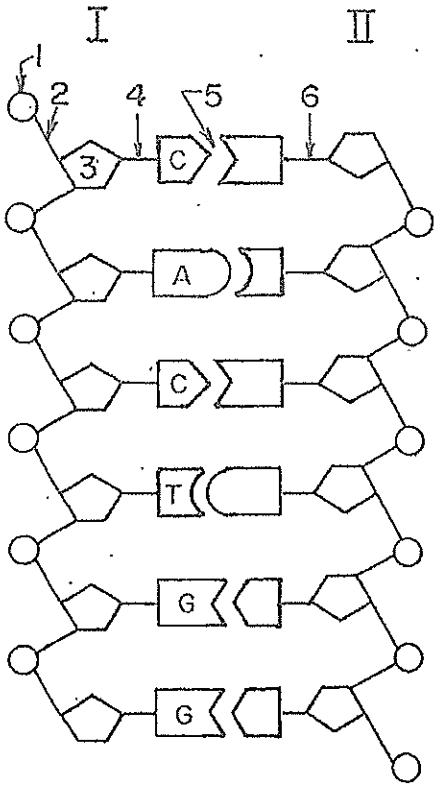
21. Which structures code information for the inheritance of traits?
    1) nuclear membranes
    3) vacuoles
    2) cell membranes
    (4) genes

22. In any naturally occurring population, the mutation rate of a particular allele is predictable. However, the actual mutation of any single allele will
    1) always yield a recessive allele
    2) occur by means of nondisjunction
    (3) be a completely random occurrence
    4) result from random mating

23. Which genetic disorder can be detected by karyotyping?
    1) PKU
    (3) Down's syndrome
    2) Tay-Sachs
    4) sickle-cell anemia

Chromosomal disorders
NOT
genetic diseases

24. Base your answer to the following question on the diagram below which represents a portion of a double-stranded DNA molecule and on your knowledge of biology.



The base sequence of strand II is most likely
    1) C-A-C-T-G-G
    (3) G-T-G-A-C-C
    2) G-G-T-C-A-C
    4) G-T-G-U-C-C

25. What is the relationship between an organism's DNA and protein specificity?
    1) DNA becomes a specific part of the protein structure.
    2) DNA determines the ribosomal RNA sequence that becomes part of the protein structure.
    3) DNA determines which RNA molecules are incorporated into protein molecules.
    (4) DNA determines the amino acid sequence of each protein.

26. When red-flowered snapdragons are crossed with white-flowered snapdragons, all the F_1 plants will have pink flowers. If Mendel had used snapdragons instead of pea plants, he would have had difficulty in formulating his principle of
    (1) dominance
    3) multiple alleles
    2) sex-linked traits
    4) mutation

27. A high concentration of an enzyme that breaks down RNA molecules is introduced into a cell. Which cellular activity would probably be affected first?
    1) metabolism of fats
    2) synthesis of proteins
    3) hydrolysis of ATP
    4) oxidation of glucose

28. A normal bacterial cell carries on the chemical reaction represented below.

$$A \xrightarrow{\text{enzyme X}} B$$

    A certain mutant bacterial cell cannot produce substance *B*. The mutation was most likely the result of a change in the
    1) ribosome on which enzyme *X* is made
    2) ability of the DNA to replicate
    3) amino acid sequence of RNA
    4) gene that codes for enzyme *X*

29. During meiosis, crossing-over (gene exchange between chromosomes) may occur. Crossing-over usually results in
    1) overproduction of gametes
    2) fertilization and development
    3) the formation of identical offspring
    4) variation within the species

30. The coded information of a DNA molecule is determined by the
    1) sequence of amino acids
    2) number of ribose units
    3) sequence of the nitrogenous bases
    4) sequence of the sugar-phosphate units

31. A cross between two mice with long tails and brown fur produced the four types of offspring listed below:

    long tailed with brown fur
    long tailed with white fur
    short tailed with brown fur
    short tailed with white fur

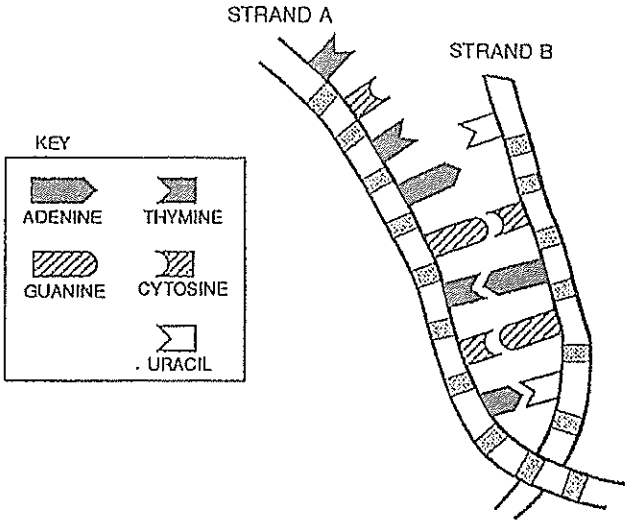
    Which genetic mechanism best explains the results of this cross?
    1) intermediate inheritance
    2) gene linkage
    3) independent assortment
    4) crossing-over

32. According to the table below, which amino acid sequence would most likely be determined by a section of a DNA molecule with the base sequence A-A-G-G-A-T-C-C-G?

Messenger RNA Codon	Amino Acid
A-G-A	arginine
C-U-A	leucine
G-G-C	glycine
U-U-C	phenylalanine

    1) phenylalanine–arginine–glycine
    2) glycine–arginine–leucine
    3) glycine–leucine–arginine
    4) phenylalanine–leucine–glycine

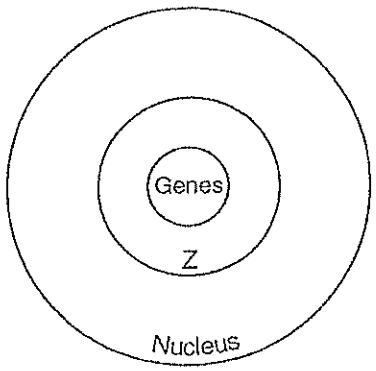
33. Base your answer to the following question on the diagram below and on your knowledge of biology.



    If strand *B* represents messenger RNA, it would transport the genetic code from the
    1) ribosome to the nucleus
    2) nucleus to the ribosome
    3) mitochondria to the nucleus
    4) nucleus to the mitochondria

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

Big ↓ Bigger ↓ Biggest ☺



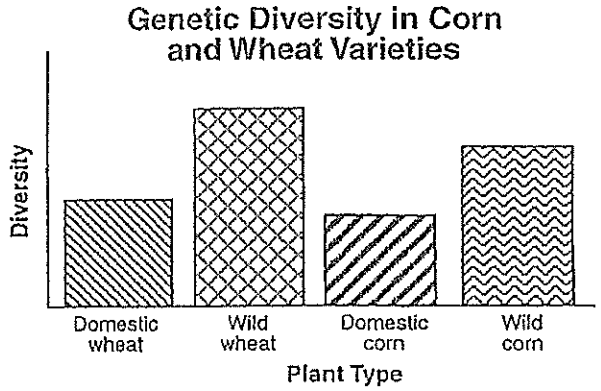
The circle labeled *Z* most likely represents

1) amino acids
2) chromosomes
3) vacuoles
4) molecular bases

35. Which statement best describes chromosomal mutations?

1) They only involve changes in the chromosome number.
2) They only involve changes in the chromosome structure.
3) They involve changes in the chromosome number or the chromosome structure.
4) They never involve changes in the chromosome number or the chromosome structure.

36. Base your answer on the graph below and on your knowledge of biology.



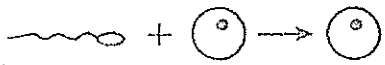
If the environment were to change dramatically or a new plant disease were to break out, which plant type would most likely survive?

1) wild wheat
2) domestic wheat
3) wild corn
4) domestic corn

37. Identical twins separated at birth and raised by different parents were found to have dramatically different personalities. This finding provides evidence for

1) mutation and genetic recombination
2) independent assortment
3) segregation of alleles
4) environmental influence on gene expression

38. The diagram below represents a reproductive process that takes place in humans.



Where there's sex, there's variety !!

Which statement does *not* correctly describe this process?

1) The normal species chromosome number is restored.
2) Males and females each contribute DNA to the offspring.
3) The zygote will develop to become identical to the dominant parent.
4) The sex of the zygote is determined by DNA in the gametes.

39. In an experiment, corn seeds were germinated and grown in the dark. When leaves developed, they were white. Several days later, the plants were exposed to sunlight and the leaves turned green. A possible explanation for this color change is that the

1) expression of the genes controlling chlorophyll production is influenced by environmental factors
2) genes that control chlorophyll production cannot be expressed until the plant is mature
3) alleles for leaf color in corn plants are codominant
4) exposure to ultraviolet radiation present in sunlight caused a mutation in the corn plants

40. Mutagenic agents are substances that

1) increase the rate of gene mutations
2) decrease the rate of gene mutations
3) have no effect upon the rate of gene mutations
4) cause gene mutations but not other chromosomal changes

Most variation