"Molecular Genetics"

Class MG 4

Warm-up

Indicate whether the statement is true or false.

1. RNA polymerase has to bind to DNA for an enzyme to be synthesized.
2. The only function of RNA polymerase is to control mRNA synthesis in eukaryotes.
3. One strand of a double-stranded DNA helix is oriented in the 5' (carbon of the deoxyribose molecule) to 3' direction, while the complementary strand it is bonded to is oriented in the 3' to 5' direction.
4. In eukaryotes, transcription can *not* take place when the DNA is packaged in nucleosomes.

1. T
2. F
3. T
4. F

Warm-up

Identify the choice that best completes the statement or answers the question.

5. Which series is arranged in order from largest to smallest in size?
   a. chromosome, nucleus, cell, DNA, nucleotide
   b. cell, nucleus, chromosome, DNA, nucleotide
   c. nucleotide, chromosome, cell, DNA, nucleus
   d. cell, nucleotide, nucleus, DNA, chromosome
6. Which of the following sequences of processes correctly reflects the central dogma?
   a. protein synthesis, transcription, translation
   b. protein synthesis, translation, transcription
   c. transcription, translation, protein synthesis
   d. translation, transcription, protein synthesis

5. B
6. C

Protein Synthesis

http://www.brookscole.com/chemistry_d/templates/student_resources/shared_resources/animations/protein_synthesis/protein_synthesis.html

Transcription, rna processing, & translation

http://207.207.4.198/pub/flash/26/transmenu_s.swf

Central Dogma

http://wps.prenhall.com/esm_freeman_biosci_1/0,6452,499049-,00.html

Gene regulation and mutation
Objectives

- Summarize the various types of mutations.

gene regulation and mutation

MAIN IDEA

Gene expression is regulated by the cell, mutations can affect this expression.

Mutations

Cells sometimes make mistakes during replication.

The cell has repair mechanisms that can repair some damage.

A permanent change that occurs in a cell's DNA is called a mutation.

Sometimes mutations are associated with diseases and disorders.

Types of mutations

Mutations can range from changes in a single base pair to the deletions of large pieces of chromosomes.

1. Point mutations involve a chemical change in just one base pair.

   A point mutation in which one base pair is exchanged for another is called a substitution.

Types of mutations

a) Most substitutions are missense mutations, where the DNA code is altered so that it codes for the wrong amino acid.

b) Nonsense mutations are substitutions that change the codon for an amino acid to a stop codon.

Nonsense mutations cause translation to terminate early.

Most nonsense mutations lead to proteins that cannot function normally.

Types of mutations

2. Another type of mutation that occurs involves the gain or loss of a nucleotide.

a) Insertions are additions of a nucleotide.

b) Deletions are the loss of a nucleotide.

They are called frame-shift mutations because they change the “frame” of the amino acid sequence.

Types of mutations

3. Large portions of DNA can be involved in a mutation.

   A piece of the chromosome containing one or more genes can be deleted or moved to a different location on the chromosome or to a different chromosome.

   This often has drastic effects on the expression of these genes.

Types of mutations

4. Tandem repeats happens when there is an increase in the number of copies of repeated codons.

   The increase in repeated sequences is involved with a number of inherited disorders like fragile X syndrome.

Types of mutations

http://glencoe.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::550::400::/sites/dl/free/0078695104/383936/Table12_3a.swf::Mutations – A

http://glencoe.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::550::400::/sites/dl/free/0078695104/383936/Table12_3b.swf::Mutations - B

Protein folding and stability

The change in one amino acid for another can change the sequence of amino acids in a protein enough to change both the folding and stability of the protein.

Numerous diseases involve problems with protein folding, including sickle-cell disease, Alzheimer's disease, cystic fibrosis, diabetes, and cancer.

Causes of mutation

Some mutations can occur spontaneously.

During replication, DNA polymerase sometimes adds the wrong nucleotides.

The wrong nucleotide gets added only 1 in 100,000 bases.

It goes unfixed in less than 1 in 1 billion.

Causes of mutation

Certain chemicals and radiation also damage DNA.

Substances which cause mutations are called mutagens.

Some of these mutagens affect DNA by changing the chemical structure of the bases.

These changes cause bases to bond with the wrong base.

Causes of mutation

Other mutagens have chemical structures that resemble nucleotides so they can substitute for them.

If this happens the DNA can not replicate properly.

This type of chemical is used in the treatment of HIV.

Once the drug is incorporated in the viral DNA, the DNA can not copy itself properly.

Body cell vs. Sex cell mutation

When a mutation in a body cell occurs, it becomes part of the genetic sequence in that cell and in future daughter cells.

The cell mutation is not passed on to the next generation.

In some cases, the mutations do not cause problems for the cell.

These mutations are called neutral mutations.

Body cell vs. Sex cell mutation

When the mutation occurs in sex cells, the mutations are passed on to the organism's offspring and will be present in every cell of the offspring.

These might affect the offspring drastically.

Class Work

Complete Mutations by Analogy

&

Review

Mutations by Analogy

1. Original message

   Hallo!

   Point mutation

   Hello!

   What was the effect of this mutation

   One letter was changed

   If this had been an mRNA coding for a protein, what would have been changed?

   One amino acid was changed.

Mutations by Analogy

2. Original message

Mixture

Point deletion mutation

mi.

What was the effect of this mutation

Message stopped prematurely

If this had been an mRNA coding for a protein, what would have been changed?

Only part of the protein synthesized. Protein unlikely to function correctly.

Mutations by Analogy

1. Original message

   What?

   Point insertion mutation

   WhaSFgW

   What was the effect of this mutation

   Wrong letters, no stop code.

   If this had been an mRNA coding for a protein, what would have been changed?

   Longer, but nonfunctioning, protein

Mutations by Analogy

1. Original message

   Protein

   Point substitution mutation

   What was the effect of this mutation

   No message because no start

   If this had been an mRNA coding for a protein, what would have been changed?

   No protein because no start (MET).

Mutations by Analogy

1. Original message

   Later.

   Point substitution mutation

   Later.

   What was the effect of this mutation

   No change

   If this had been an mRNA coding for a protein, what would have been changed?

   No change in protein.

Mutations by Analogy

6. During this activity you modeled protein synthesis using mRNA. But where did the mutation originally occur?

   In DNA base-pair order.

7. What is a mutation?

   Change in base order of DNA in a cell's chromosome.

Mutations by Analogy

8. How can a mutation in the DNA cause a change in an organism's protein?

Change in DNA → change in mRNA → change in order, or number, of amino acids in the protein.

9. Do all mutations in the DNA coding for mRNA cause a change in an organism? Why or why not?

No. The code is redundant: most amino acids (& STOP) have more than one code. Some changes in base order do **NOT** cause changes in amino acids.

Mutations by Analogy

10. Are mutations helpful or harmful?

Some are helpful (disease resistance)

(Hallo! → Hello!)

Some are harmful (cancer)

(What? → WhaSFgW)

Most are neutral (little or no change in organism)

(Later. → Later.)

Whether a mutation is good or bad is often a function of the environment!

Class Work

Complete WSs SG 85, SG 86, SG 87, & SG 88

These will help you study for tomorrows Test.

Study Guide Review

1. Phosphate
2. Sugar
3. Purine
4. Guanine
5. Pyrimidine
6. Cytosine
7. Adenine (A), nitrogenous bases
8. cytosine
9. Nucleotides
10. Purine
11. Double helix
12. Genetic material
13. Single-ring
14. Double-ring
15. Nucleic acids
16. chromosome

Study Guide Review

1. E
2. A
3. F
4. C
5. D
6. B
7. Leading strand
8. DNA polymerase
9. Parental DNA
10. Okazaki fragments
11. DNA ligase
12. DNA polymerase

Study Guide Review

1. True
2. False
3. AUG GCU AAU UGU UGA
4. Start (methionine), alanine, asparagine, cysteine, stop
5. Start: AUG, stop: UAA, UGA, UAG
6. mRNA
7. Cytoplasm
8. Ribosome
9. Protein
10. Translation
11. tRNA
12. Anticodon
13. Start codon

Study Guide Review

1. True
2. An operon
3. Transcription
4. True
5. Body plan
6. AUG-AAG-UUU-GGC-ACA-UUG-UAA
7. Substitution
8. Substitution
9. Frameshift

HW

STUDY for the Test.

Eukaryotic Gene Regulation

In eukaryotes, many genes interact with one another, requiring more elements than a single promoter and operator for a set of genes.

The organization and structure of eukaryotic cells is more complex than in prokaryotic cells, increasing the complexity of the control system.

Controlling transcription

Eukaryotes control gene expression through proteins called transcription factors.

Transcription factors ensure that a gene is used at the right time and that proteins are made in the right amounts.

There are two main sets of transcription factors.

One set forms complexes that guide and stabilize the binding of the RNA polymerase to a promoter.

Controlling transcription

The other set includes regulatory proteins that help control the rate of transcription.

Activators fold DNA so that enhancer sites are close to the complex and increase the rate of gene transcription.

Repressors bind to specific sites and prevent the binding of activators.

Controlling transcription

The complex structure of eukaryotic DNA also regulates transcription.

Eukaryotic DNA is wrapped around histones to form nucleosomes.

This structure provides some inhibition of transcription.

Class Work

Complete WS QC 96

Review

1. The parts of an operon include an operator, a promoter, a regulatory gene, and the genes coding for proteins.
2. Hox genes are a group of genes that control differentiation of cells in zygotes.
3. The loss or gain of a nucleotide in a sequence lead to frameshift mutations.

Class work

4. Both mutations are the result of a substitution. In missense mutations, the DNA code is altered so that is codes for the wrong amino acid. In nonsense mutations, the codon is changed to a stop codon, and translation terminates early.
5. Student answers will vary, but one of the bases T, C, A, or G (not U) should be inserted into the sequence such as TTTGCACGAC.