Chap 12: DNA - Genetic Material
QOD

1. Draw and label a nucleotide.
2. What are the 4 bases and how do they pair?
3. Draw and label a strand of DNA.

Matching

1. mutagen
2. thymine
3. anticodon
4. adenine
5. cytosine
6. guanine
7. genetic code
8. replication
9. nucleotide
10. uracil
11. transcription
12. double helix
13. translation
14. ribosome

a. Sequence of three bases on transfer RNA
b. A purine in DNA that pairs only with thymine
c. Process of making messenger RNA
d. Examples: ultraviolet light and x-rays
e. A pyrimidine in RNA that pairs only with adenine
f. Subunit of a DNA molecule, made of a base, a sugar, and a phosphate group
g. A purine in DNA that pairs only with cytosine
h. A structure in the cytoplasm where proteins are synthesized
i. Manner in which cells store the information that they pass from one generation to the next.
j. Process of converting genetic code in RNA into the amino acid sequence that makes up a protein
k. A pyrimidine in DNA that pairs only with guanine
l. The structure of DNA molecule
m. Process of making copies of DNA
n. A pyrimidine in DNA that pairs only with adenine
Matching:

D 1. mutagen  
N 2. thymine  
A 3. anticodon  
B 4. adenine  
K 5. cytosine  
G 6. guanine  
I 7. genetic code  
M 8. replication  
F 9. nucleotide  
E 10. uracil  
C 11. transcription  
L 12. double helix  
J 13. translation  
H 14. ribosome

a. Sequence of three bases on transfer RNA  
b. A purine in DNA that pairs only with thymine  
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j. Process of converting genetic code in RNA into the amino acid sequence that makes up a protein  
k. A pyrimidine in DNA that pairs only with guanine  
l. The structure of DNA molecule  
m. Process of making copies of DNA  
n. A pyrimidine in DNA that pairs only with adenine
Nucleotide: basic unit of nucleic acid

- Phosphate
- Sugar
- Nitrogen Base
Types of Bases:

- **Purine**
  - Adenine
  - Guanine

- **Pyrimidine**
  - Cytosine
  - Thymine
  - Uracil

The order of bases are the instructions for what organism you are, and what you look like = your genetics.
Base Pairing!

**Adenine** with **Thymine**
- double H bond

**Guanine** with **Cytosine**
- triple H bond

This is called: **complementary base pairs**
Covalent Bond: between the phosphate and sugar, stronger bond

Hydrogen Bond: between nitrogen bases, weaker bond
13.1 – THE GENETIC MATERIAL

Finding the molecule.....the material must be...

1. Able to store information that pertains to the development, structure and metabolic activities of the cell
2. Stable so that it can be replicated
3. Able to undergo changes (mutations)
1869 – Discovering Nucleic Acids

• Swiss Physician, Johannes Friedrich Miescher isolated the chemical he called “nuclein” from the nuclei of pus cells

• Now called nucleic acids

  ▪ DNA (deoxyribonucleic acid)
  ▪ RNA (ribonucleic acid)
THE BIG QUESTION

Is it nucleic acids that contain the genetic code or is it proteins?

Proteins contain 20 amino acids that can be organized in countless ways to determine traits.

Nucleic acids only contained 4 different nucleotides.
TRANSFORMATION OF BACTERIA

Frederick Griffith attempted to find a vaccine against *pneumococcus*

He found that one type of bacteria could turn into another
a. Injected live S strain has capsule and causes mice to die.

b. Injected live R strain has no capsule and mice do not die.

c. Injected heat-killed S strain does not cause mice to die.

d. Injected heat-killed S strain plus live R strain causes mice to die. Live S strain is withdrawn from dead mice.
Injected live S strain has capsule and causes mice to die.
Injected live R strain has no capsule and mice do not die.
Injected heat-killed S strain does not cause mice to die.
In the image, there are two bacterial strains denoted by 'S' and 'R'. The image illustrates the following process:

1. **Injected heat-killed S strain plus live R strain causes mice to die.**
2. **Live S strain is withdrawn from dead mice.**
DNA WAS DETERMINED TO BE THE TRANSFORMING SUBSTANCE

Conclusions:
• DNA from S strain bacteria causes R strain to be transformed
• Enzymes that degrade proteins will not stop the transformation
• Enzymes that degrade DNA does stop the transformation

Transformation Animation Activity
Alfred Hershey and Martha Chase
Experiments
Bacteriophages – viruses that infect bacteria

• Consist of a protein capsid
• And a core of DNA (or RNA)
• Experiments used radioactive sulfur to tag the protein
• And radioactive phosphorous to tag the DNA

• The goal was to see which substance (protein or DNA) moved into the infected cell
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[Image of a viral particle and its interaction with E. coli]

Figure 13.2a
Conclusion: The radioactive tag on the DNA went into the bacteria
Conclusion: The radioactive tag on the protein did not go into the bacteria

Animation of the Hershey and Chase Experiment
THE RACE IS ON!
Who will be the first to discover the structure of DNA?
The Race to Establish the Structure of DNA

The players:

- Wilkins
- Chargaff

Secret of life
- Start at 38
Examine the data below. Do you notice a pattern?

<table>
<thead>
<tr>
<th>Species</th>
<th>A</th>
<th>T</th>
<th>G</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Homo sapiens</em></td>
<td>31.0</td>
<td>31.5</td>
<td>19.1</td>
<td>18.4</td>
</tr>
<tr>
<td><em>Drosophila melanogaster</em></td>
<td>27.3</td>
<td>27.6</td>
<td>22.5</td>
<td>22.5</td>
</tr>
<tr>
<td><em>Zea mays</em></td>
<td>25.6</td>
<td>25.3</td>
<td>24.5</td>
<td>24.6</td>
</tr>
<tr>
<td><em>Neurospora crassa</em></td>
<td>23.0</td>
<td>23.3</td>
<td>27.1</td>
<td>26.6</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>24.6</td>
<td>24.3</td>
<td>25.5</td>
<td>25.6</td>
</tr>
<tr>
<td><em>Bacillus subtilis</em></td>
<td>28.4</td>
<td>29.0</td>
<td>21.0</td>
<td>21.6</td>
</tr>
</tbody>
</table>
So did Erwin Chargaff... noticed that all a species had similar ratios of A, T, G, C

Chargaff’s Rule

Amount of A, T, G, C varies by species, but

\[ A = T \]
\[ G = C \]
ROSALIND FRANKLIN & WILKENS
Took pictures of DNA using X-RAY DIFFRACTION
DNA
WATSON & CRICK
DNA: THE DOUBLE HELIX

Steps of ladder are bases (A, T, G, C)

Sides of ladder are sugar & phosphate

Both sides held together by hydrogen bonds
Each side is antiparallel, the numbers represent the carbons attached in a ring to make deoxyribose.
Start numbering on the carbon to the right of the oxygen on the ring...

...and work around to the side chain carbon.
5’ and 3’ ENDS

Each Side is ANTIPARALLEL
Deoxyribonucleic Acid (DNA)

Sugar-phosphate backbone  Base pairs  Sugar-phosphate backbone

A - T  G - C
Hydrogen bonds  Base pair

Nucleotide

DNA DOUBLE HELIX - origami

Origami template
DNA REPLICATION

-the process by which DNA makes a copy of itself
-occurs during interphase, prior to cell division
-location: nucleus

Replication is called semi-conservative, because one half of the original strand is always saved, or "conserved"
**DNA Replication**

The process:

1. DNA “unwinds”, DNA “unzips” at the Hydrogen bonds – by the enzyme **Helicase**.

2. Complimentary bases added form 3’ to 5’ end for a new half.
   - by enzyme **DNA polymerase**.
   - Ligase: enzyme that connects the fragments together.

**Helicase**

**DNA polymerase**

**glue**
3. Mismatch repair where damaged DNA is taken out by DNA nuclease
4. DNA Polymerase is released. The DNA **zips back up and then rewinds**.

Two **identical strands** of identical DNA are formed.
Replication fork: There are multiple replication forks all down the strand.
Figure 13.9a

a. Replication in prokaryotes
DNA helicase = unzips replication fork = area were “unzip” occurs

DNA polymerase: adds nucleotides and binds the sugars and phosphates.

***DNA polymerase travels from the 3' to the 5' end. The DNA is called the template strand.***

leading strand – side that follows the helicase as it unwinds.

lagging strand - its moving away from the helicase (in the 5' to 3' direction).

OKAZAKI FRAGMENTS are bound by DNA LIGASE
Other vocab

**Okazaki fragment:** a string of nucleotides added to the lagging size at once

**RNA primer:** locates the area where DNA polymerase bind and will start

**Telomeres:** nonsense DNA at end of chromosome to protect from loss of genes
DNA replication video

http://highered.mcgraw-hill.com/olc/dl/120076/bio23.swf
Activities at Replication Fork
Animations and Videos of DNA REPLICATION

DNA Replication at stolaf.edu

How Nucleotides are Added in DNA Replication (mcgraw-hill)

DNA Replication Tutorial at wiley.com

DNA Replication Fork at harvard.edu
GENES SPECIFY ENZYMES

From Genes to Drug Metabolism

Genes

DNA

Proteins

Genes are the recipes for proteins

Enzymes

Enzymes are protein machines that carry out drug metabolism

Proteins are the building blocks of enzymes
QOD

1. Compare and contrast DNA and RNA
   - may want to use a table or visual diagram
2. Define the following:
   Okazaki fragment:
   RNA primer:
   Telomeres:
There are 2 Types of Nucleic Acids:

<table>
<thead>
<tr>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Monomers are nucleotides.</td>
<td>1. Monomers are nucleotides.</td>
</tr>
<tr>
<td>2. Each nucleotide has 3 parts:</td>
<td>2. Each nucleotide has 3 parts:</td>
</tr>
<tr>
<td>a. Phosphate group</td>
<td>a. Phosphate group</td>
</tr>
<tr>
<td>b. Deoxyribose, a 5-carbon sugar</td>
<td>b. Ribose, a 5-carbon sugar</td>
</tr>
<tr>
<td>c. Nitrogenous base:</td>
<td>c. Nitrogenous base:</td>
</tr>
<tr>
<td>*adenine – thymine</td>
<td>*adenine – uracil</td>
</tr>
<tr>
<td>*cytosine - guanine</td>
<td>*cytosine - guanine</td>
</tr>
<tr>
<td>4. Only in nucleus</td>
<td>4. May leave nucleus</td>
</tr>
</tbody>
</table>

**Okazaki fragment:** a string of nucleotides added to the lagging size at once

**RNA primer:** locates the area where DNA polymerase bind and will start

**Telomeres:** nonsense DNA at end of chromosome to protect from loss of genes
Studying the Gradual Erosion of DNA

The three recipients of this year’s Nobel Prize in Physiology or Medicine solved a genetic puzzle involving chromosomes.

Setting a limit on a cell’s lifespan

Chromosomes are copied whenever a cell divides, and with each copy the chromosome’s ends, called telomeres, get shorter. When they get too short the cell is prevented from dividing again.

Resetting the limit

Work by the recipients led to the discovery of telomerase, a special enzyme that can prevent telomere shortening and extend cell life by adding extra pieces of DNA. The enzyme is usually active only at the beginning of life, but is reactivated in some 80 to 90 percent of human cancer cells.

Source: Nobel Committee for Physiology or Medicine
Cells have three major types of RNA:

1. **mRNA** carries the genetic “message” from the nucleus to the cytosol.
2. **tRNA** carries specific amino acids, helping to form polypeptides.
3. **rRNA** is the major component of ribosomes.
GENES SPECIFY PROTEINS

![Image of normal and sickled red blood cells at 2,500x magnification]

**a.**

- $Hb^A$
  - 1: valine
  - 2: histidine
  - 3: leucine
  - 4: threonine
  - 5: proline
  - 6: glutamate
  - 7: glutamate

- $Hb^S$
  - 1: valine
  - 2: histidine
  - 3: leucine
  - 4: threonine
  - 5: proline
  - 6: valine
  - 7: glutamate

**b.**

- Glutamate (polar $R$ group)
- Valine (nonpolar $R$ group)
RNA is a lot like DNA, except:

1. Ribose
2. Uracil
3. Single Strand

*Can leave the nucleus, carries the "message"
The Central Dogma

DNA

RNA

Amino Acid (Protein)
Every 3 bases on mRNA (messenger RNA) is called a CODON

Each CODON specifies one AMINO ACID

Chains of amino acids are proteins
(ex. hemoglobin)
Protein Synthesis: Transcription

The Process:
1. **RNA polymerase** attaches to the DNA molecule at the **promoter** – the “start signal”. The DNA “unwinds” and “unzips” in one region, exposing the gene. (-Gene: a piece of DNA that codes for a protein.)
2. Complimentary bases form a new mRNA molecule.
3. **RNA polymerase** reaches the **termination signal** or **mRNA transcript**- the “stop signal”.
4. The DNA “re-winds” and “re-zips” The mRNA can now leave the nucleus.
**Figure 10.10**

RNA codons

<table>
<thead>
<tr>
<th>First Base</th>
<th>Second Base</th>
<th>Third Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>UUU phenylalanine</td>
<td>UCU serine</td>
<td>UAU tyrosine</td>
</tr>
<tr>
<td>UUC phenylalanine</td>
<td>UCC serine</td>
<td>UAC tyrosine</td>
</tr>
<tr>
<td>UUA leucine</td>
<td>UCA serine</td>
<td>UAA stop</td>
</tr>
<tr>
<td>UUG leucine</td>
<td>UCG serine</td>
<td>UAG stop</td>
</tr>
<tr>
<td>CUU leucine</td>
<td>CUC proline</td>
<td>CAU histidine</td>
</tr>
<tr>
<td>CUC leucine</td>
<td>CCC proline</td>
<td>CAC histidine</td>
</tr>
<tr>
<td>CUA leucine</td>
<td>CCA proline</td>
<td>CAA glutamine</td>
</tr>
<tr>
<td>CUG leucine</td>
<td>CGC proline</td>
<td>CGA arginine</td>
</tr>
<tr>
<td>AUU isoleucine</td>
<td>ACU threonine</td>
<td>AAU asparagine</td>
</tr>
<tr>
<td>AUC isoleucine</td>
<td>ACC threonine</td>
<td>AAG arginine</td>
</tr>
<tr>
<td>AUA isoleucine</td>
<td>ACA threonine</td>
<td>AAA lysine</td>
</tr>
<tr>
<td>AUG (start) methionine</td>
<td>ACG threonine</td>
<td>AAG lysine</td>
</tr>
<tr>
<td>GGU valine</td>
<td>GCC alanine</td>
<td>GAA aspartate</td>
</tr>
<tr>
<td>GUC valine</td>
<td>GCG alanine</td>
<td>GAG glutamate</td>
</tr>
<tr>
<td>GUA valine</td>
<td>GAG alanine</td>
<td>GGU glycine</td>
</tr>
<tr>
<td>GUG valine</td>
<td>GGG alanine</td>
<td>GGU glycine</td>
</tr>
</tbody>
</table>

DNA

```
ATTCGGT
```

RNA

```
A-U-G/C-G-U
```

Translation:

- DNA: ATTCGGT
- RNA: A-U-G/C-G-U

Translated into proteins:

- **isoleucin**
- **arginin**
Transcription

gene

DNA

RNA molecules
Transcription Questions

1. Where does transcription occur?
2. What is the main idea of transcription?
3. What is the name of the enzyme that catalyzes transcription?
4. What would the complimentary mRNA bases for the DNA (to the right) molecule be?
Transcription Questions

1. Where does transcription occur?
   In the nucleus.

2. What is the main idea of transcription?
   DNA is copied onto a complementary strand of mRNA.

3. What is the name of the enzyme that catalyzes transcription?
   RNA polymerase.

4. What would the complimentary mRNA bases for the DNA (to the right) molecule be?

<table>
<thead>
<tr>
<th>DNA</th>
<th>mRNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - U</td>
<td>U</td>
</tr>
<tr>
<td>T - A</td>
<td>A</td>
</tr>
<tr>
<td>T - A</td>
<td>A</td>
</tr>
<tr>
<td>C - G</td>
<td>G</td>
</tr>
<tr>
<td>C - G</td>
<td>G</td>
</tr>
<tr>
<td>A - U</td>
<td>U</td>
</tr>
<tr>
<td>T - A</td>
<td>A</td>
</tr>
<tr>
<td>A - U</td>
<td>U</td>
</tr>
<tr>
<td>C - G</td>
<td>G</td>
</tr>
<tr>
<td>G - C</td>
<td>C</td>
</tr>
<tr>
<td>T - A</td>
<td>A</td>
</tr>
<tr>
<td>A - U</td>
<td>U</td>
</tr>
</tbody>
</table>
Transcription Animations
http://www.youtube.com/watch?v=NJxobgkPEA0
http://www.youtube.com/watch?v=Ynmxwqiv7j8
Transcription: Stolaf.edu
Transcription: Concord.org
1. **Primary Protein Structure** - The sequence of the amino acid chain.

2. **Secondary Protein Structure** - Twisting of the amino acid chain.

3. **Tertiary Protein Structure** - Folding of the amino acid chain.

4. **Quaternary Protein Structure** - Consists of more than one amino acid chain.
Translation: process by which protein is built from the mRNA

tRNA is used to build an amino acid chain

Each 3 bases on mRNA codes for a single amino acid.
3 bases on mRNA = a codon

Matching 3 bases on tRNA = anticodon

tRNA has a single attached amino acid
<table>
<thead>
<tr>
<th>DNA Sequence</th>
<th>mRNA Codon</th>
<th>tRNA Anticodon</th>
<th>Amino Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>UUU</td>
<td>AAA</td>
<td></td>
</tr>
<tr>
<td>GTC</td>
<td>CAG</td>
<td>GUC</td>
<td></td>
</tr>
<tr>
<td>GGA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUG</td>
<td></td>
<td>Methionine or &quot;Start&quot;</td>
<td></td>
</tr>
<tr>
<td>GAT</td>
<td></td>
<td>GUG</td>
<td></td>
</tr>
</tbody>
</table>

AUG is the codon that codes to start transcription
<table>
<thead>
<tr>
<th>1st base</th>
<th>2nd base</th>
<th>3rd base</th>
<th>Amino Acid from mRNA codon</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>C</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>Serine</td>
<td>Tyrosine</td>
<td>Cysteine</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>Serine</td>
<td>Tyrosine</td>
<td>Cysteine</td>
</tr>
<tr>
<td>Leucine</td>
<td>Serine</td>
<td>Stop Codon</td>
<td>Stop Codon</td>
</tr>
<tr>
<td>Leucine</td>
<td>Serine</td>
<td>Stop Codon</td>
<td>Tryptophan</td>
</tr>
<tr>
<td>U</td>
<td>C</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>Leucine</td>
<td>Proline</td>
<td>Histidine</td>
<td>Arginine</td>
</tr>
<tr>
<td>Leucine</td>
<td>Proline</td>
<td>Histidine</td>
<td>Arginine</td>
</tr>
<tr>
<td>Leucine</td>
<td>Proline</td>
<td>Glutamine</td>
<td>Arginine</td>
</tr>
<tr>
<td>Leucine</td>
<td>Proline</td>
<td>Glutamine</td>
<td>Arginine</td>
</tr>
<tr>
<td>C</td>
<td>U</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>Threonine</td>
<td>Asparagine</td>
<td>Serine</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>Threonine</td>
<td>Asparagine</td>
<td>Serine</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>Threonine</td>
<td>Lysine</td>
<td>Arginine</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>Threonine</td>
<td>Lysine</td>
<td>Arginine</td>
</tr>
<tr>
<td>A</td>
<td>C</td>
<td>U</td>
<td>G</td>
</tr>
<tr>
<td>Methionine</td>
<td>Threonine</td>
<td>Lysine</td>
<td>Arginine</td>
</tr>
<tr>
<td>Valine</td>
<td>Alanine</td>
<td>Aspartic Acid</td>
<td>Glycine</td>
</tr>
<tr>
<td>Valine</td>
<td>Alanine</td>
<td>Aspartic Acid</td>
<td>Glycine</td>
</tr>
<tr>
<td>Valine</td>
<td>Alanine</td>
<td>Glutamic Acid</td>
<td>Glycine</td>
</tr>
<tr>
<td>Valine</td>
<td>Alanine</td>
<td>Glutamic Acid</td>
<td>Glycine</td>
</tr>
</tbody>
</table>
Translation occurs on the ribosome

mRNA is threaded through the small and large subunit

a. Structure of a ribosome
b. Binding sites of ribosome
All genes start with **AUG**, also called the **START CODON**

It attaches to anticodon **UAC** and the amino acid **methionine**

---

A small ribosomal subunit binds to mRNA; an initiator tRNA with the anticodon **UAC** pairs with the mRNA start codon **AUG**.

The large ribosomal subunit completes the ribosome. Initiator tRNA occupies the P site. The A site is ready for the next tRNA.
Translation

The process:
1. Initiation - mRNA attaches to a ribosome- tRNA attaches to the start codon
2. Elongation - A tRNA with an amino acid joins with mRNA according to complementary base pairing (codons to anticodons)
   - The amino acid joins the peptide chain by forming a peptide bond.
   Elongation (cont.) - The tRNA is released into the cytoplasm
   - The next tRNA is positioned, the polypeptide chain grows.
3. Termination - the process ends when a stop codon is reached
4. Disassembly - the ribosome falls apart and the protein is released.
2. **Elongation** - A tRNA with an amino acid joins with mRNA according to complementary base pairing (codons to anticodons).
- The amino acid joins the peptide chain by forming a peptide bond.

Elongation (cont.) - The tRNA is released into the cytoplasm.
- The next tRNA is positioned, the polypeptide chain grows.

---

1. A tRNA--amino acid approaches the ribosome and binds at the A site.
2. Two tRNAs can be at a ribosome at one time; the anticodons are paired to the codons.
3. Peptide bond formation attaches the peptide chain to the newly arrived amino acid.
4. The ribosome moves forward; the "empty" tRNA exits from the E site; the next amino acid--tRNA complex is approaching the ribosome.
3. **Termination** - the process ends when a stop codon is reached.

4. **Disassembly** - the ribosome falls apart and the protein is released.
The Big Picture (aka The Central Dogma)

DNA ➔ RNA ➔ Protein
Animations of Translation

Translation: Stolaf.edu

Translation: University of Nebraska

Translation: Concord.org
Introns: “noncoding” lie between exons, are cut out before the gene is translated

Complete mRNA contains:

Exons: “coding mRNA” the parts of the gene that will represent the codons for creating the protein “exit the nucleus”

poly(A) tail: protects the mRNA molecule from enzymatic degradation in the cytoplasm and aids in transcription termination

Start and stop codons
Exon - RNA sequences in the primary transcript that are found in the mRNA
Intron - RNA sequences between exons that are removed by splicing, not in final mRNA

RNA Transcript:
In between step of RNA that include introns and exons
Aka pre-mRNA

1. A gene composed of exons and introns is transcribed to RNA by RNA polymerase.
2. Processing involves ribozymes and proteins in the nucleus to remove the intron-derived RNA and splice together the exon-derived RNA into mRNA.
3. After further modification, the mature mRNA travels to the cytoplasm, where it directs protein synthesis.
Translation in Prokaryotes

Transcription & translation are simultaneous in bacteria.
DNA is in cytoplasm.
No mRNA editing.
Ribosomes read mRNA as it is being transcribed.
Translation: prokaryotes vs. eukaryotes

Differences between prokaryotes & eukaryotes
time & physical separation between processes
takes eukaryote ~1 hour
from DNA to protein
no RNA processing
Prokaryote vs. Eukaryote genes

Prokaryotes
DNA in cytoplasm
Circular chromosome
Naked DNA
No introns

Eukaryotes
DNA in nucleus
Linear chromosomes
DNA wound on histone proteins
Introns vs. exons

Exon = coding (expressed) sequence
Intron = noncoding (inbetween) sequence
6. What process does this picture show?
7. Is this a prokaryotic or eukaryotic cell?
<table>
<thead>
<tr>
<th>DNA Sequence</th>
<th>mRNA Codon</th>
<th>tRNA Anticodon</th>
<th>Amino Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GTC</td>
<td></td>
<td>GGA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GUG</td>
<td>Methionine or &quot;Start&quot;</td>
</tr>
<tr>
<td>GAT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>