5 Core Biology Concepts

Information Flow, Exchange & Storage	*Cells, organs and organisms have multiple mechanisms to perceive and transmit information*
Evolution	*The diversity of life arose over time by processes of mutation, selection, and genetic drift*
Systems	*Living systems and pathways are interconnected and respond dynamically to changes in their environment*
Structure and Function	*Biological structures, from molecules to ecosystems, impact function*
Transformations of Energy & Matter	*Biological systems are governed by the laws of thermodynamics*

study guide:
information flow II

You should be able to:

Compare and contrast the structure & function of RNA and DNA

Describe the process of transcription & translation, including a description of the necessary factors and their specific functions

Compare and contrast transcription in prokaryotes and eukaryotes

Convert DNA seq--> RNA seq--> protein (with codon table)

Predict how disrupting a part of the transcription or translation machinery would affect mRNA and/or protein synthesis

Explain the different levels of protein structure and the bonds involved in each

Explain the properties of an amino acid when provided with its structure

Know the cellular location of transcription & translation in prokaryotes and eukaryotes

Predict how changes in affinity of sigma for a promoter could impact transcription

Provide an example of how a change in genotype could impact phenotype and fitness

study guide vocabulary: information flow II

You should be able to use these words/phrases appropriately while completing the tasks described in the previous slide

affinity
template vs. non-template strand
upstream/downstream
RNA Polymerase
Sigma
R group
ribose vs. deoxyribose
acidic/basic
peptide bond
ribosome
mRNA
tRNA
Ribosome E, P, and A sites
ribosome binding site
codon/anti-codon
start codon/stop codon
amino acid
promoter
translocation (of the ribosome)
primary/secondary/tertiary/quarternary structure

Announcements:

- Office Hours Wednesday 3:30-4:20 Kane 234
- Review Session Thursday 2:30-3:20 Kane 120
- Exam Friday

Information Flow ii

- Transcription
- Translation
- Protein Structure & Mutations

Information Flow, Exchange & Storage

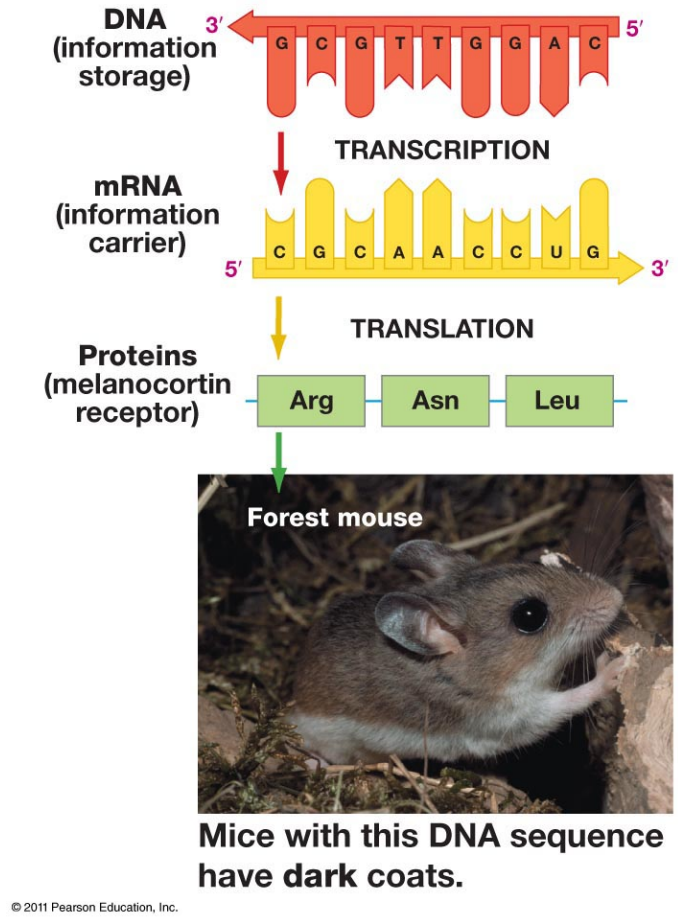
Cells, organs and organisms have multiple mechanisms to perceive and transmit information

Studying for Exam

- Exam covers material through lecture wednesday and central dogma lab
- Use study guides & vocabulary lists (1st slides of each lecture packet)
- Practice exam questions: write answers, check with key on Thursday
  (are your answers complete?)
- Office hours Wed 3:30-4:20 Kane 234
- Review session Thur 2:30-3:20 Kane 120
- T.A. office hours!
- TriBeta: M-Th 3:30-6:30 HCK (4th floor lounge)
- For text: focus on figures mentioned during lecture (answer Q's in text and do the "you should be able to" activities)
- Ask yourself questions:
  - How does structure of DNA make it well-suited to store information?
  - What would happen to transcription if you added a poison to a cell that inhibited sigma binding?

Genetic Information Flows From DNA to RNA to Proteins

Today: Focus on Transcription



GENOTYPE

What is the product of Transcription?

What is the product of Translation?

PHENOTYPE

Fig. 16.4

What is a gene?

What does it mean to “express” or “turn on” a gene?

Are all genes “turned on” all the time?

Representation of a Gene

Where is upstream for this gene?

Where is the promoter and what does it do?

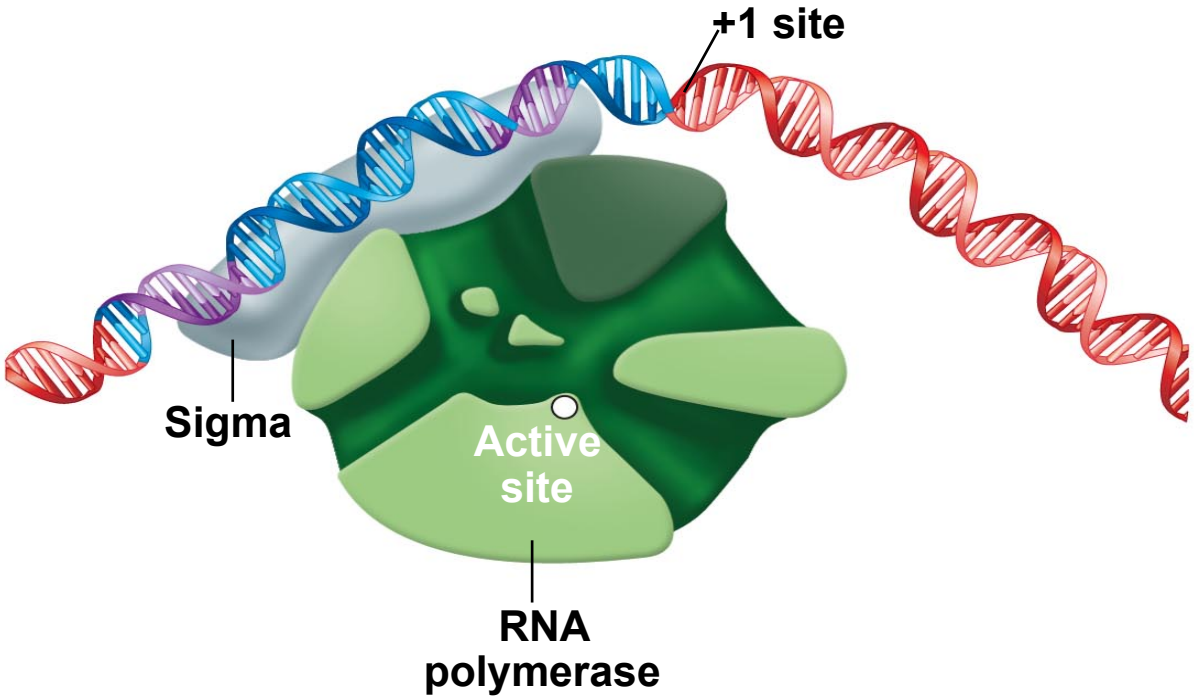


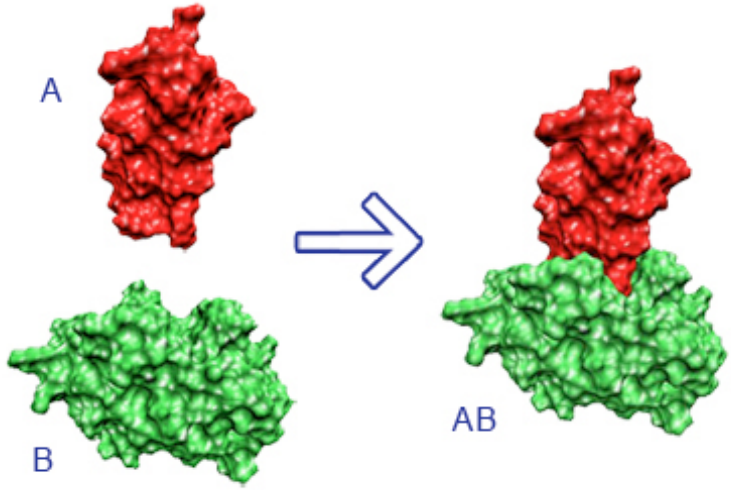
Fig. 17.3

Molecular Affinity

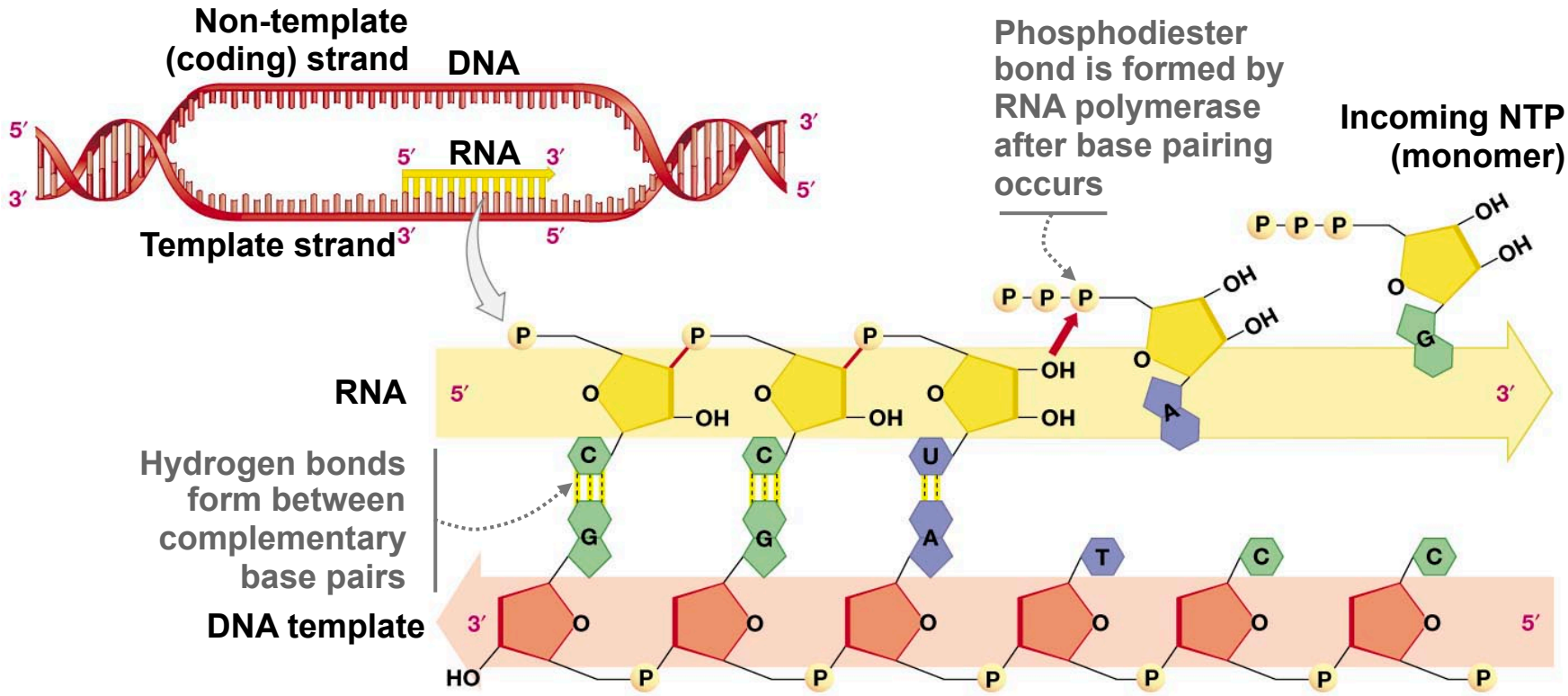
Level of attraction between two molecules:

High/strong affinity = high probability of an interaction

Low/weak affinity = low probability of an interaction



All interactions in the cell are **dynamic**



Which strand is the new RNA complementary to?

What would happen if covalent bonds formed between DNA and the newly made RNA?

Fig. 17.1

Transcription Initiation

What is required for RNA polymerase to initiate transcription?

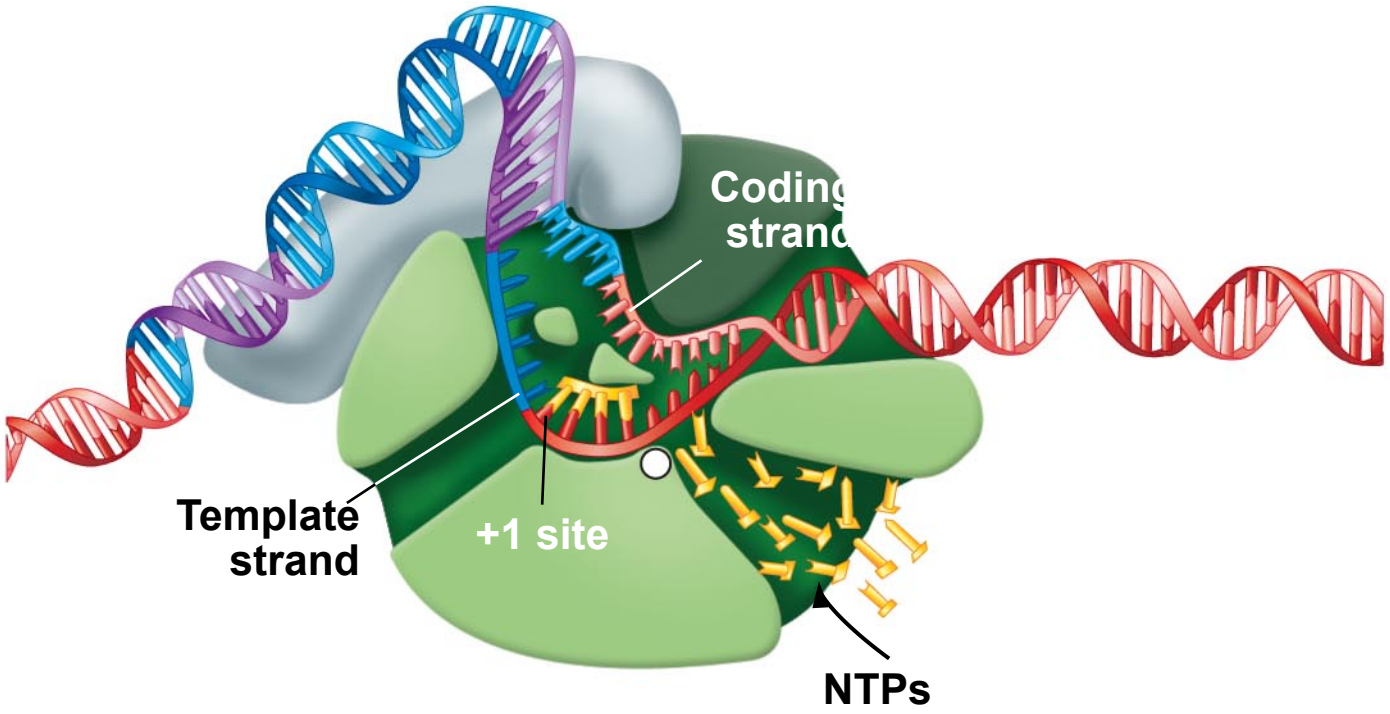


Fig. 17.3

Transcription Termination

What happens after transcription terminates:

To the RNA polymerase?

To the DNA?

To the mRNA?

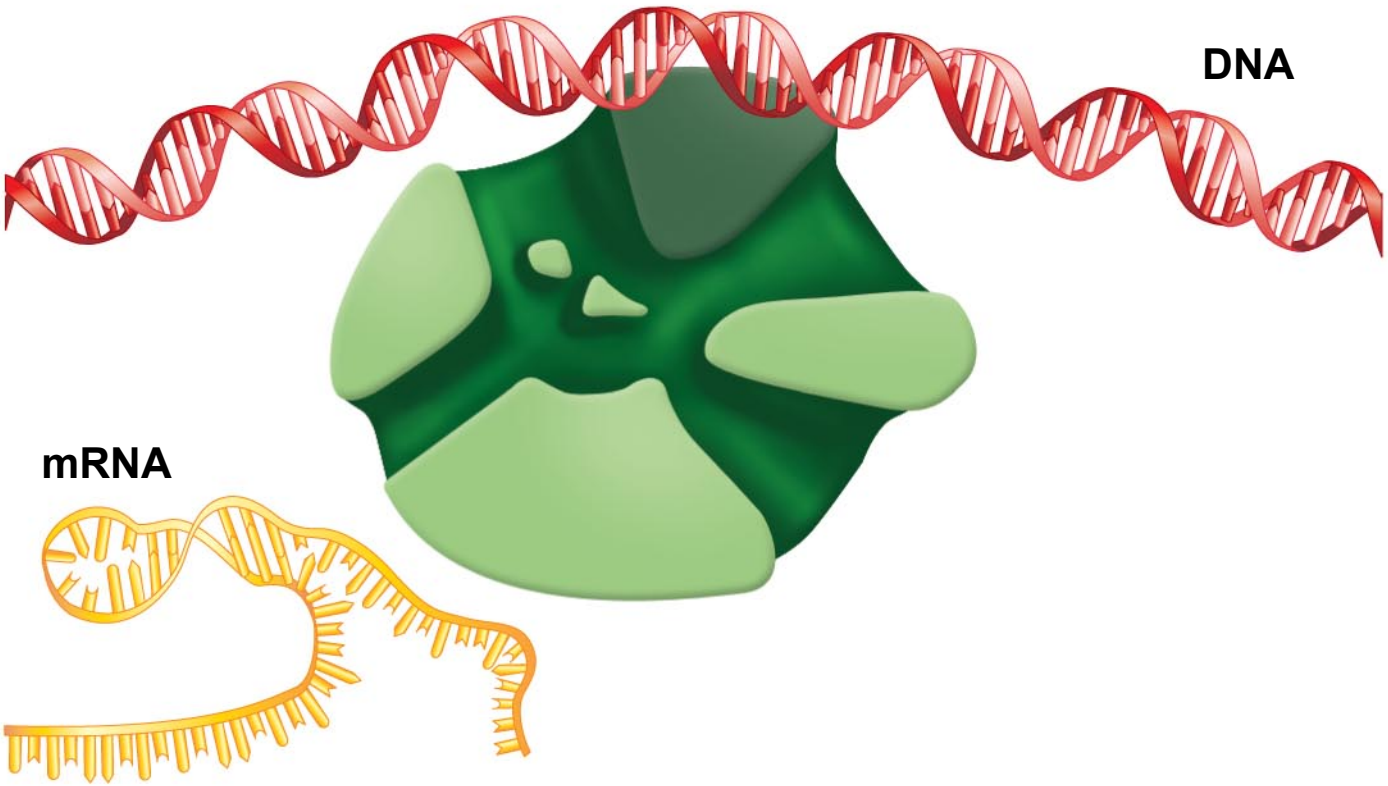


Fig. 17.4

What do we mean when we say that transcription is a way to optimize phenotype

genotype phenotype fitness

Why do these 2 plants with the same genotype have a different phenotypes?

At home:
Compare and contrast transcription in prokaryotes and eukaryotes (how is it similar, how is it different?)

Table 17.1: compares prok and euk transcription

study guide: information flow II

After this lecture you should be able to:

compare and contrast the structure & function of RNA and DNA

describe the processes of transcription & translation, including a description of the necessary factors and their specific functions

convert DNA seq--> RNA seq--> protein (with codon table)

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Information Flow II

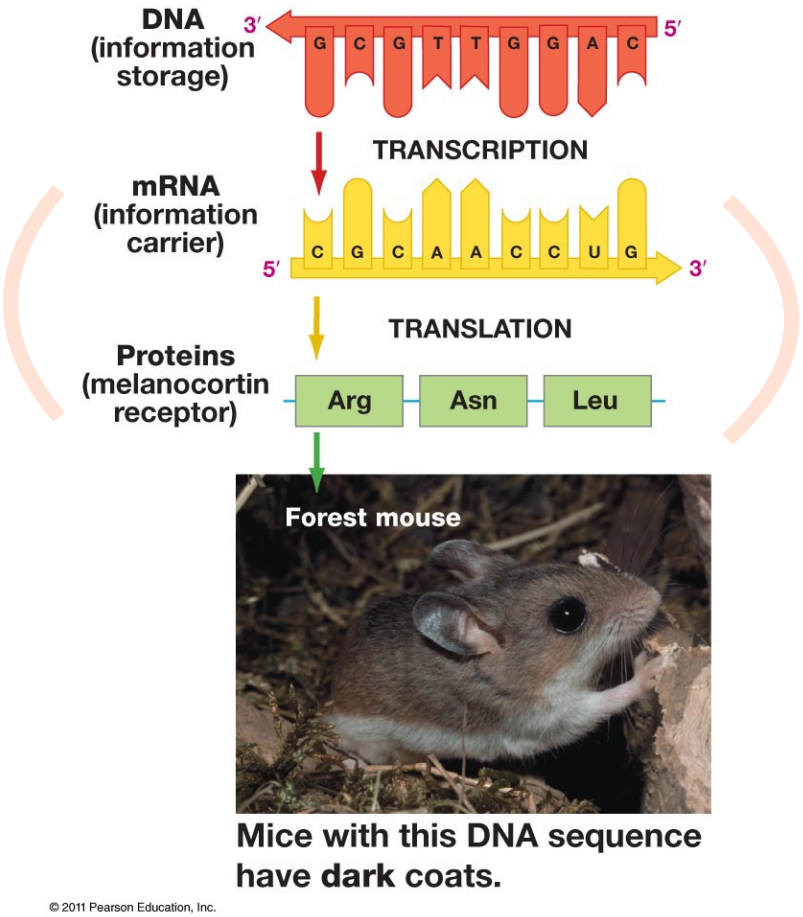
- Transcription
- **Translation**
- Protein Structure & Mutations

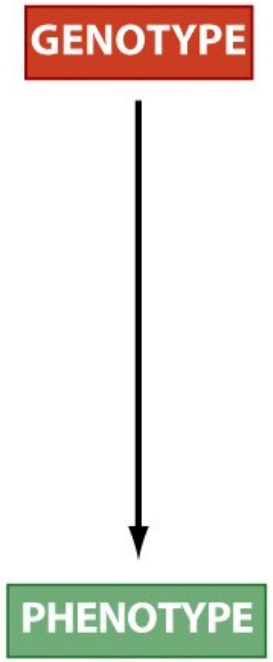
Information Flow, Exchange & Storage

Cells, organs and organisms have multiple mechanisms to perceive and transmit information

Genetic Information Flows From DNA to RNA to Proteins

Today: Focus on Translation





What enzyme is making protein from RNA? ribosome

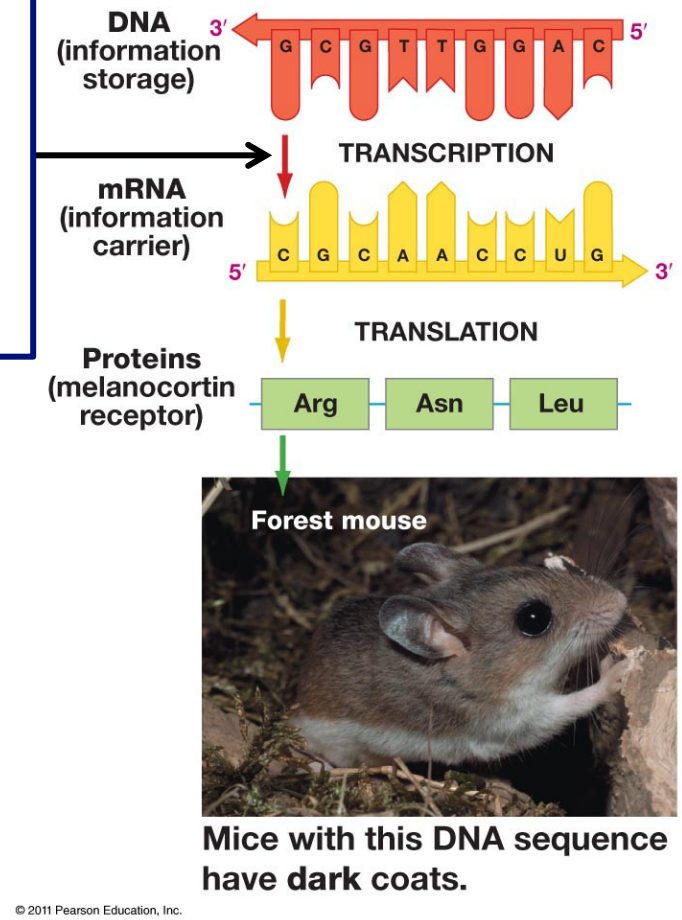
Do all genes code for proteins?

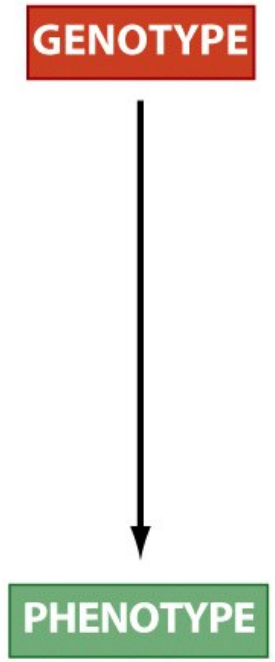
No, some genes make other RNAs (like tRNA)

Fig. 16.4

Genetic Information Flows From DNA to RNA to Proteins
Today: Focus on Translation

What does this arrow mean?



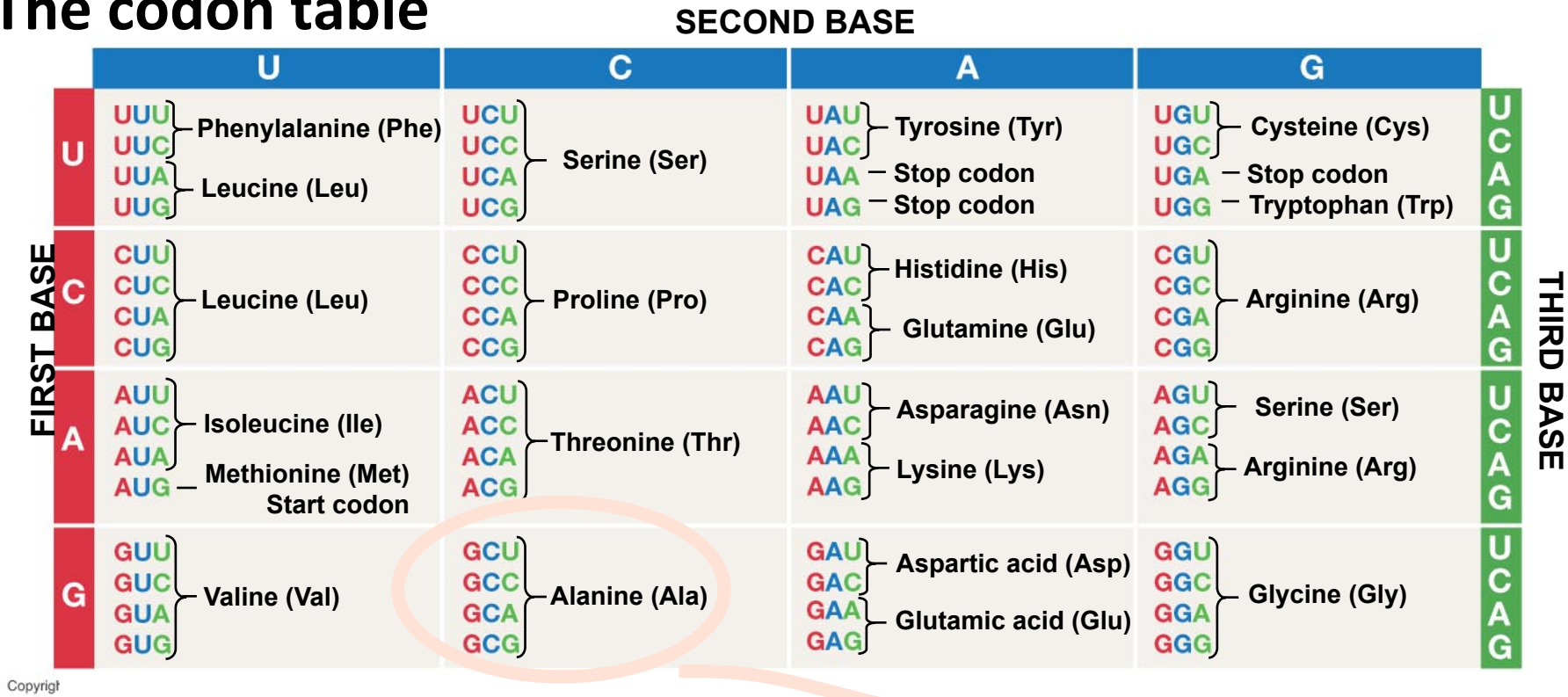


What enzyme is making protein from RNA?

Do all genes code for proteins?

Fig. 16.4

The codon table



- What does AAA code for? Lysine
- If a mutation changed a UCA to UAA, what would happen? serine —>stop codon

multiple codons code for the same

- What does it mean to say that the code is redundant?
- What does it mean to say that the code is nonrandom?

each one of the codons always code for the same amino acid

At home: Using the DNA below (<u>and assuming promoter is to the left</u>)

```
5′ GGC ATG CCC CTG GAG TGA CAT 3′
3′ CCG TAC GGG GAC CTC ACT GTA 5′
```

Complete the mRNA sequence and the protein sequence.

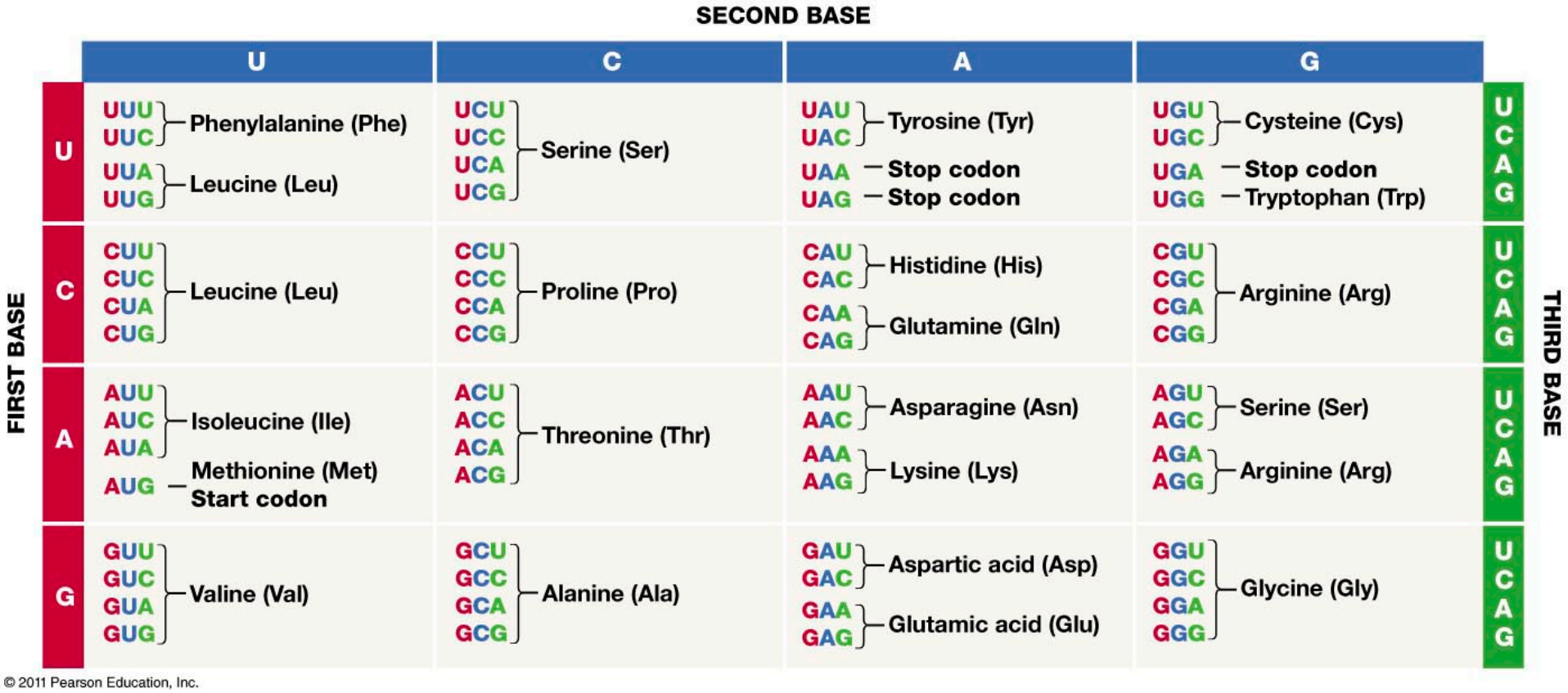


Fig. 16.6

Can tRNAs with different anticodons carry the same amino acid?

YES.

What 2 features can differ between tRNAs?

anticodon, amino acids

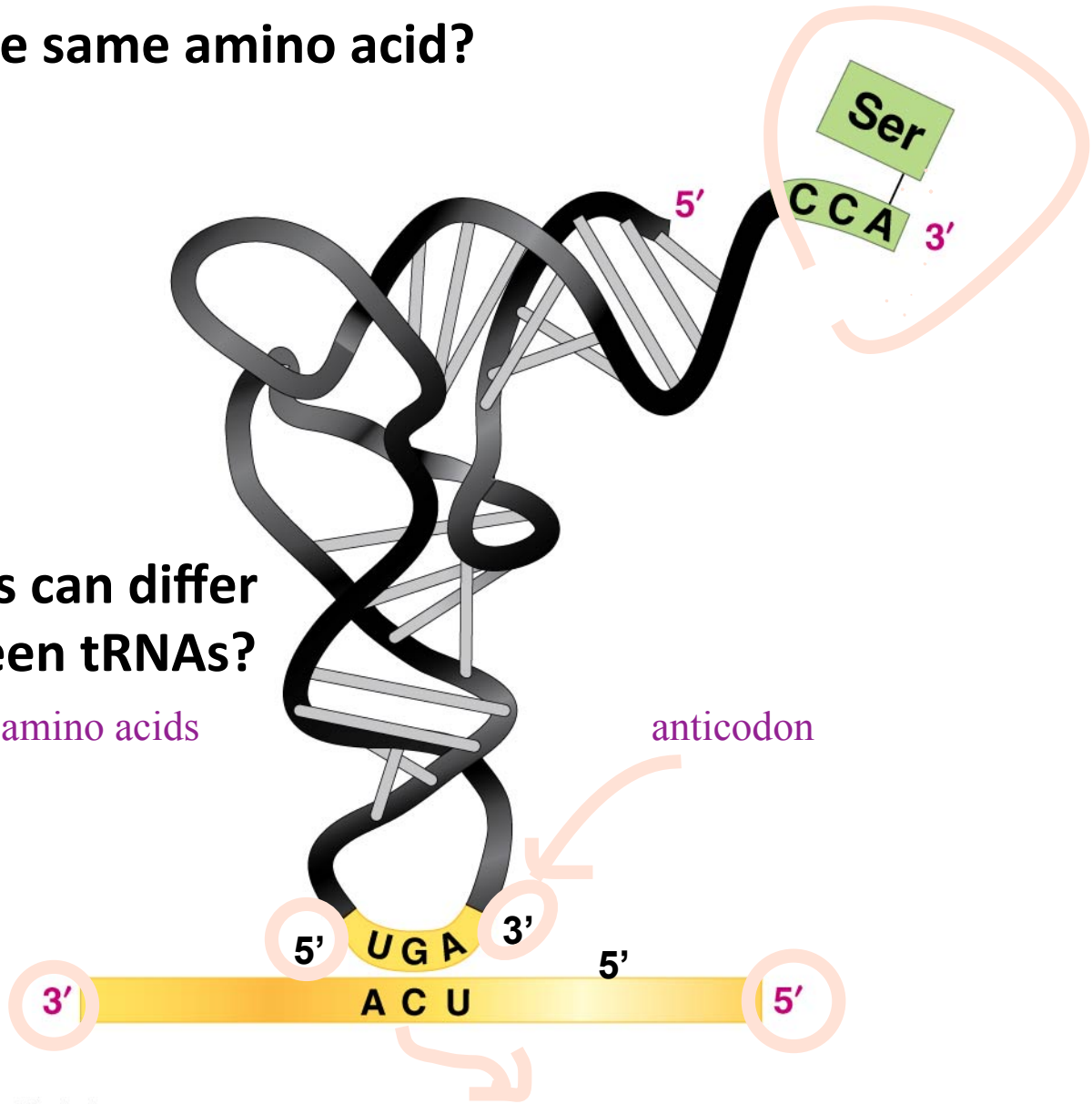


Fig. 17.11

Main points: Protein Translation

- Ribosomes translate messenger RNA (mRNA) into protein with the help of intermediary molecules called transfer RNAs (tRNAs)
- Initiation of translation occurs at the first start codon (AUG) downstream of a purine-rich ribosome binding site
- The initiating tRNA binds the AUG and carries the amino acid methionine
- Each transfer RNA carries an amino acid corresponding to its anticodon
- Peptide bond formation is catalyzed by the ribosome (RNA in the active site)
- Termination of protein synthesis occurs when a Release factor (protein) binds in the "A" site of the ribosome
- Codon = set of 3 nucleotides in DNA or RNA that codes for a certain amino acid or that terminates protein synthesis (e.g. stop codon)
- Anticodon = set of 3 ribonucleotides in the the tRNA that is complementary to the codon on the mRNA

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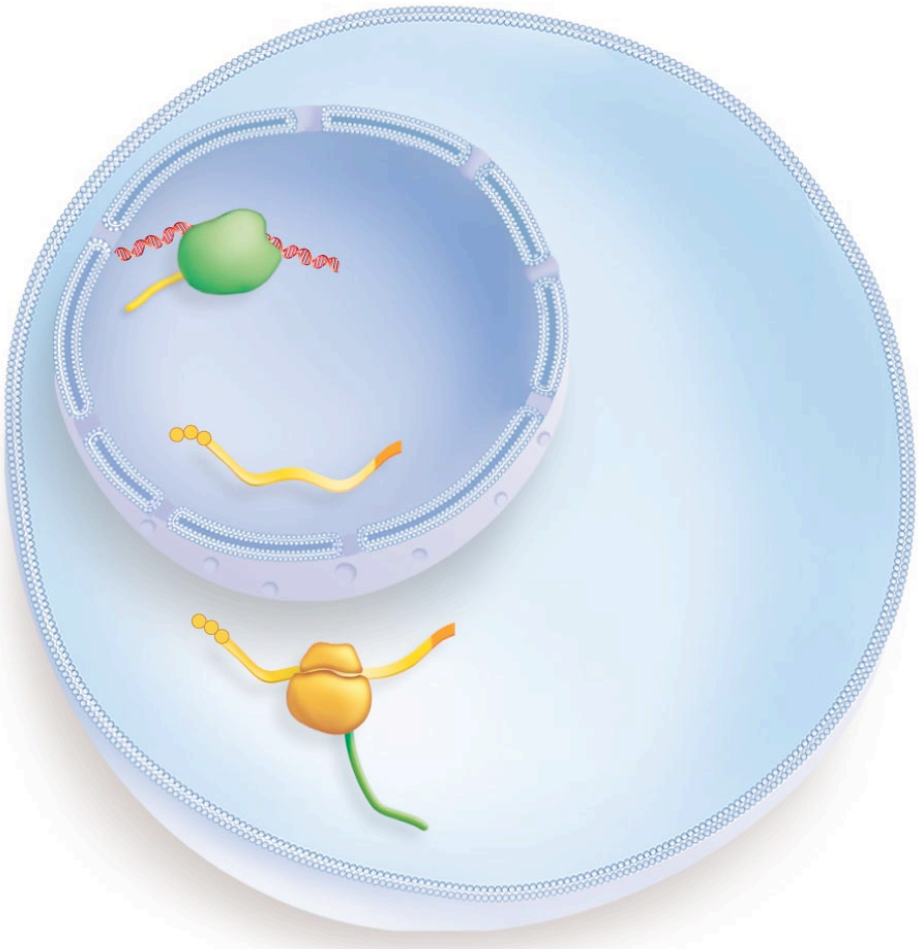
Information Flow II

- Transcription
- Translation
- **Protein Structure & Mutations**

Information Flow, Exchange & Storage

Cells, organs and organisms have multiple mechanisms to perceive and transmit information

Where do transcription and translation occur in a eukaryote?



Label on diagram:

protein,

DNA,

RNA,

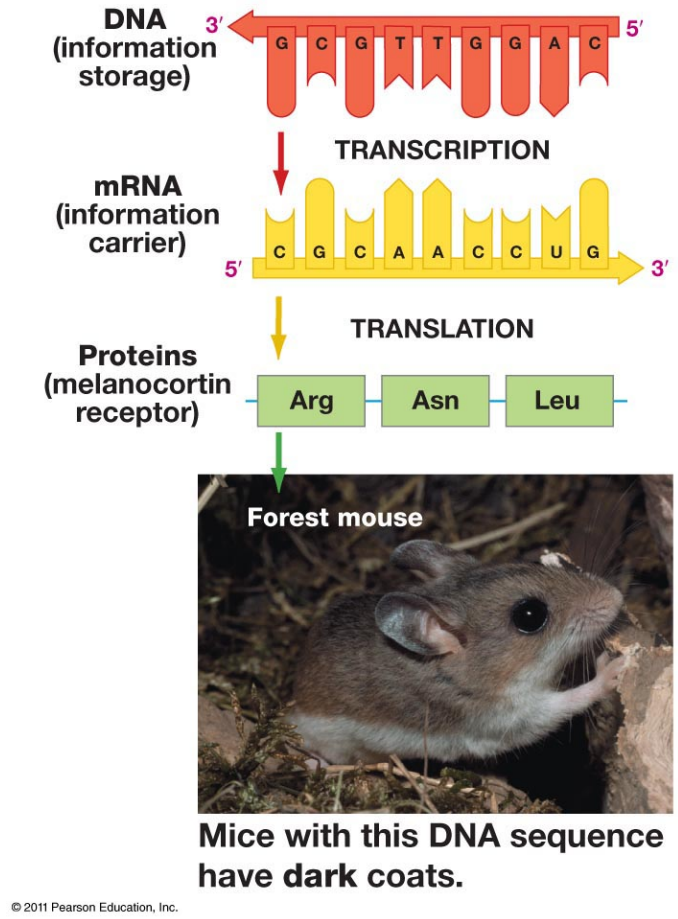
RNA polymerase,

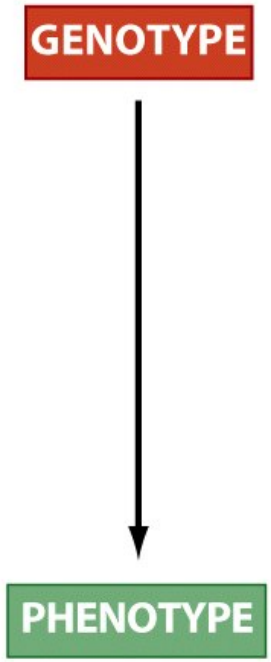
ribosome

Fig 16.3 Practice at home: Draw a similar diagram for a prokaryote

Genetic Information Flows From DNA to RNA to Proteins

Today: Focus on Protein Structure & Mutation

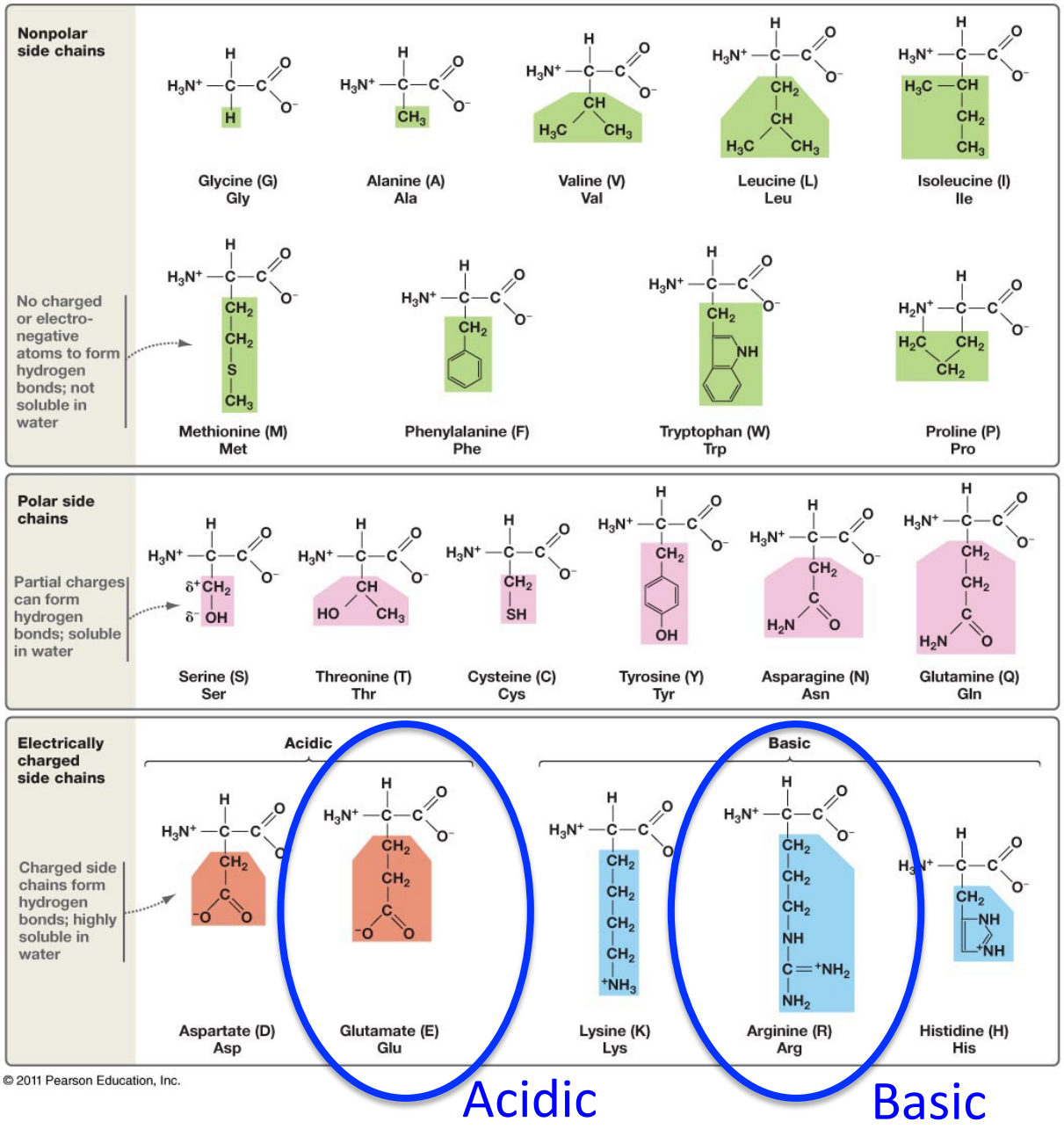




How does a protein's structure relate to its function?

Fig. 16.4

The 20 Major Amino Acids Found in Organisms



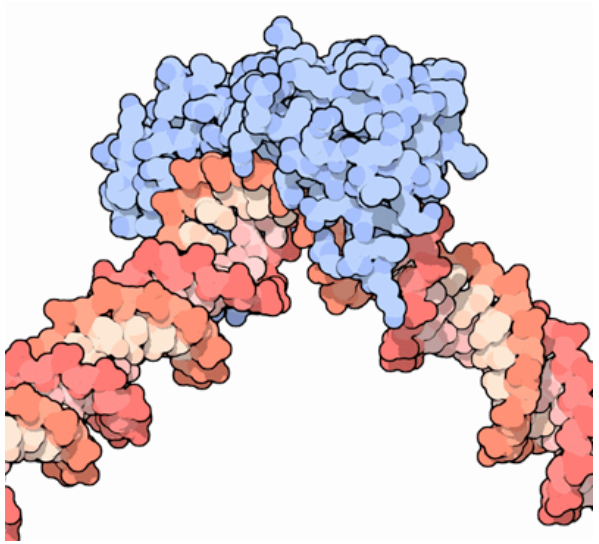
You should be able to identify which amino acids are <u>acidic/basic given their structure</u>

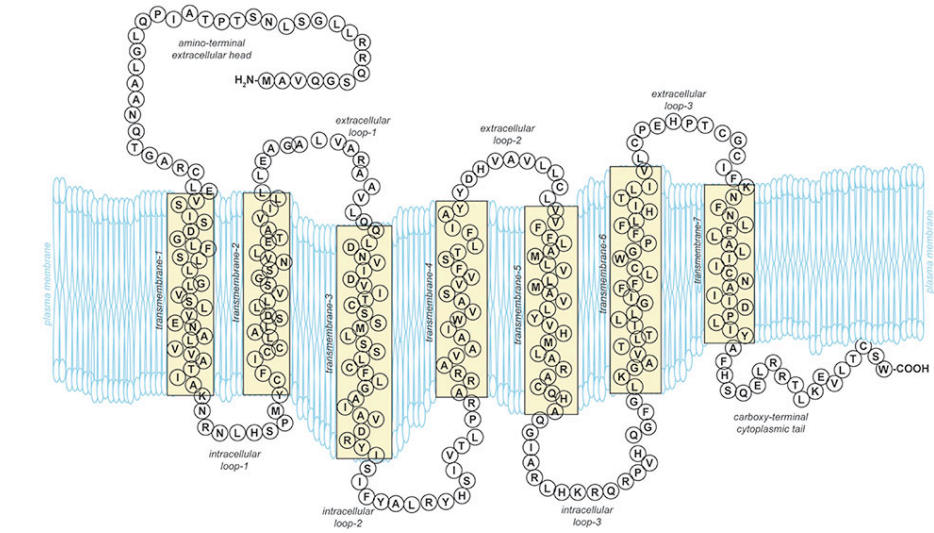
Refer back to Chemistry of Life POGIL on what it means to be hydrophilic/ hydrophobic

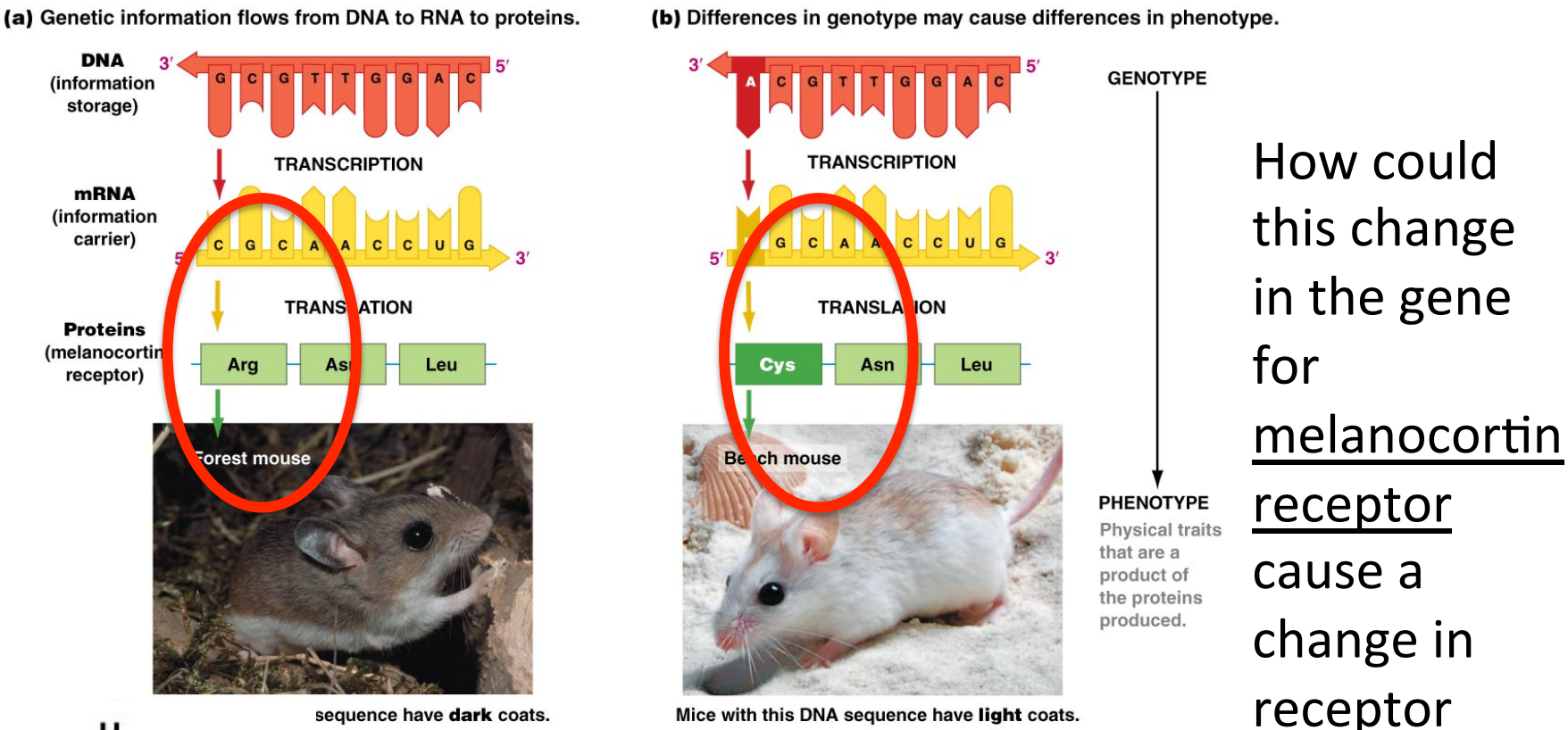
Do not need to know how to draw any structures!

Fig. 3.2

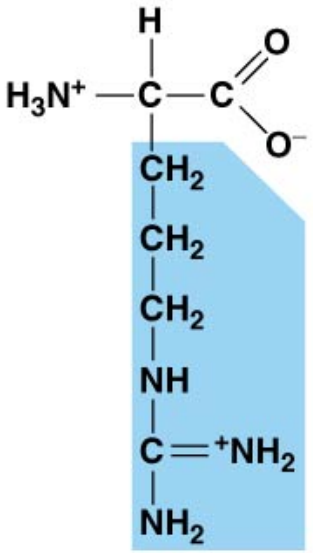
Structure = Function



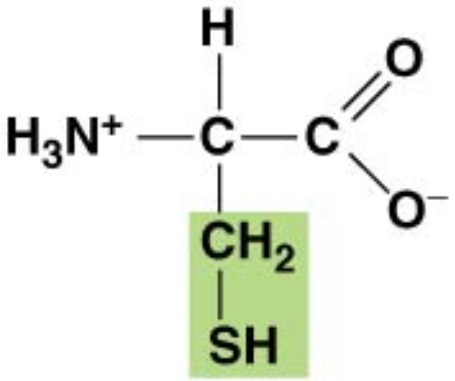




How could this change in the gene for <u>melanocortin receptor</u> cause a change in receptor function?



Arginine (Arg)



Cysteine (Cys)

Study Suggestions

- **AT HOME: Review BIG PICTURE of DNA/RNA/protein on pp. 396-397**

  (Great concept map linking many concepts/ processes!)
- AT HOME: Practice converting DNA to mRNA and protein in Fig. 16.7.
- See Table 16.1 for examples of types of mutations:

  not responsible for knowing the names of different mutation types