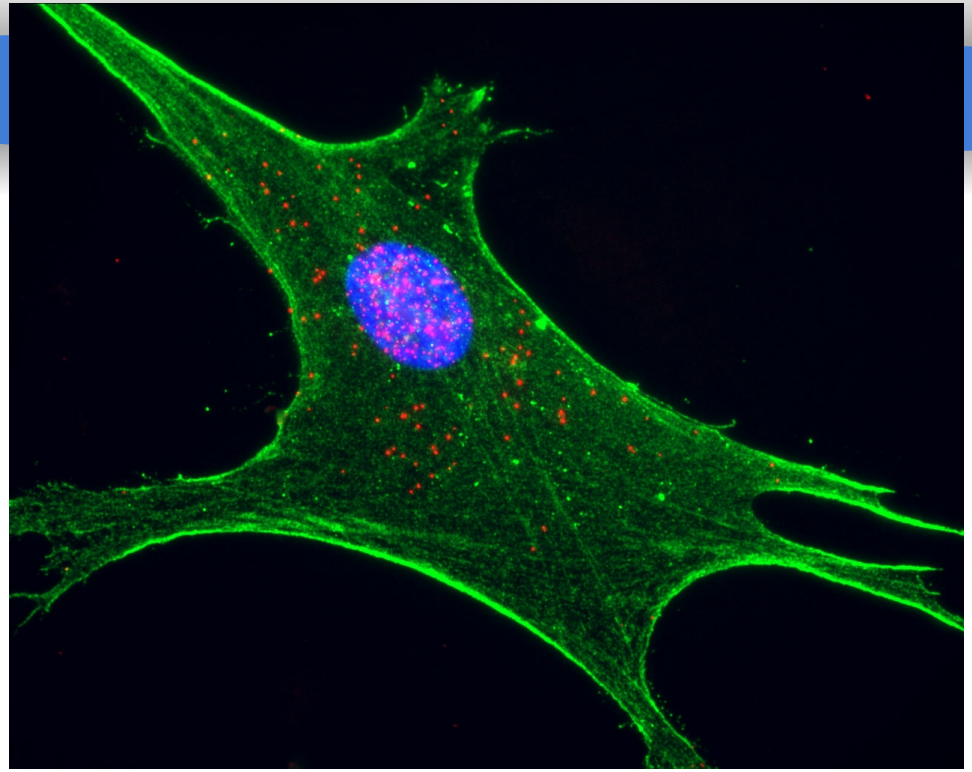
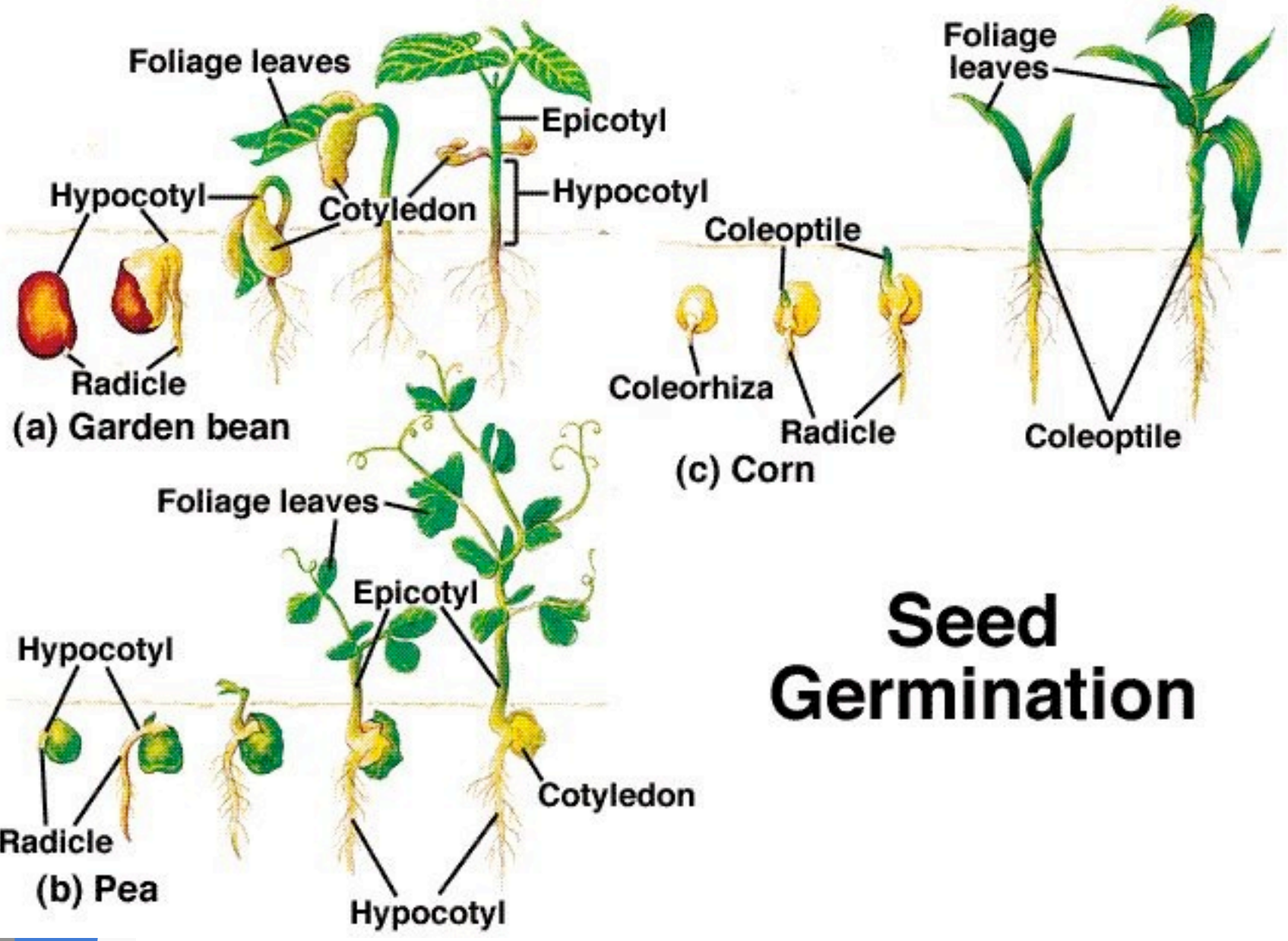
Control of Cell Function



Fluorescent image of a cell; nucleus in blue

Randy Moore, Dennis Clark, and Darrell Vodopich, Botany Visual Resource Library © 1998 The McGraw-Hill Companies, Inc. All rights reserved.

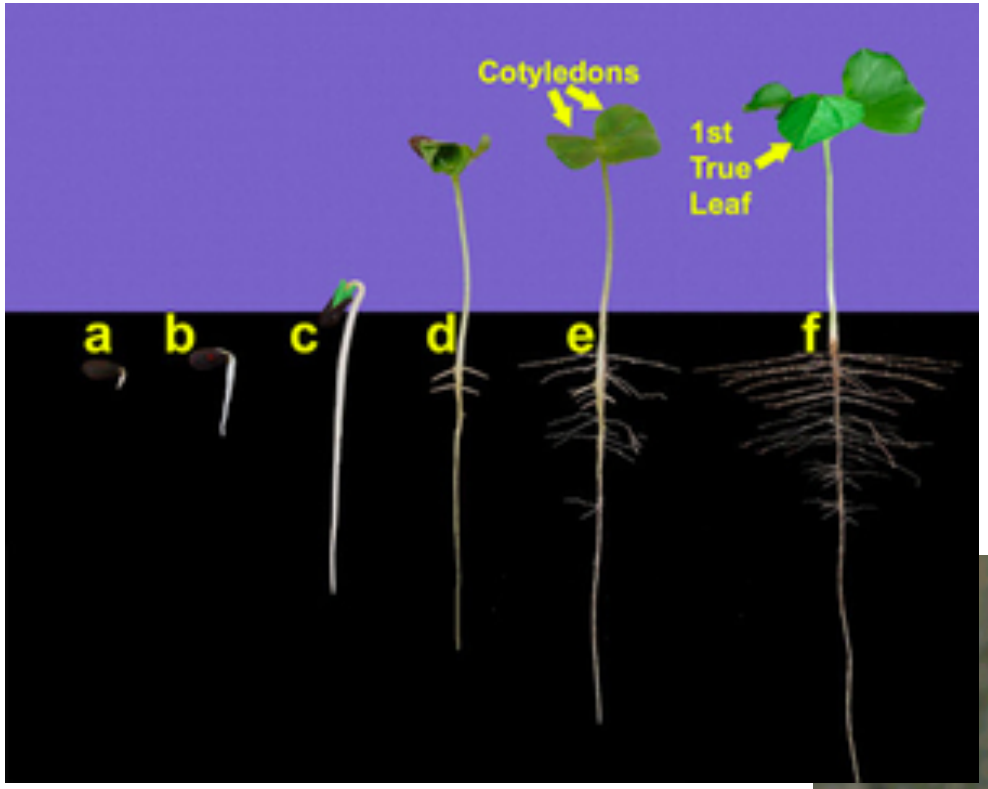


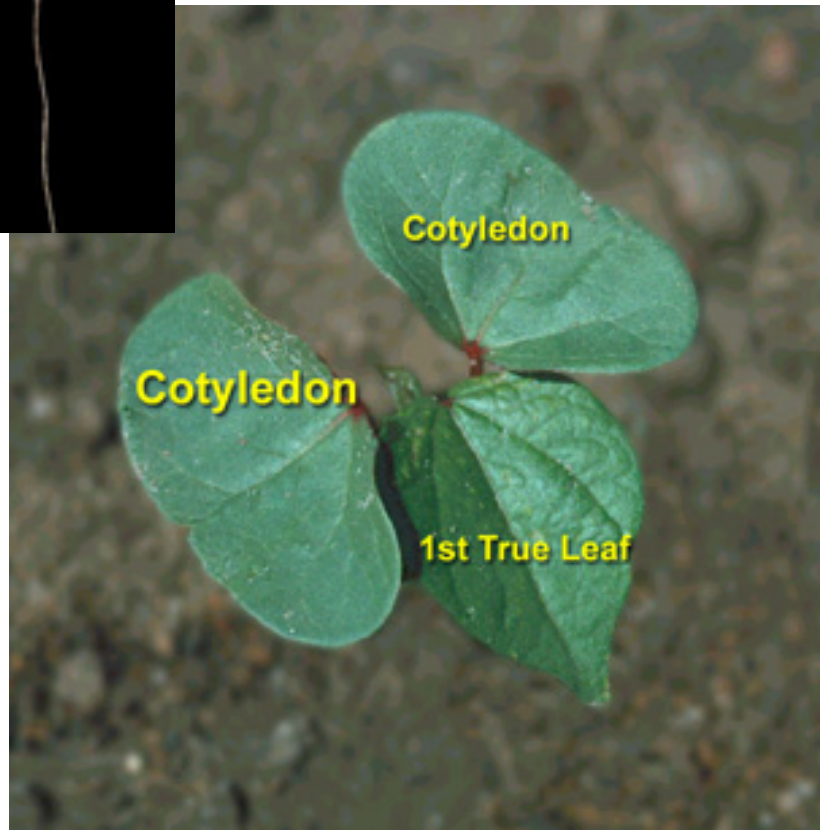
Seed Germination

Steps of Germination:

- Imbibition
- Seed swells
- Seed coat ruptures
- Endosperm exposed to oxygen
- Oxygen allows for food stored in endosperm to be converted into energy for growth
- Root grows first
- Stem grows next
- True leaves form
- Cotyledons fall off
- Seedling formed

Radish seed


Cotyledons
1st
True
Leaf
a
b
c
d
e
f


Cotyledon
Cotyledon
1st True Leaf

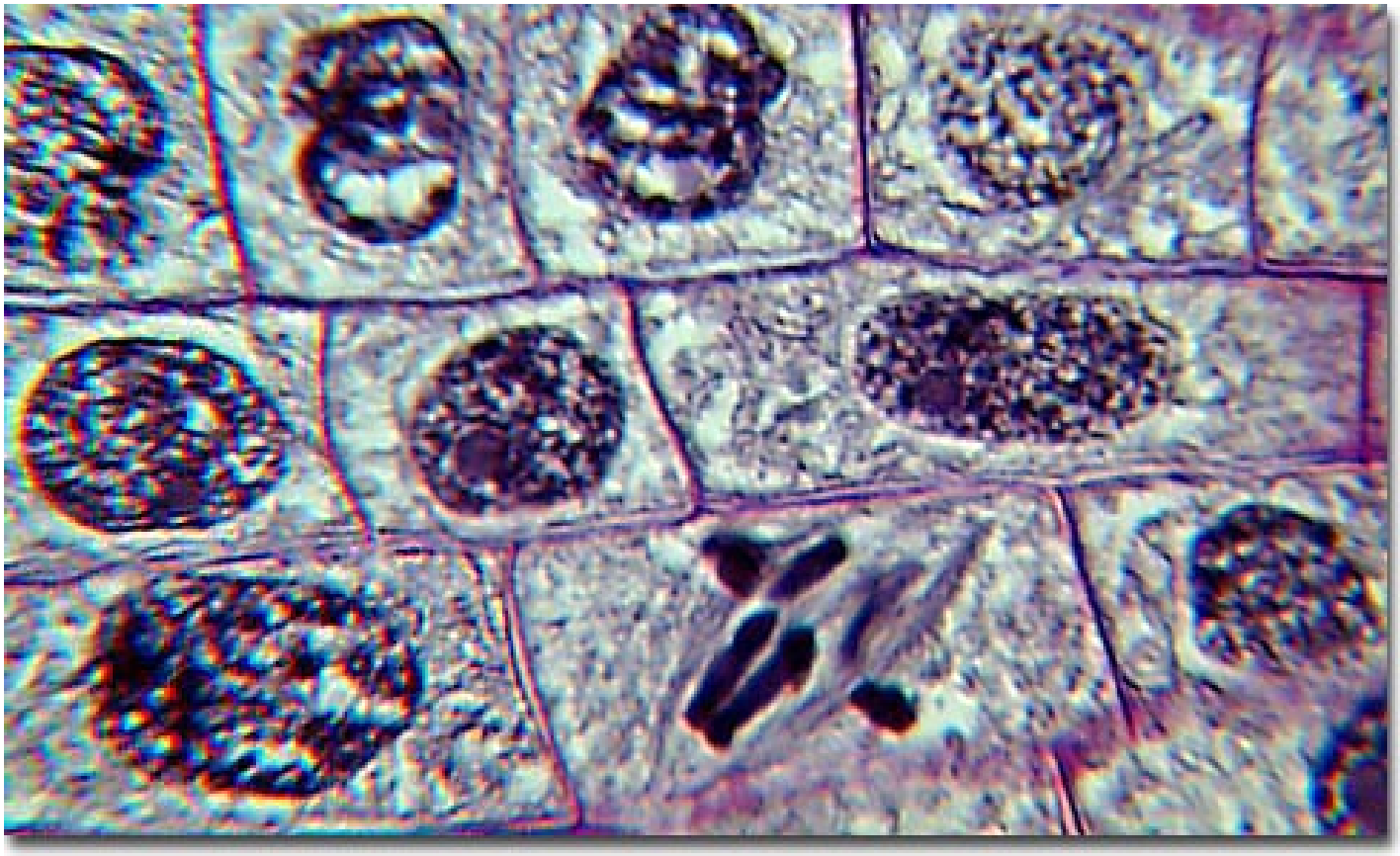
I. Control of Cell Functions Occurs in the NUCLEOID REGION or NUCLEUS (location of DNA)

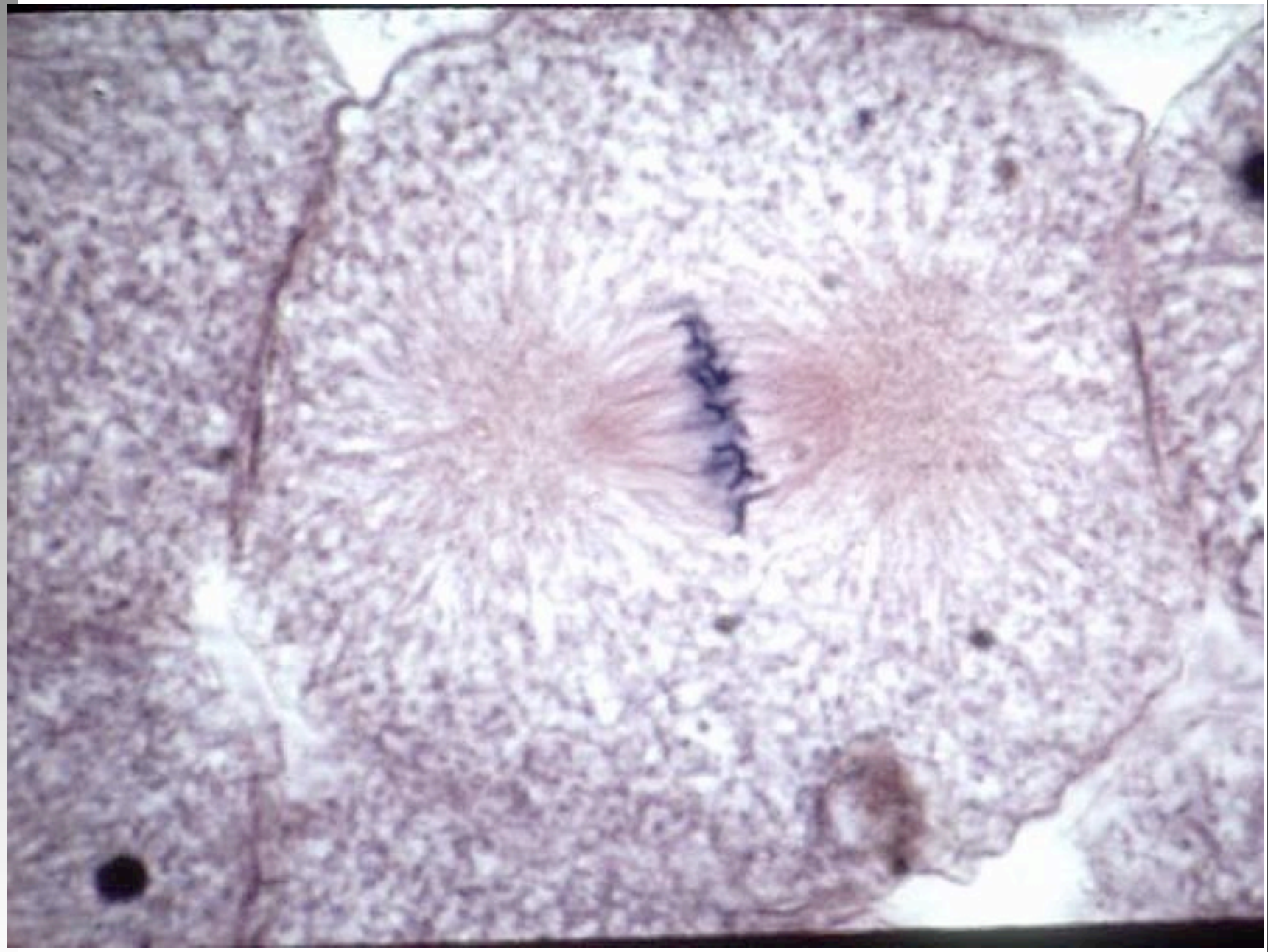
A. Chromosomes

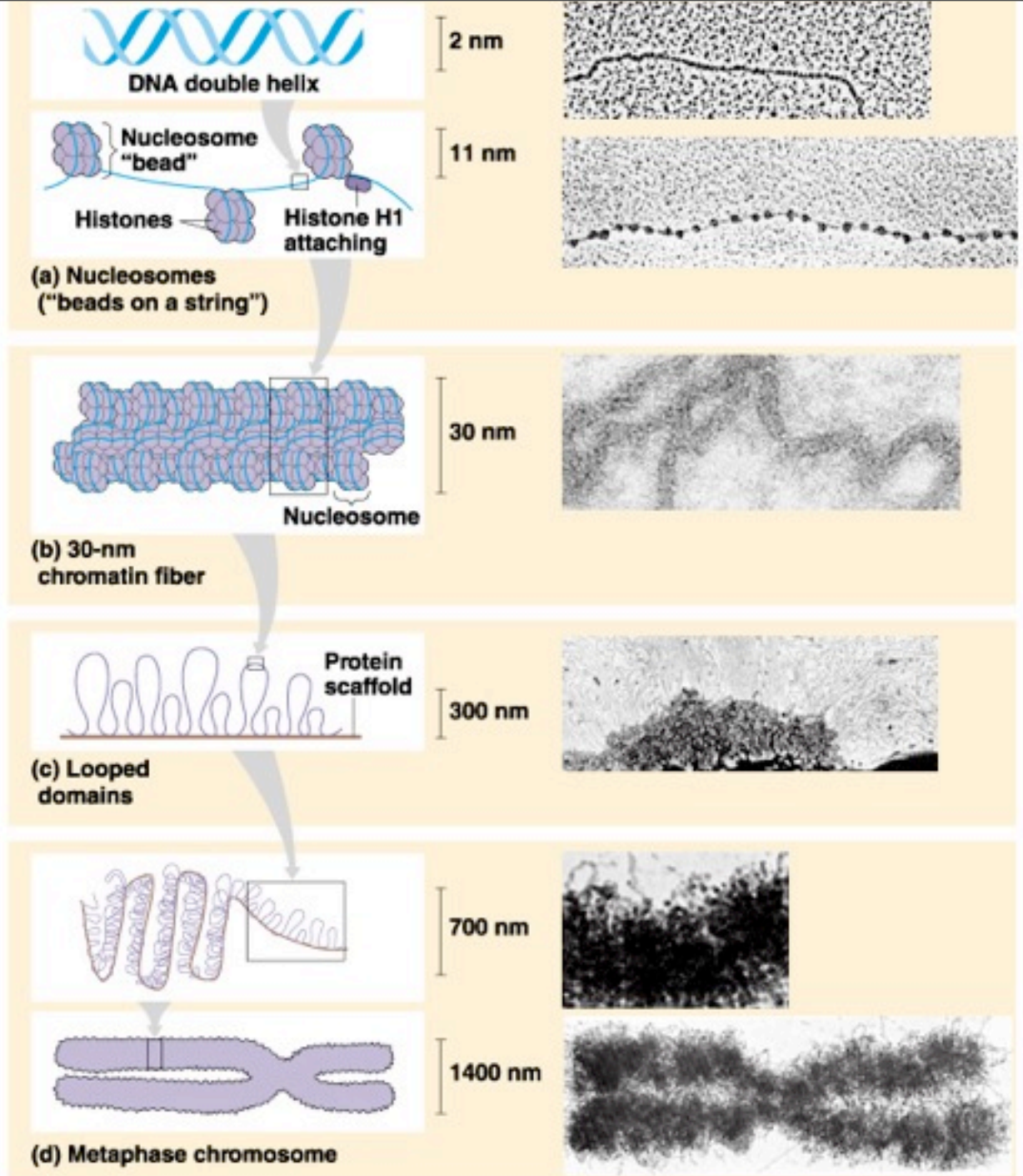
1. Single, circular ones in prokaryotic cells, no packing proteins (naked)

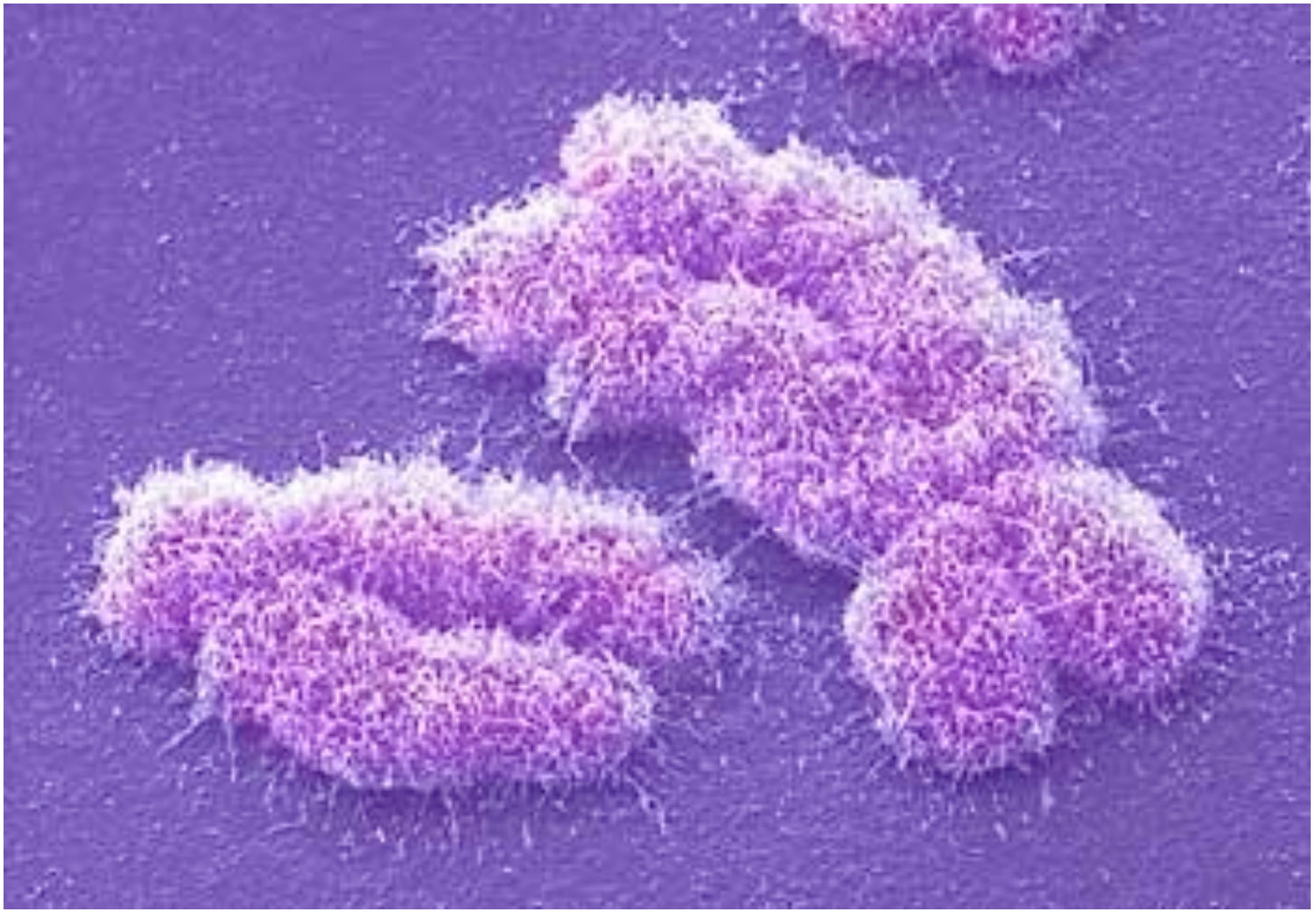
2. Eukaryotic cells: Paired (at least 2 pairs), linear chromosomes.

- Long strands of DNA + packing proteins
- Analogy- thread on a spool
- Can wind up and unwind



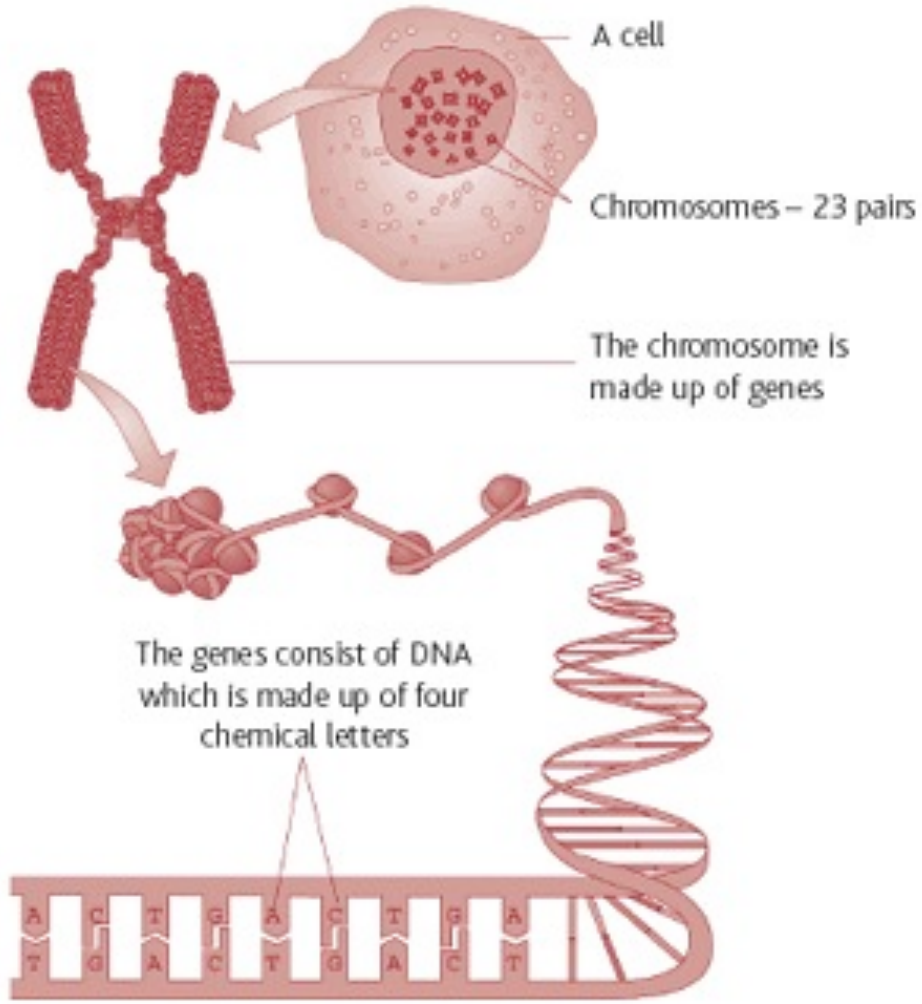



DNA double helix
2 nm
Nucleosome "bead"
Histones
Histone H1 attaching
11 nm
(a) Nucleosomes ("beads on a string")
30 nm
Nucleosome
(b) 30-nm chromatin fiber
Protein scaffold
300 nm
(c) Looped domains
700 nm
1400 nm
(d) Metaphase chromosome



1400 nm wide = __ μm = __ mm?

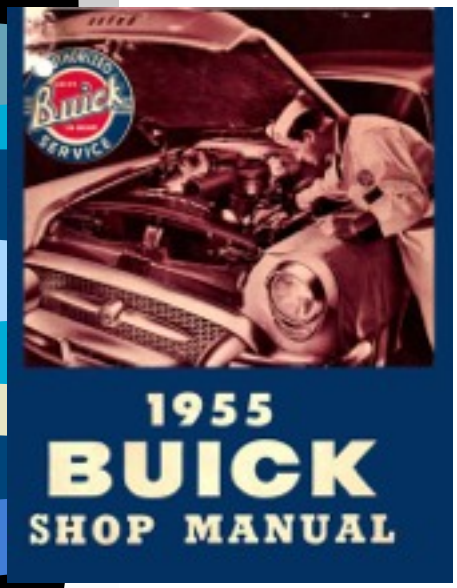
Review: Eukaryotic chromosomes are linear DNA molecules wrapped around proteins.



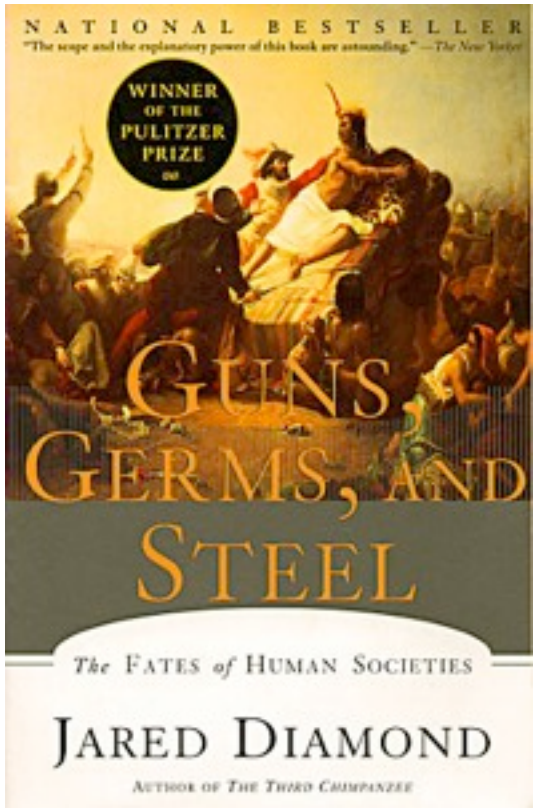
NOTE: A **genome** is the total and unique collection of genetic instructions encoded in the DNA of the chromosomes of each species.

In humans, almost every cell has the complete genome.

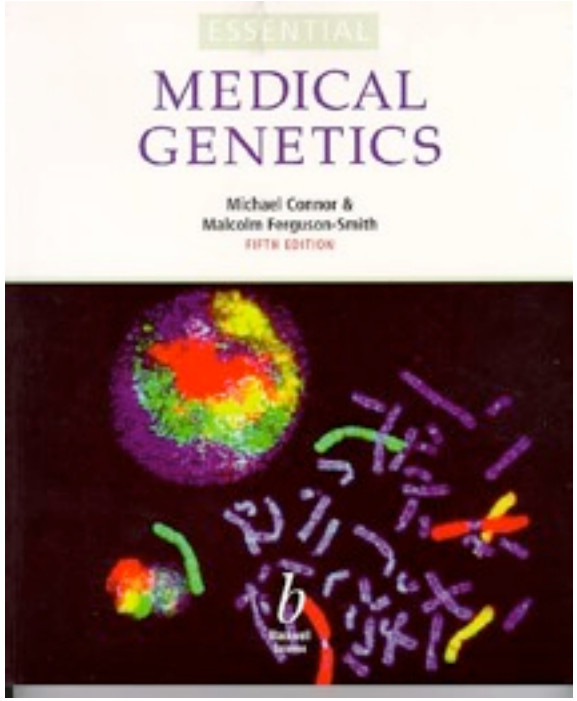
A shop manual



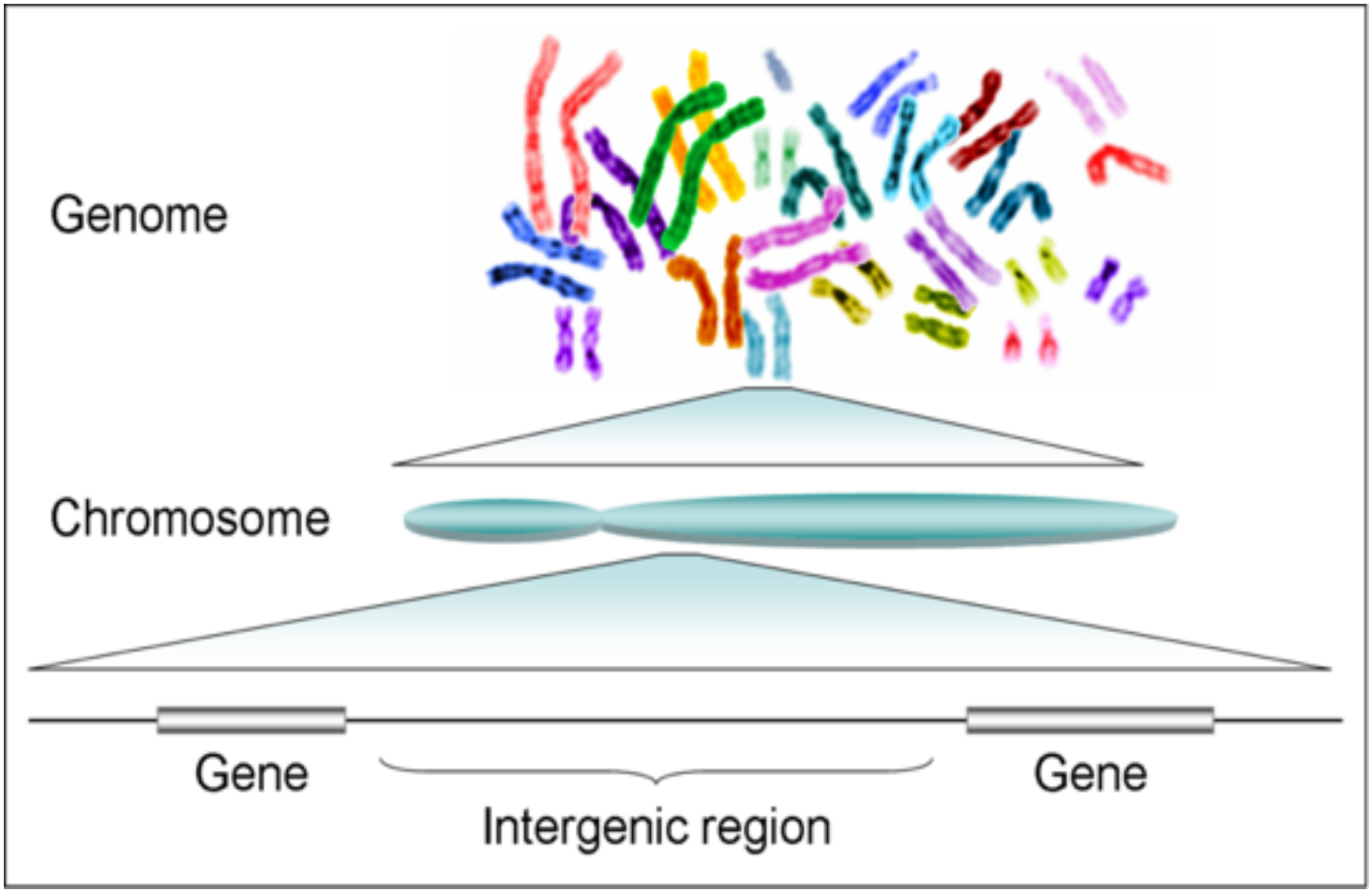
A history book

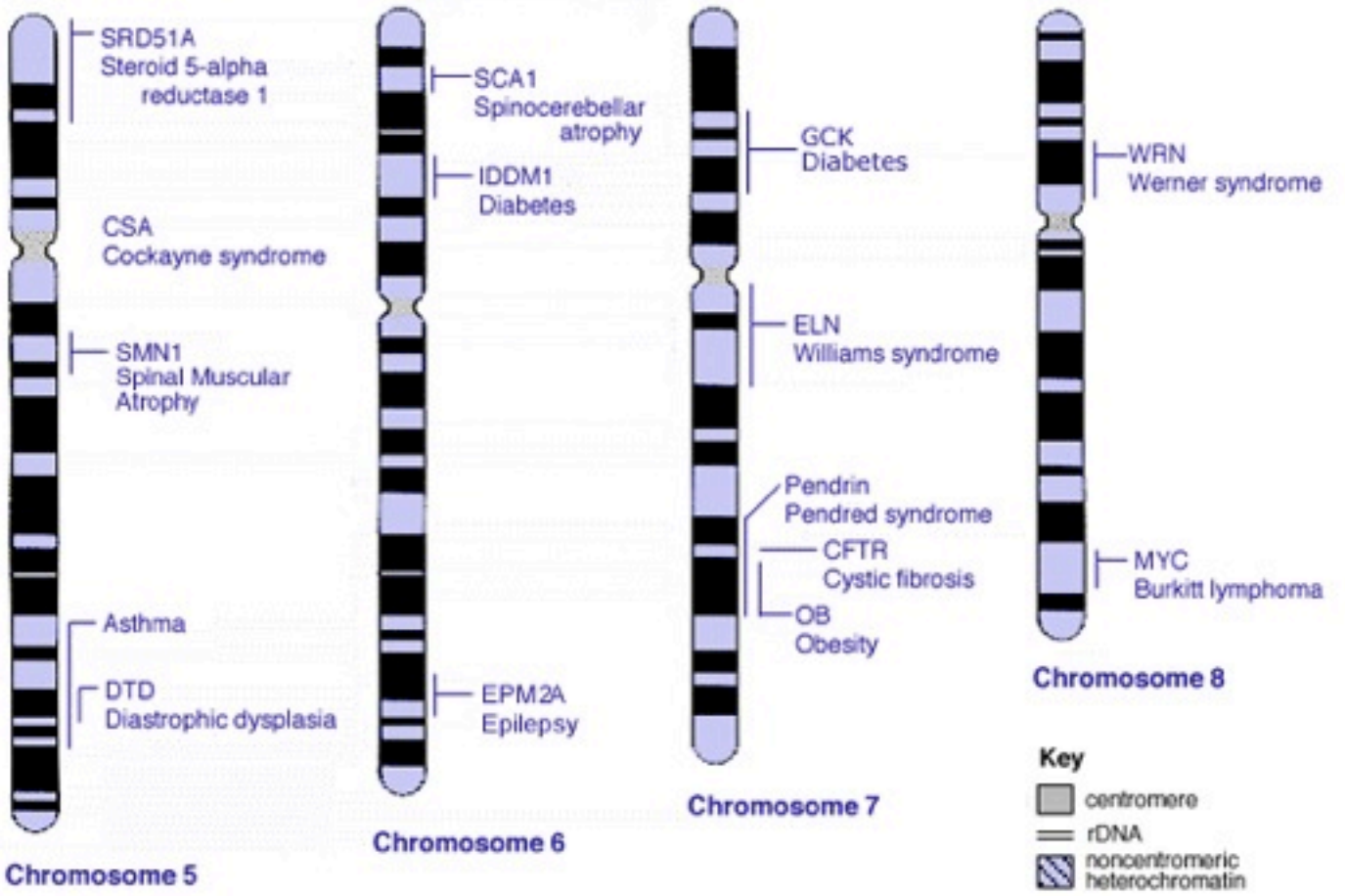


A medical textbook



B. DNA strands have CODING and NON-CODING regions




SRD51A
Steroid 5-alpha reductase 1
CSA
Cockayne syndrome
SMN1
Spinal Muscular Atrophy
Asthma
DTD
Diastrophic dysplasia
Chromosome 5
SCA1
Spinocerebellar atrophy
IDDM1
Diabetes
EPM2A
Epilepsy
Chromosome 6
GCK
Diabetes
ELN
Williams syndrome
Pendrin
Pendred syndrome
CFTR
Cystic fibrosis
OB
Obesity
Chromosome 7
WRN
Werner syndrome
MYC
Burkitt lymphoma
Chromosome 8
Key
centromere
rDNA
noncentromeric heterochromatin

1. Coding regions

1. Coding regions

- Make up <10% of DNA

1. Coding regions

- Make up <10% of DNA
- Discreet sections are called **genes**

1. Coding regions

- Make up <10% of DNA
- Discreet sections are called **genes**
- Genes code for a cell's proteins → proteins determine an organism's traits and behaviors

1. Coding regions

- Make up <10% of DNA
- Discreet sections are called **genes**
- Genes code for a cell's proteins → proteins determine an organism's traits and behaviors
- Humans have an estimated 500-25,000 genes (number keeps falling)

1. Coding regions

- Make up <10% of DNA
- Discreet sections are called **genes**
- Genes code for a cell's proteins → proteins determine an organism's traits and behaviors
- Humans have an estimated 500-25,000 genes (number keeps falling)

2. Non-coding Regions

2. Non-coding Regions

- Make up >90% of DNA

2. Non-coding Regions

- Make up >90% of DNA
- Some are repetitive sequences- may play a role in cell longevity and/or chromosome organization

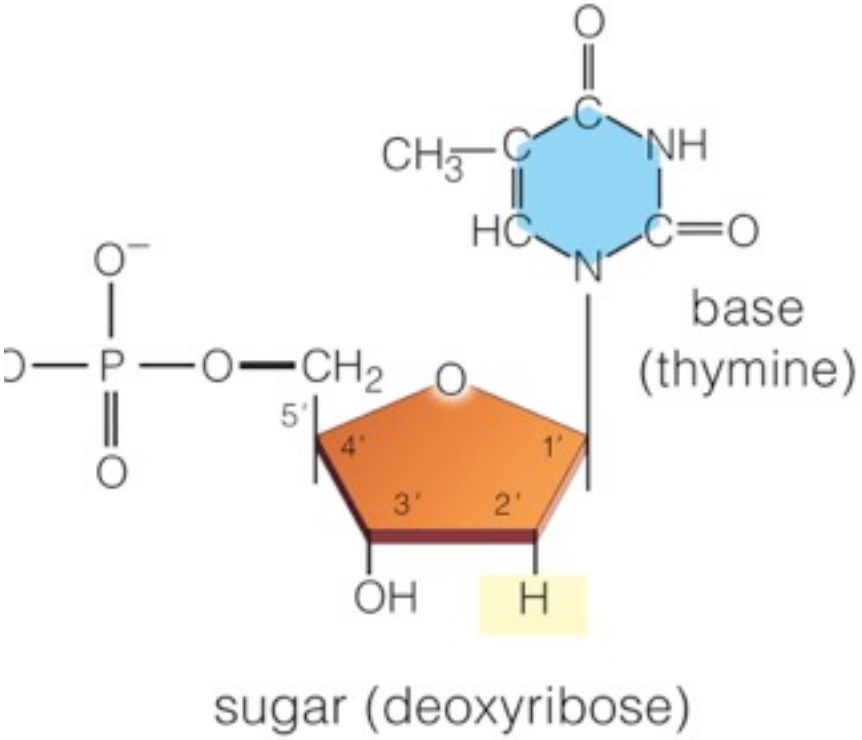
2. Non-coding Regions

- Make up >90% of DNA
- Some are repetitive sequences- may play a role in cell longevity and/or chromosome organization
- The rest is known as ‘junk’ or ‘nonsense’ DNA- may be old viruses, old unused genes ???????

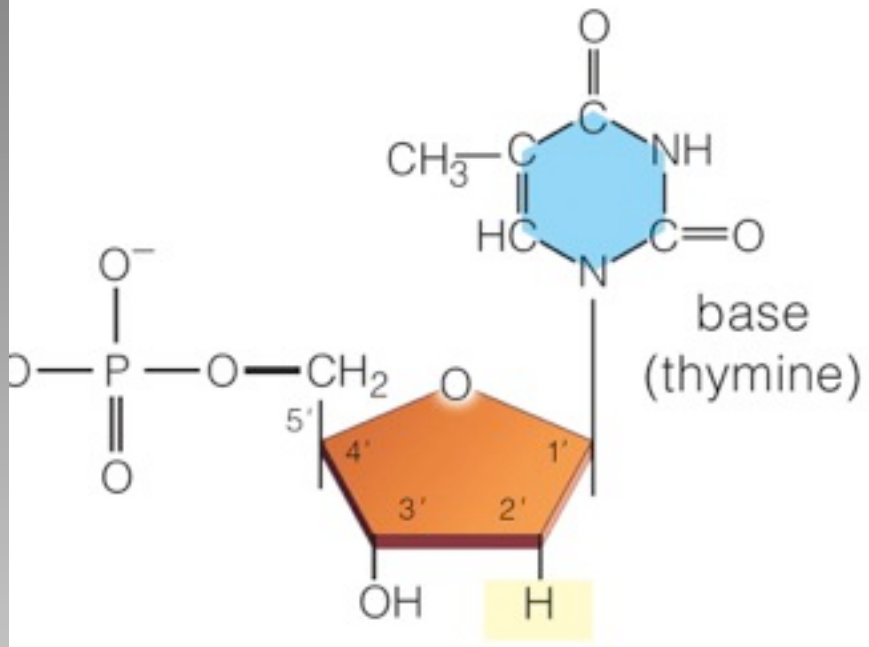
II. DNA Molecules

A. Structure

1. Nucleotides

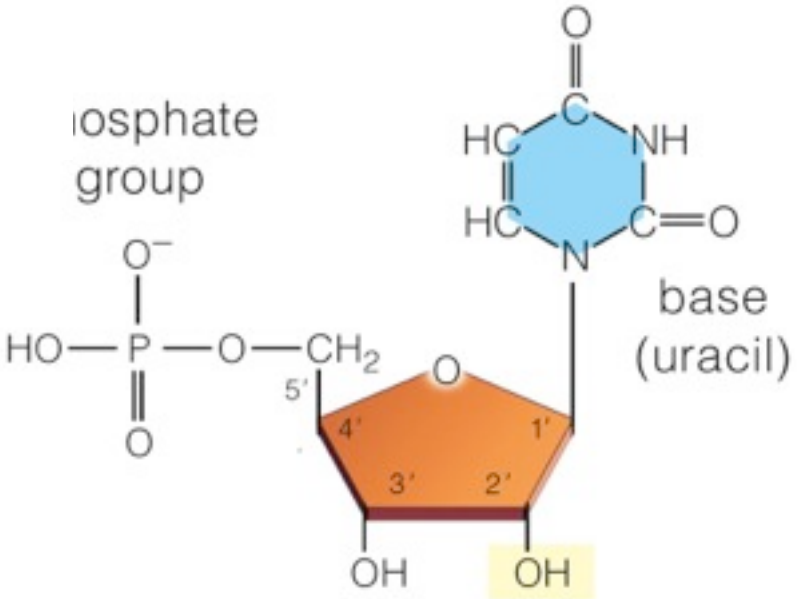


- Phosphate group
- Deoxyribose sugar
- Nitrogen base

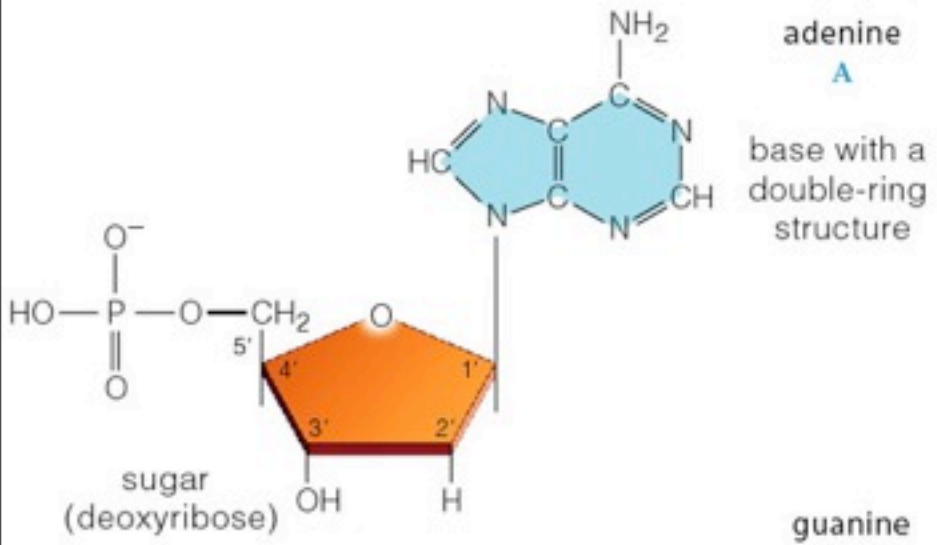


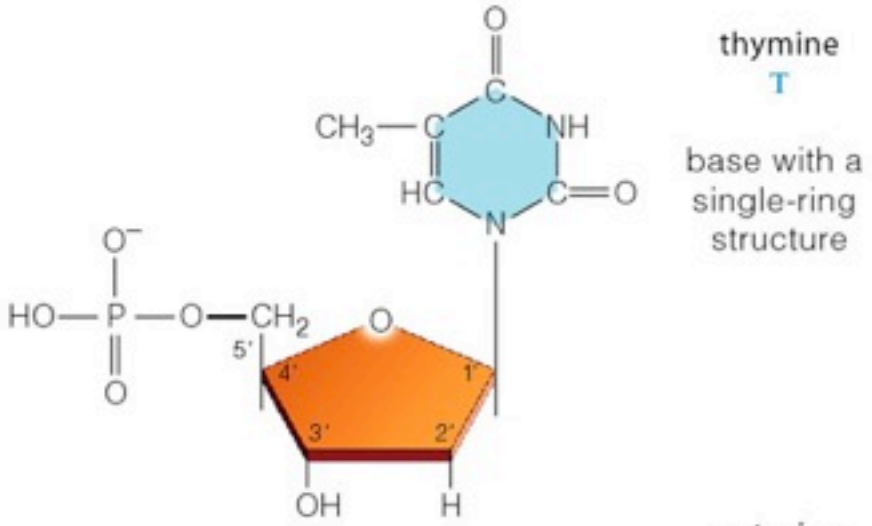
⬅ DNA nucleotide

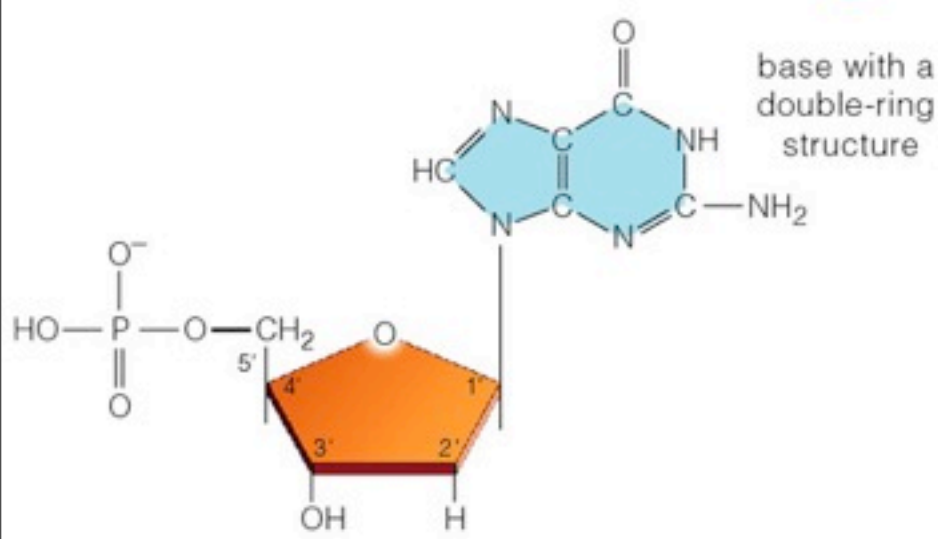
RNA nucleotide ➡

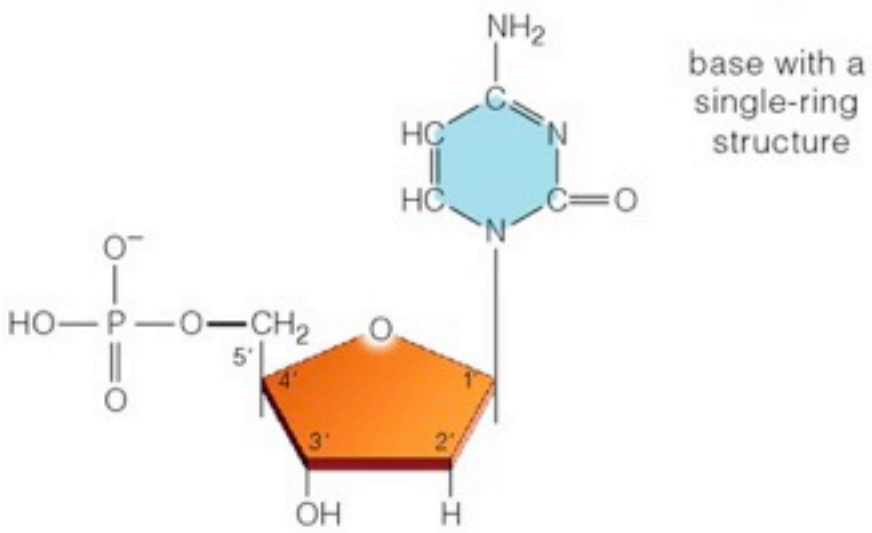


© 2006 Thomson Higher Education



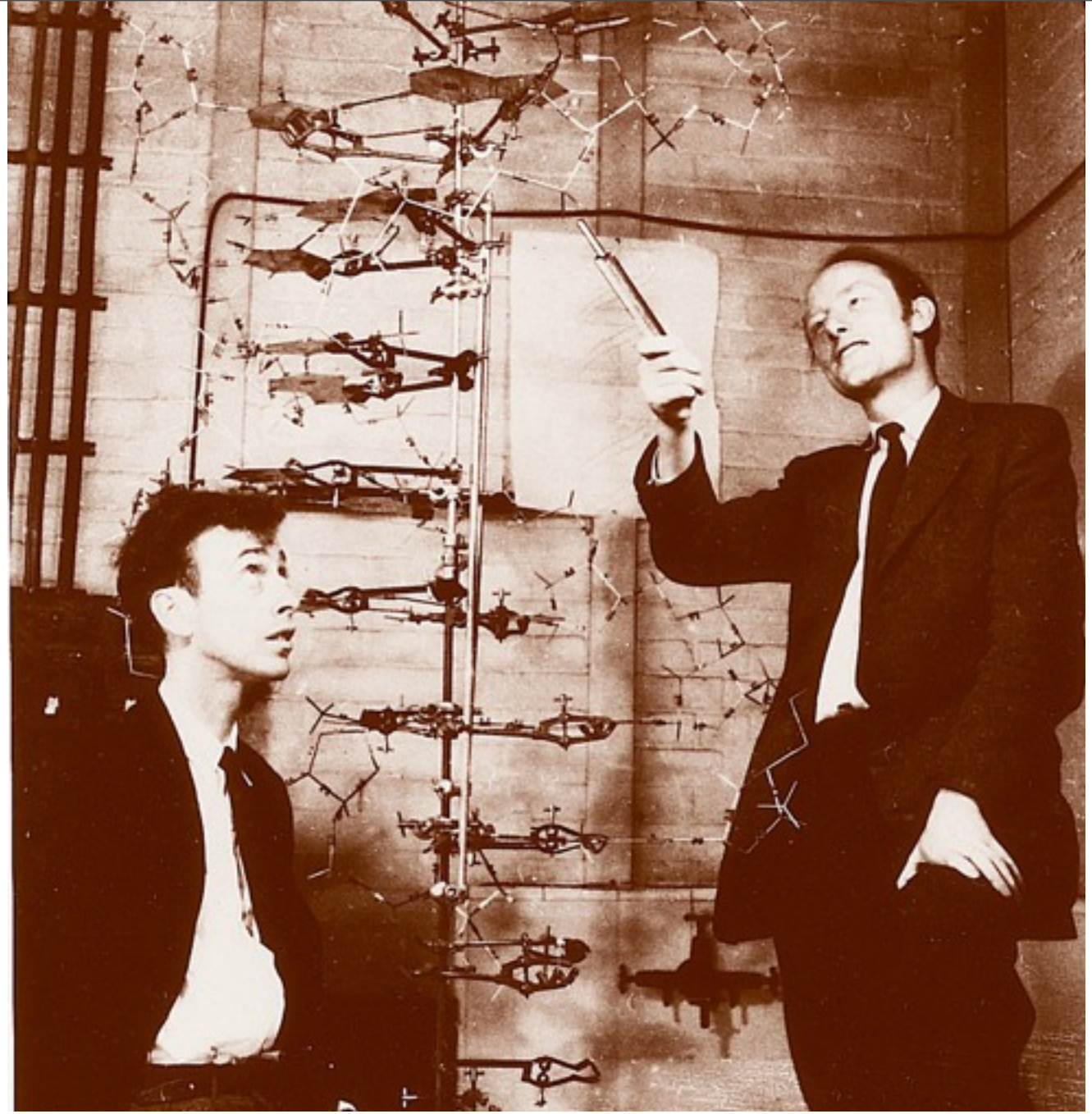






Double-ring bases
A, G

Single-ring bases
T, C

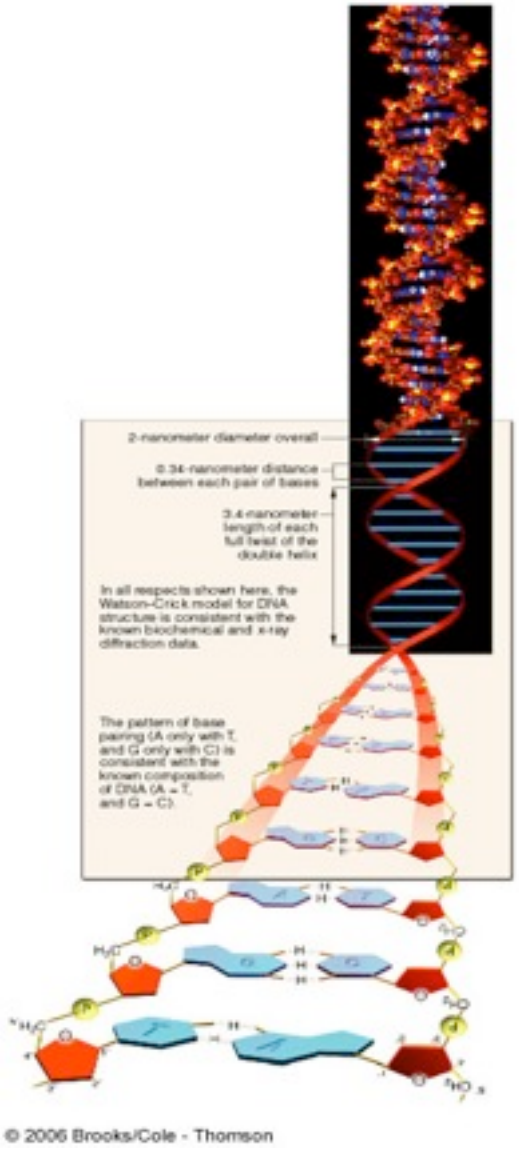


Watson

Crick

2. Watson-Crick Model

- Double helix
- Sugar-phosphate backbone
- C-G with 3 H bonds
- T-A with 2 H bonds
- Antiparallel



B. Central Dogma

B. Central Dogma

- 1st 1 gene → 1 enzyme

B. Central Dogma

- 1st 1 gene → 1 enzyme
- Next 1 gene → 1 protein

B. Central Dogma

- 1st 1 gene → 1 enzyme
- Next 1 gene → 1 protein
- Recent 1 gene → 1 polypeptide

B. Central Dogma

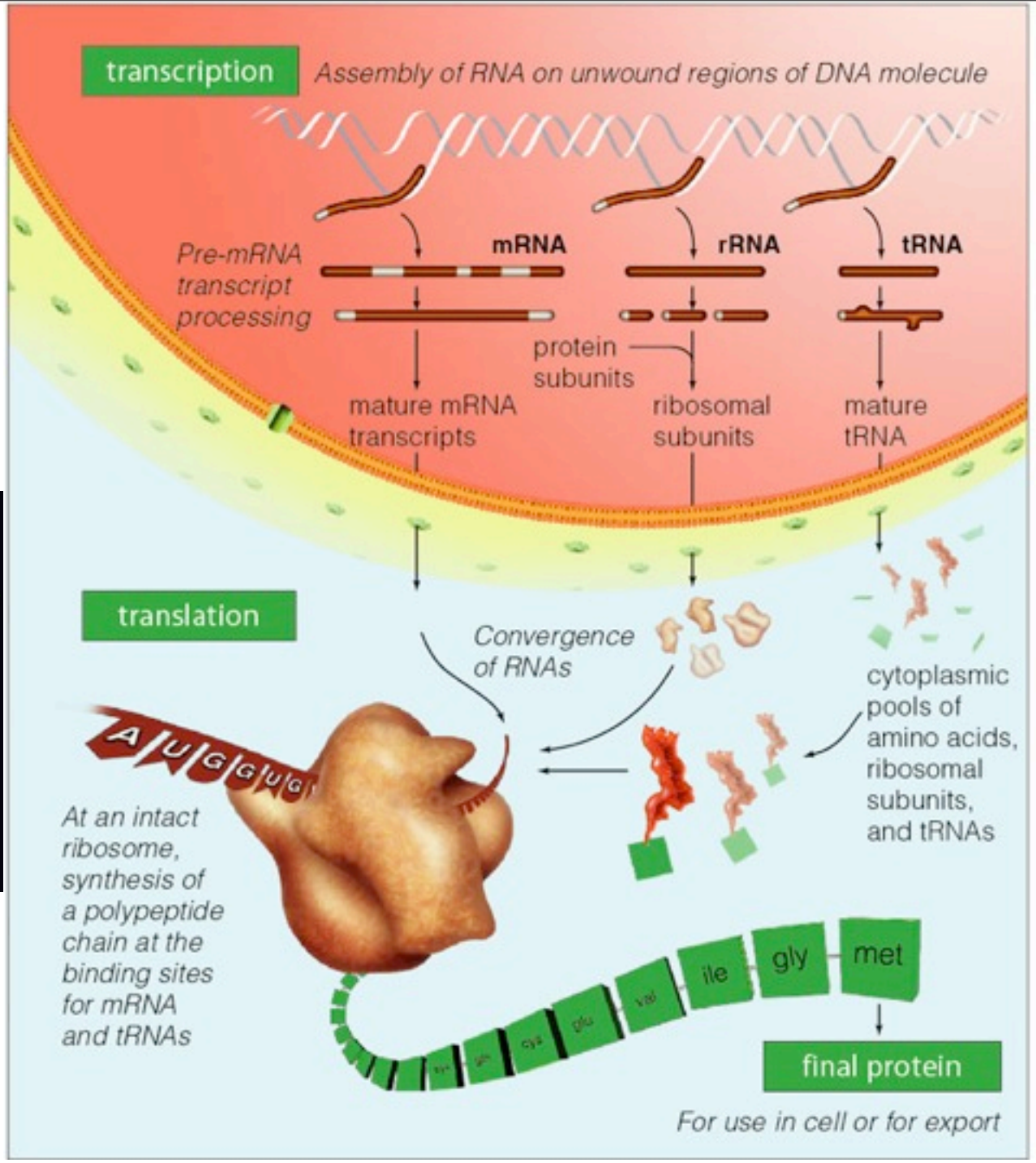
- 1st — 1 gene → 1 enzyme
- Next — 1 gene → 1 protein
- Recent — 1 gene → 1 polypeptide
- Now — 1 gene → 1-10 polypeptides

B. Central Dogma

- 1st 1 gene → 1 enzyme
- Next 1 gene → 1 protein
- Recent 1 gene → 1 polypeptide
- Now 1 gene → 1-10 polypeptides
- Humans have 25,000 genes or less and make about 100,000 different proteins. How?

OVERVIEW

DON'T PANIC


transcription
Assembly of RNA on unwound regions of DNA molecule
Pre-mRNA transcript processing
mRNA
rRNA
tRNA
protein subunits
mature mRNA transcripts
ribosomal subunits
mature tRNA
translation
Convergence of RNAs
cytoplasmic pools of amino acids, ribosomal subunits, and tRNAs
A U G G U G
At an intact ribosome, synthesis of a polypeptide chain at the binding sites for mRNA and tRNAs
ile
gly
met
final protein
For use in cell or for export

-RNA

A. Solves 2 problems for DNA
    1. Getting information from nucleus to RER or cytoplasm.
    2. Translating from the language of nucleotides (4 bases) to the language of proteins (20 amino acids).

-RNA

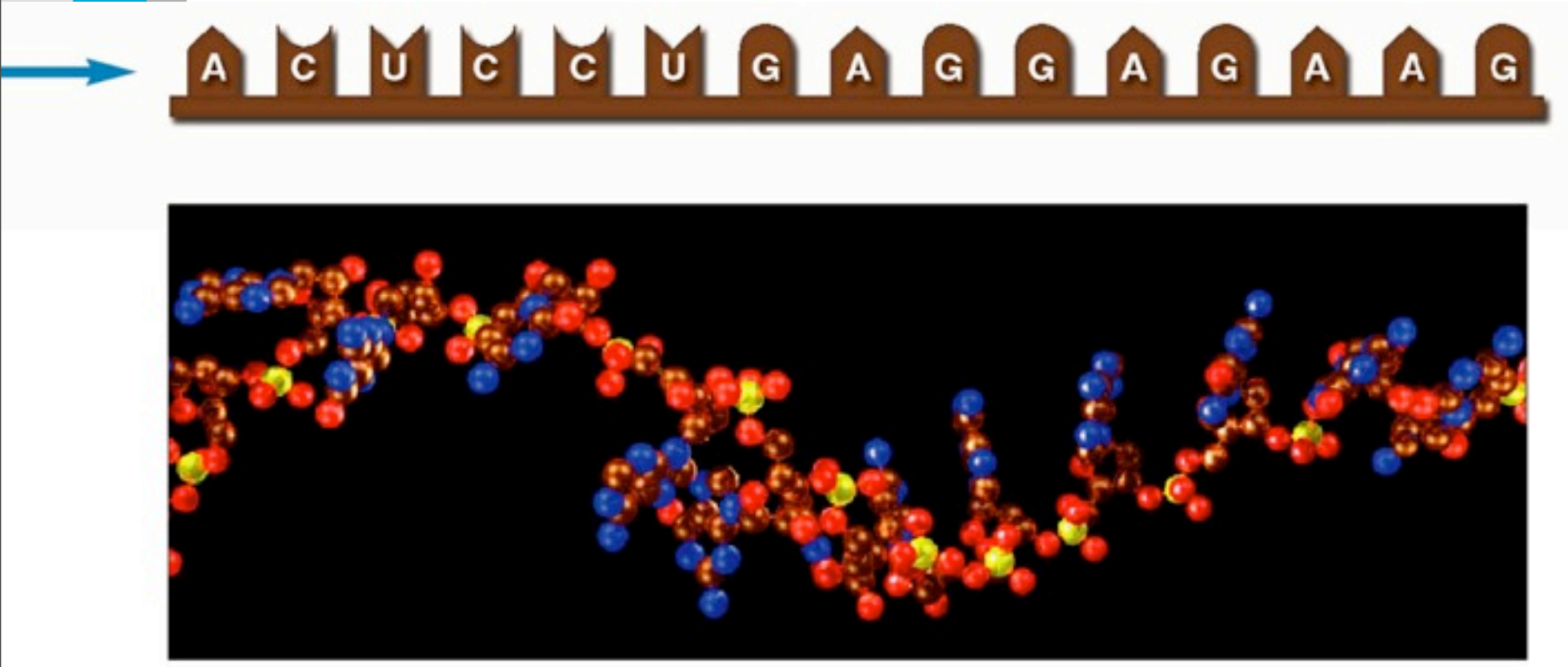
A. Solves 2 problems for DNA
   1. Getting information from nucleus to RER or cytoplasm.
   2. Translating from the language of nucleotides (4 bases) to the language of proteins (20 amino acids).

B. DNA vs. RNA

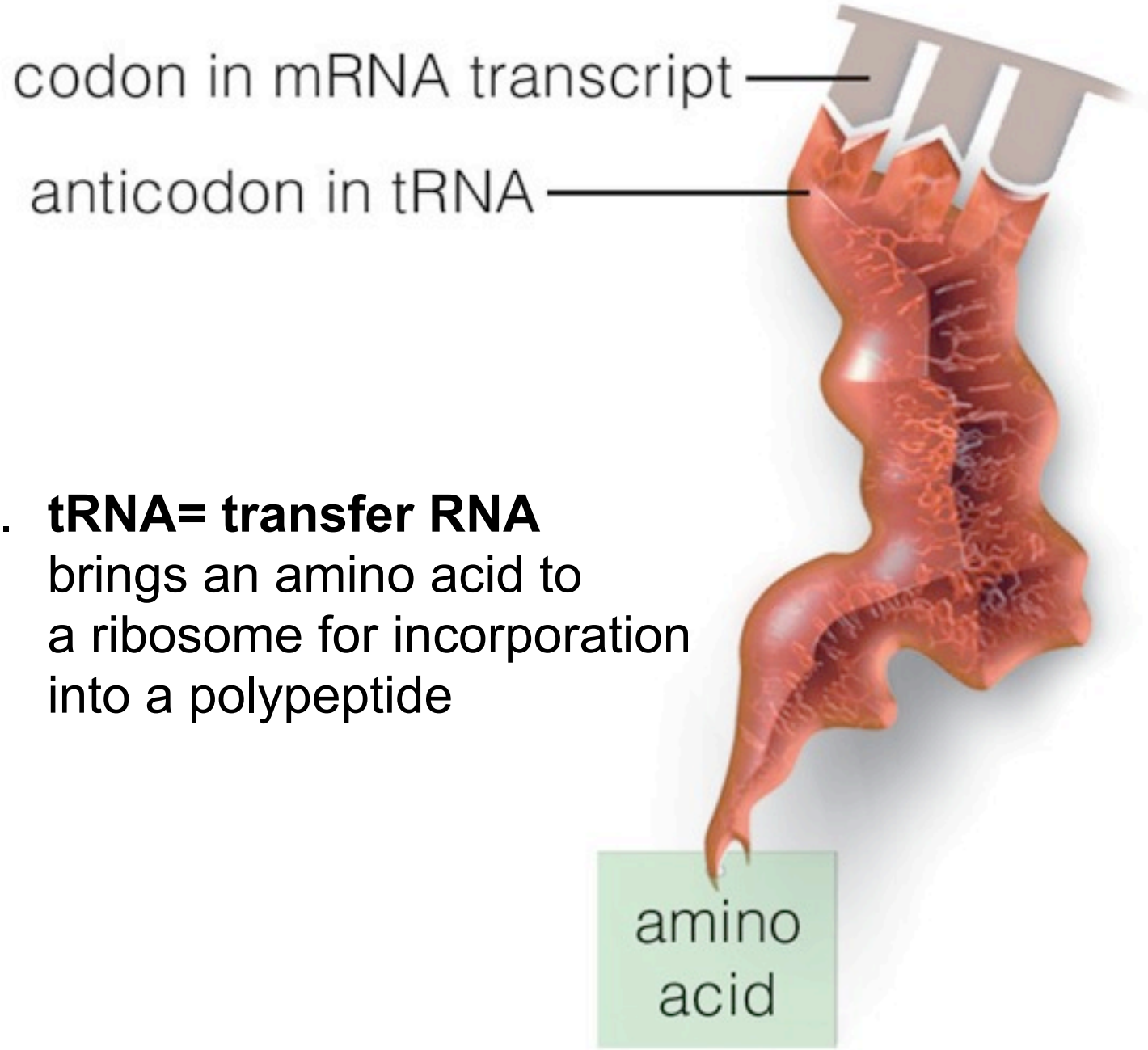
DNA	RNA
Deoxyribose- more stable	Ribose- less stable
Double-stranded	Mostly single-stranded
Nucleus or nucleoid region	Nucleus and cytoplasm
Thymine	Uracil- single ring

C. Types and Shapes and Functions

1. mRNA = messenger RNA contains the code for amino acid sequences in polypeptides



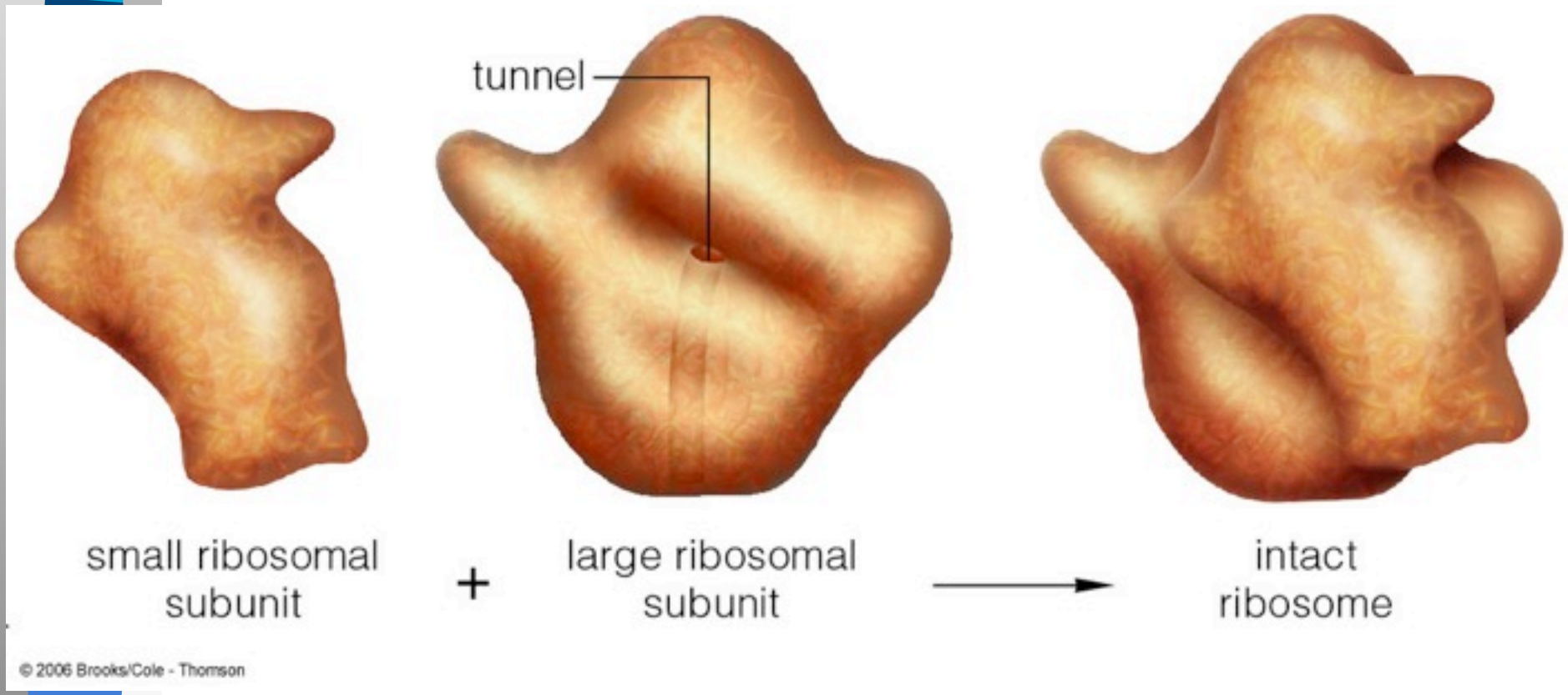
© 2006 Brooks/Cole - Thomson



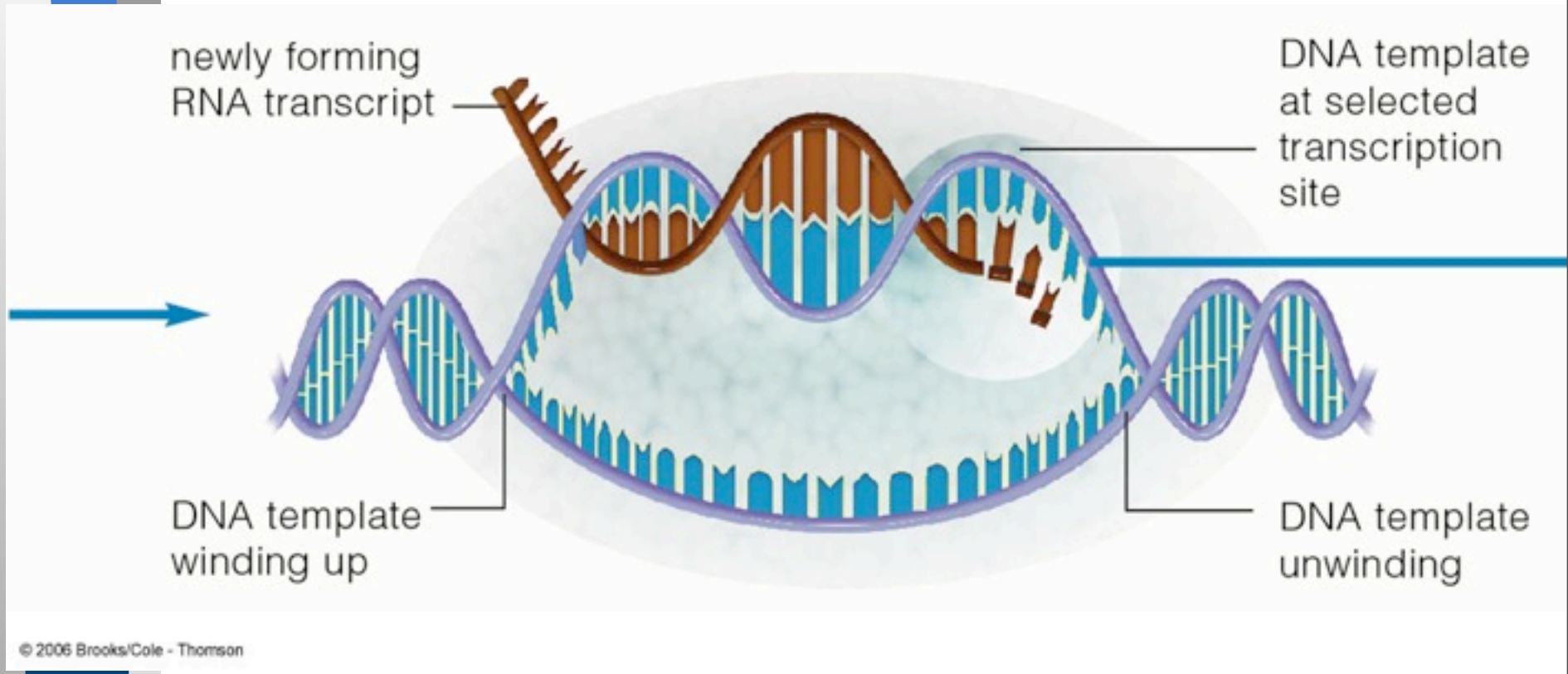
2. **tRNA= transfer RNA**
   brings an amino acid to a ribosome for incorporation into a polypeptide

© 2006 Thomson Higher Education

3. rRNA = ribosomal RNA-
   joins with other proteins to make 2 ribosomal subunits- one small and one large, these come together to make a ribosome which assembles amino acids into polypeptides

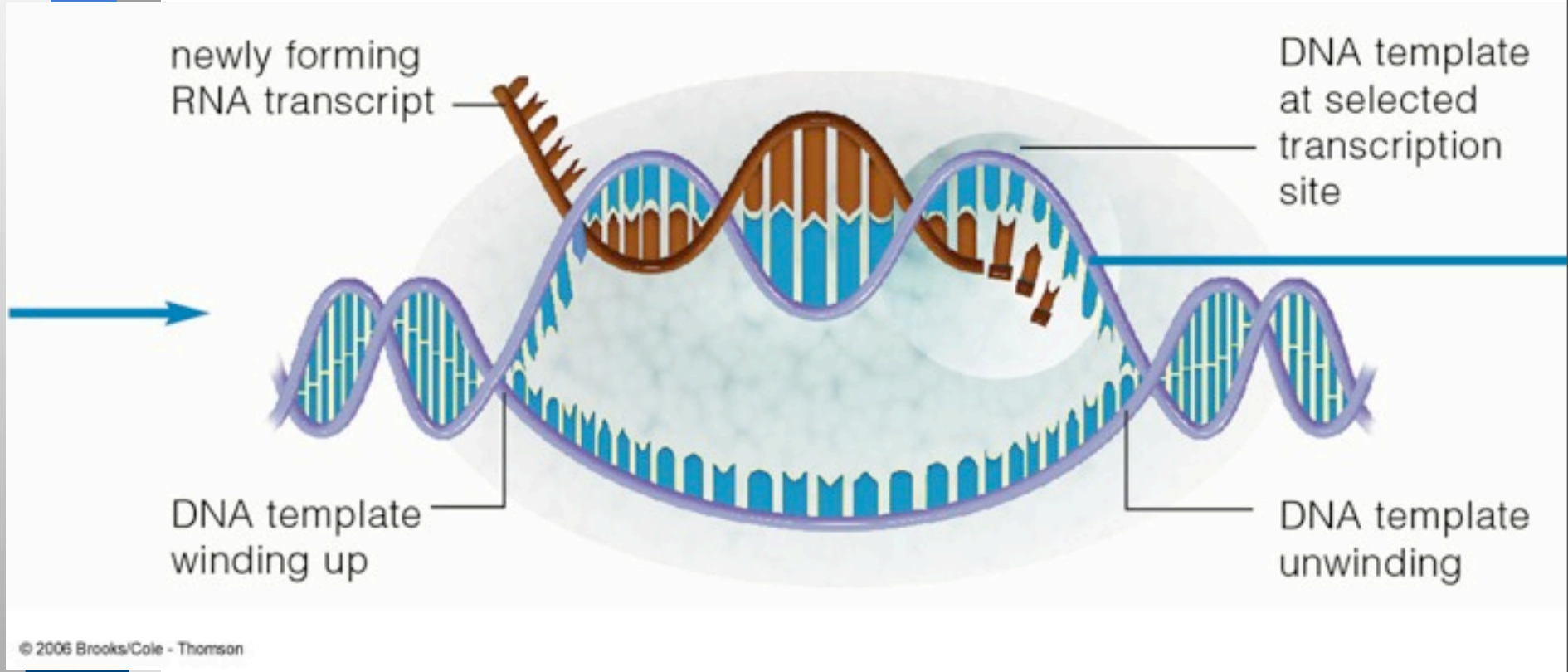


IV. Transcription (RNA Synthesis)

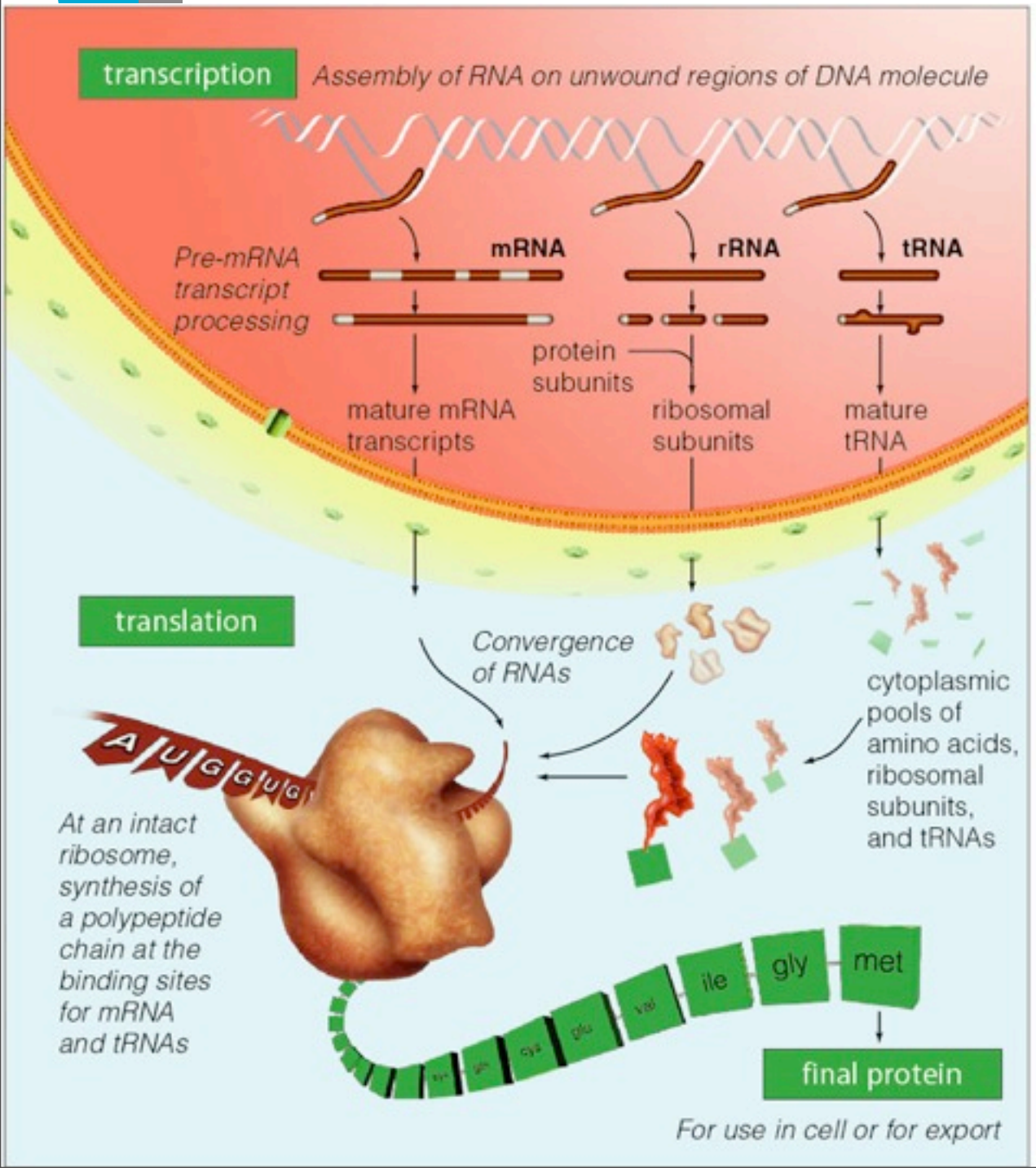


© 2006 Brooks/Cole - Thomson

IV. Transcription (RNA Synthesis)



- Uses the enzyme RNA polymerase
- RNA made in a 5' → 3' direction
- Many copies can be made at once
- RNA will be processed before used

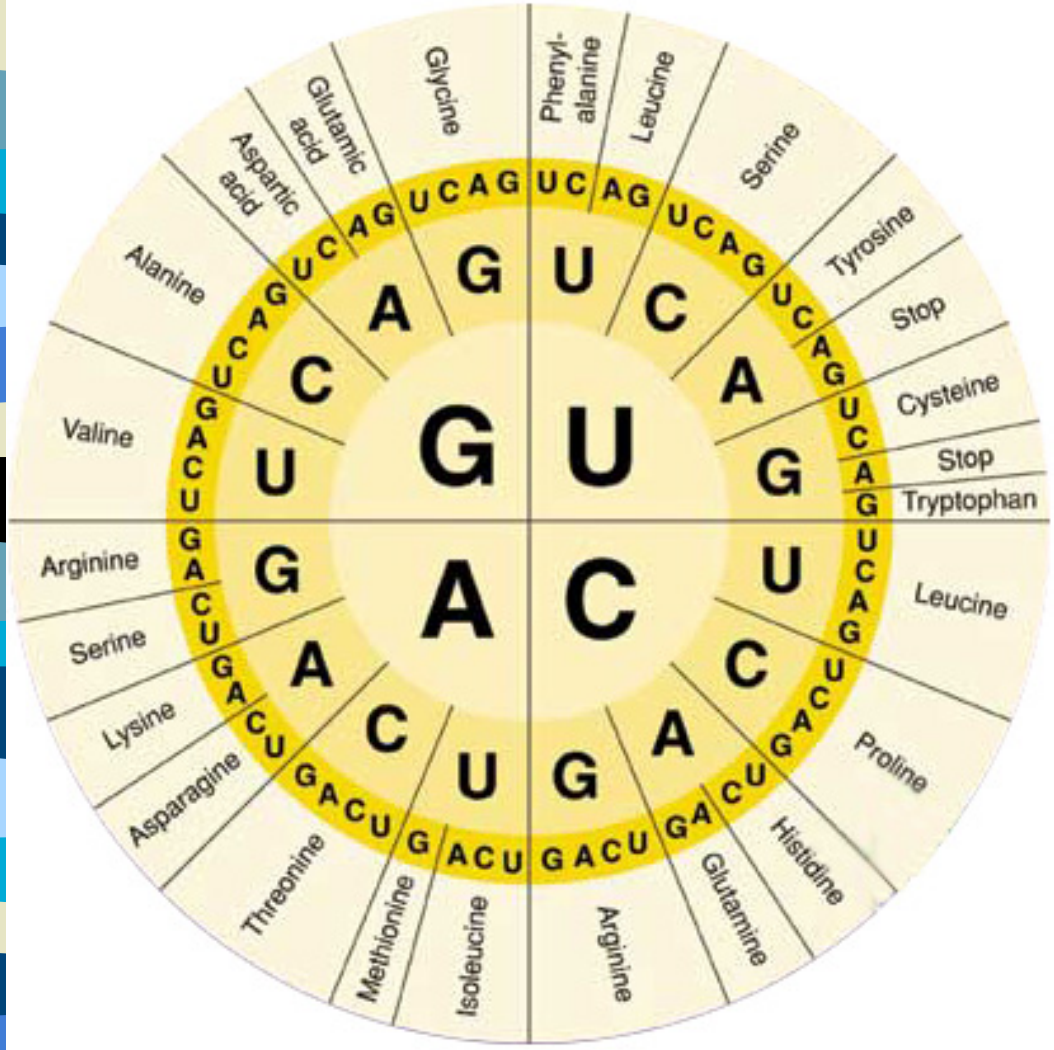


Processing:

- 5' 'cap' added
- Poly A tail added to mRNA
- Cutting, looping, and folding
- Transported to cytoplasm (*RER)

V. Translation (Protein synthesis)

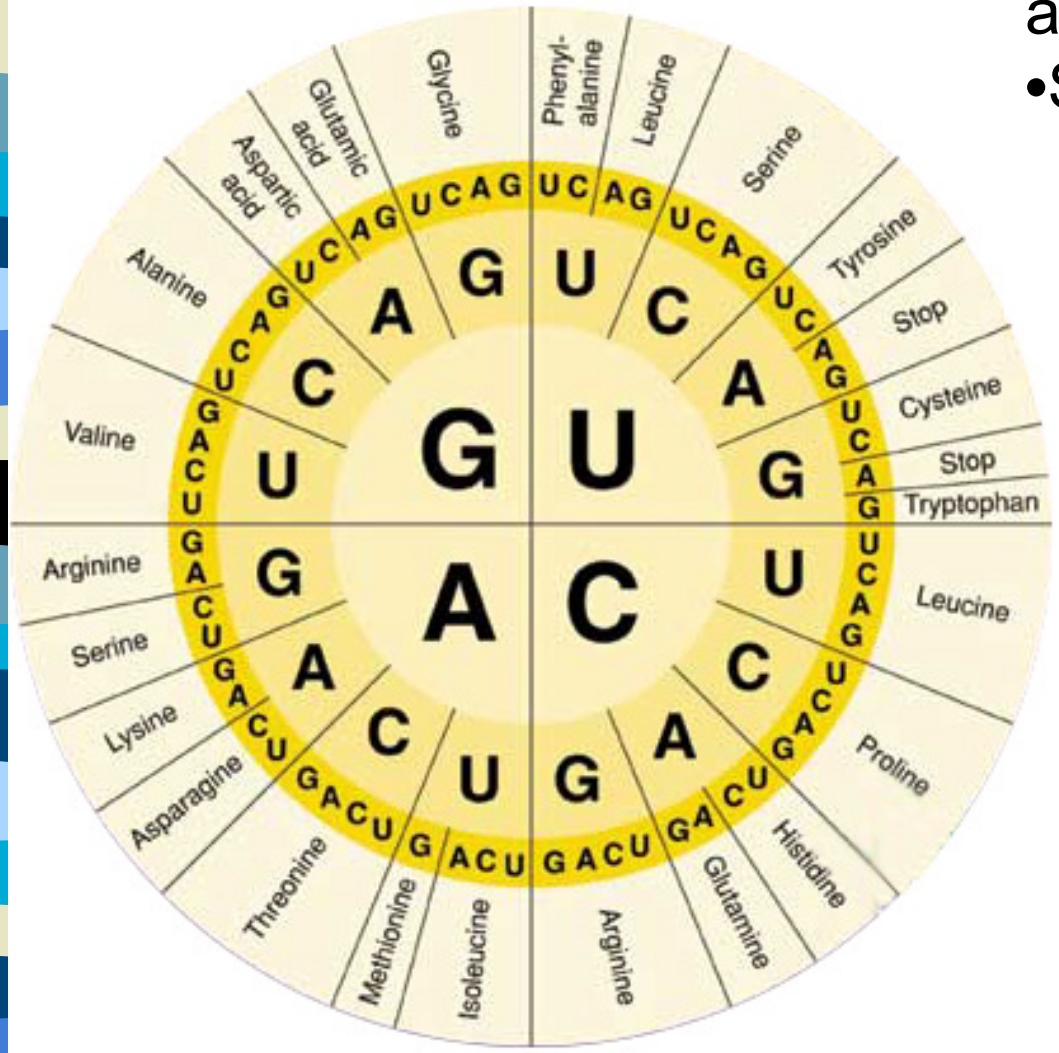
A. Genetic Code:



V. Translation (Protein synthesis)

A. Genetic Code:

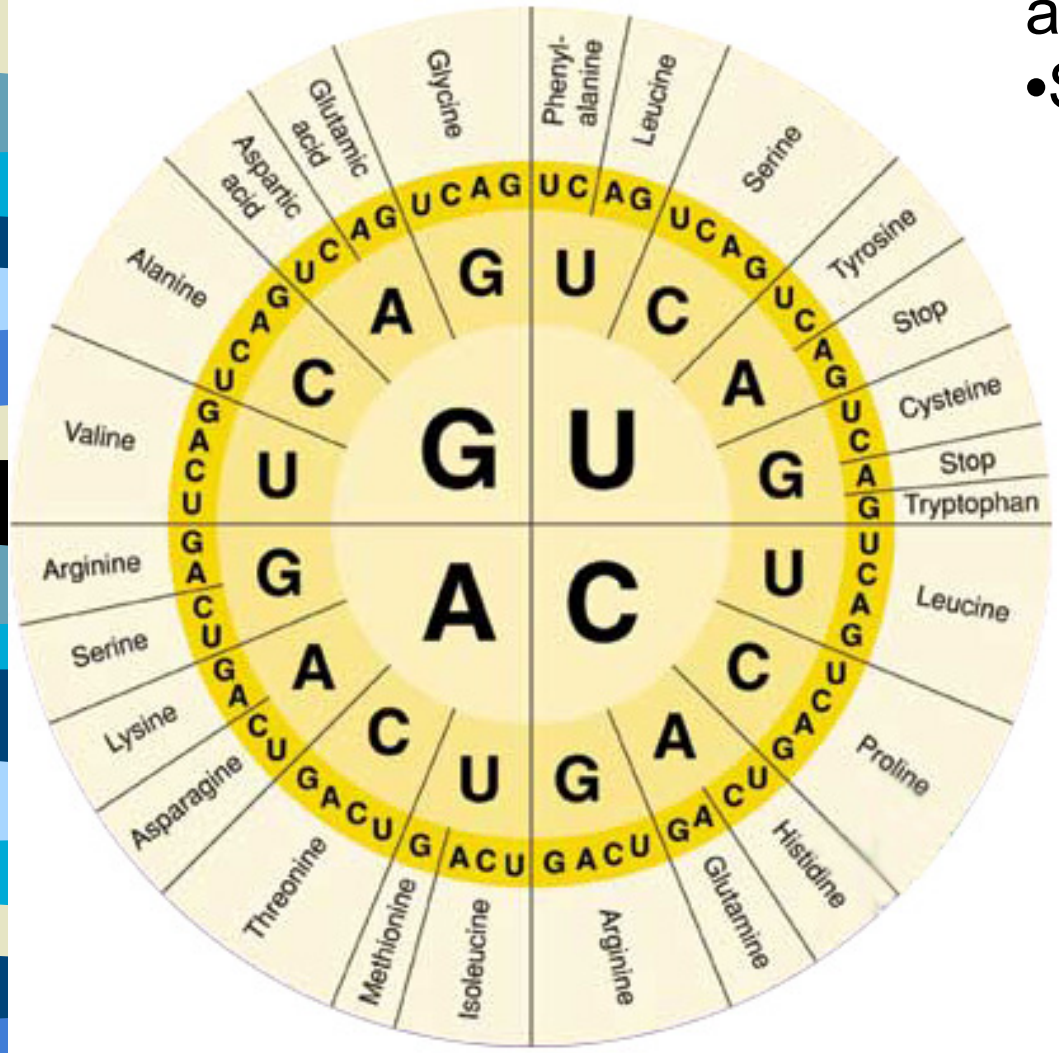
- 3 bases (codon) = 1 amino acid
- Start and stop signals



V. Translation (Protein synthesis)

A. Genetic Code:

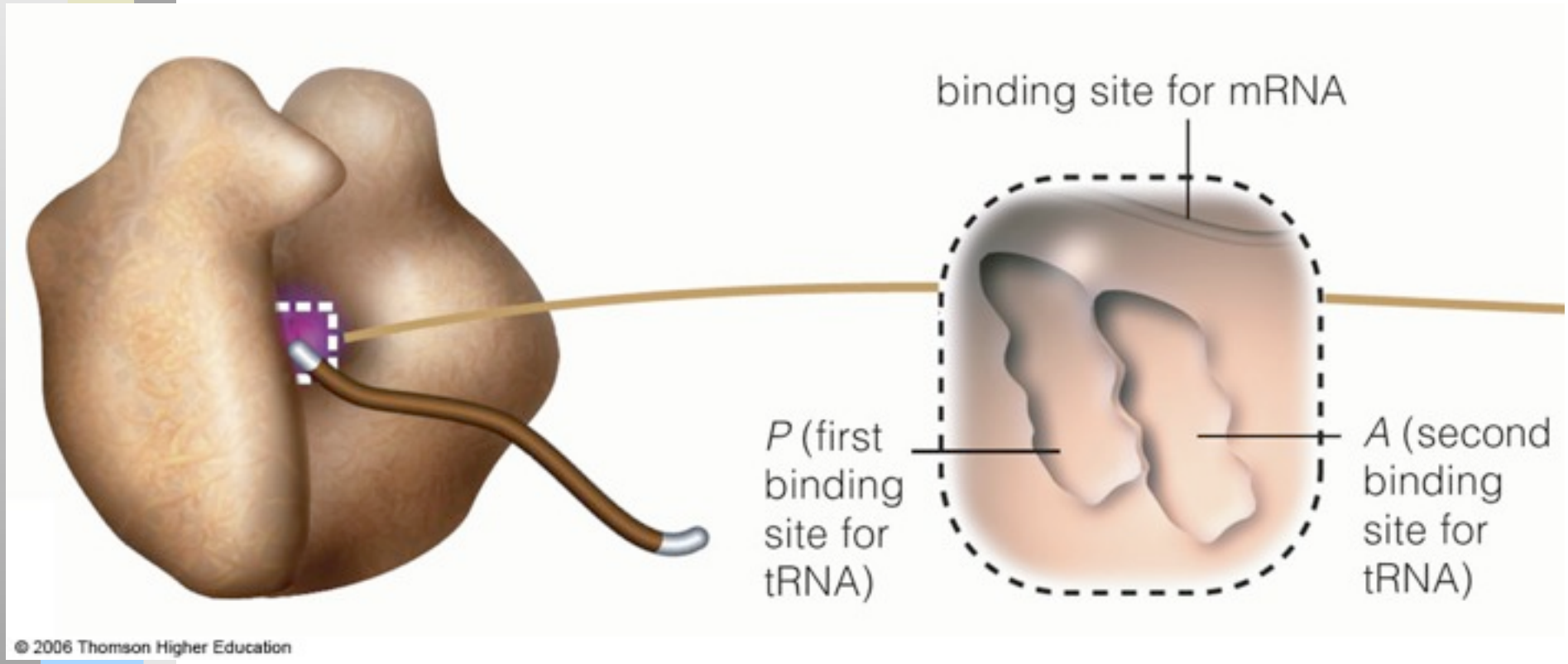
- 3 bases (codon) = 1 amino acid
- Start and stop signals



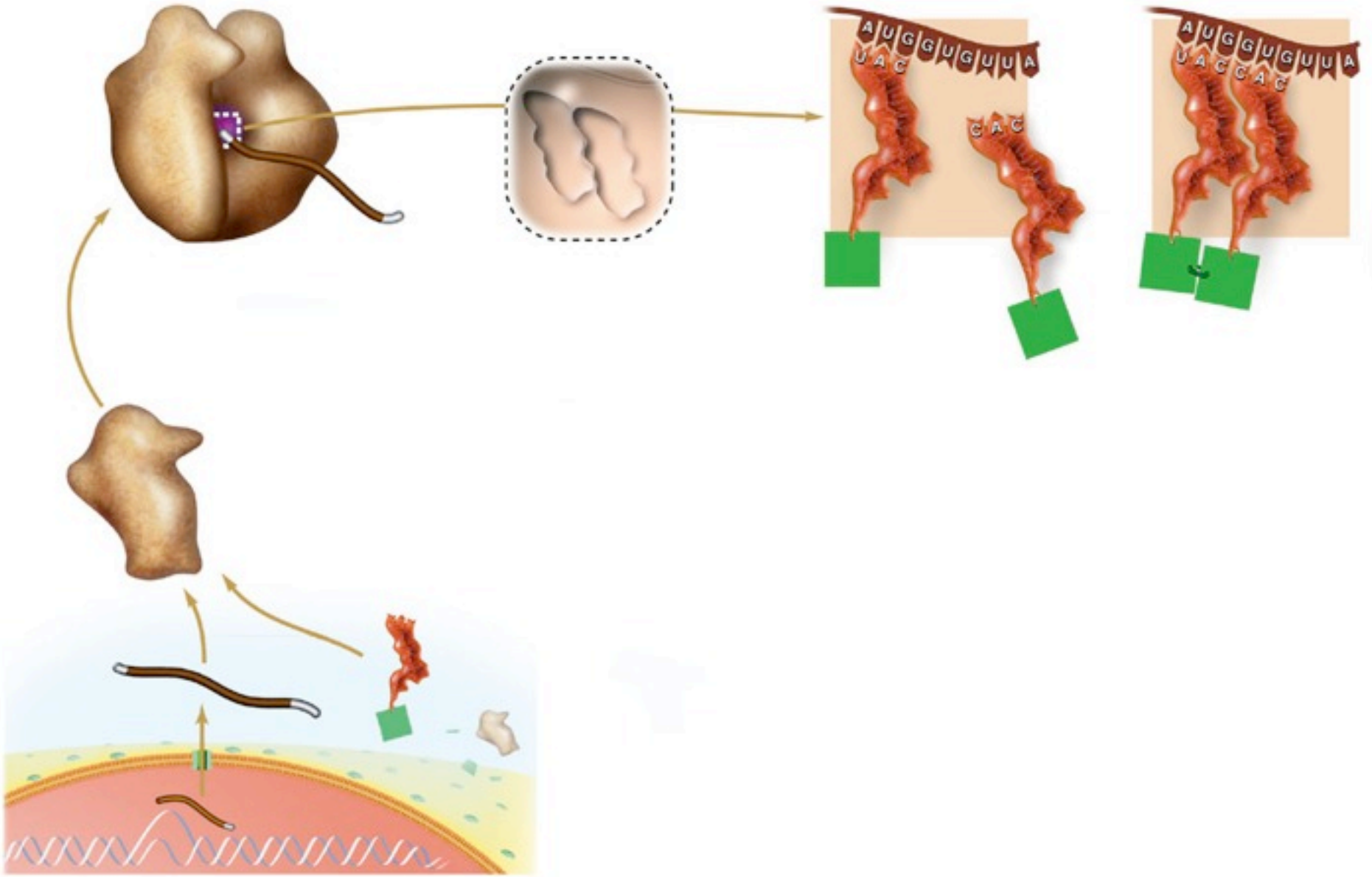
B. Components

- mRNA
- Ribosomes
- tRNAs
- Pool of amino acids

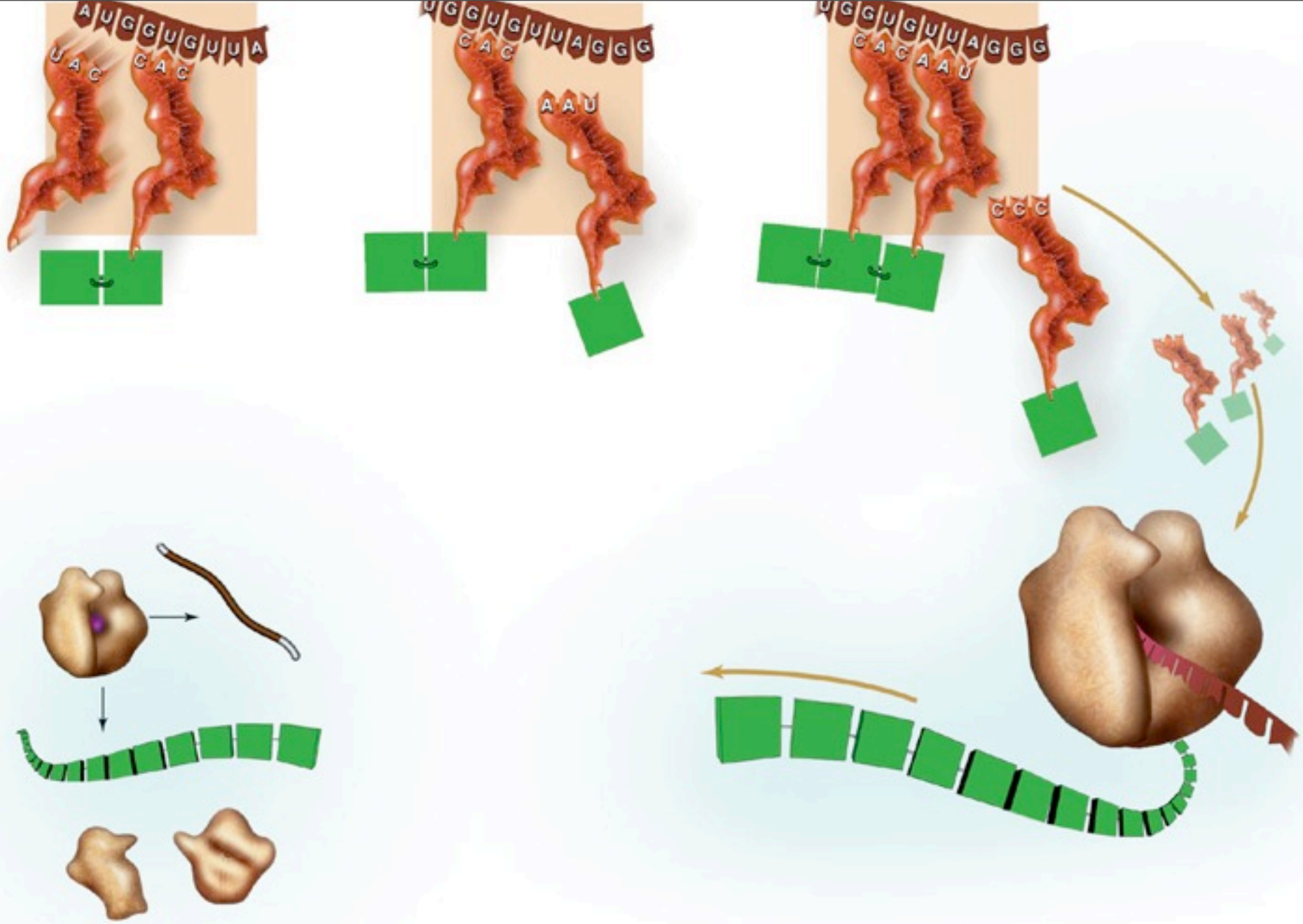
C. Steps



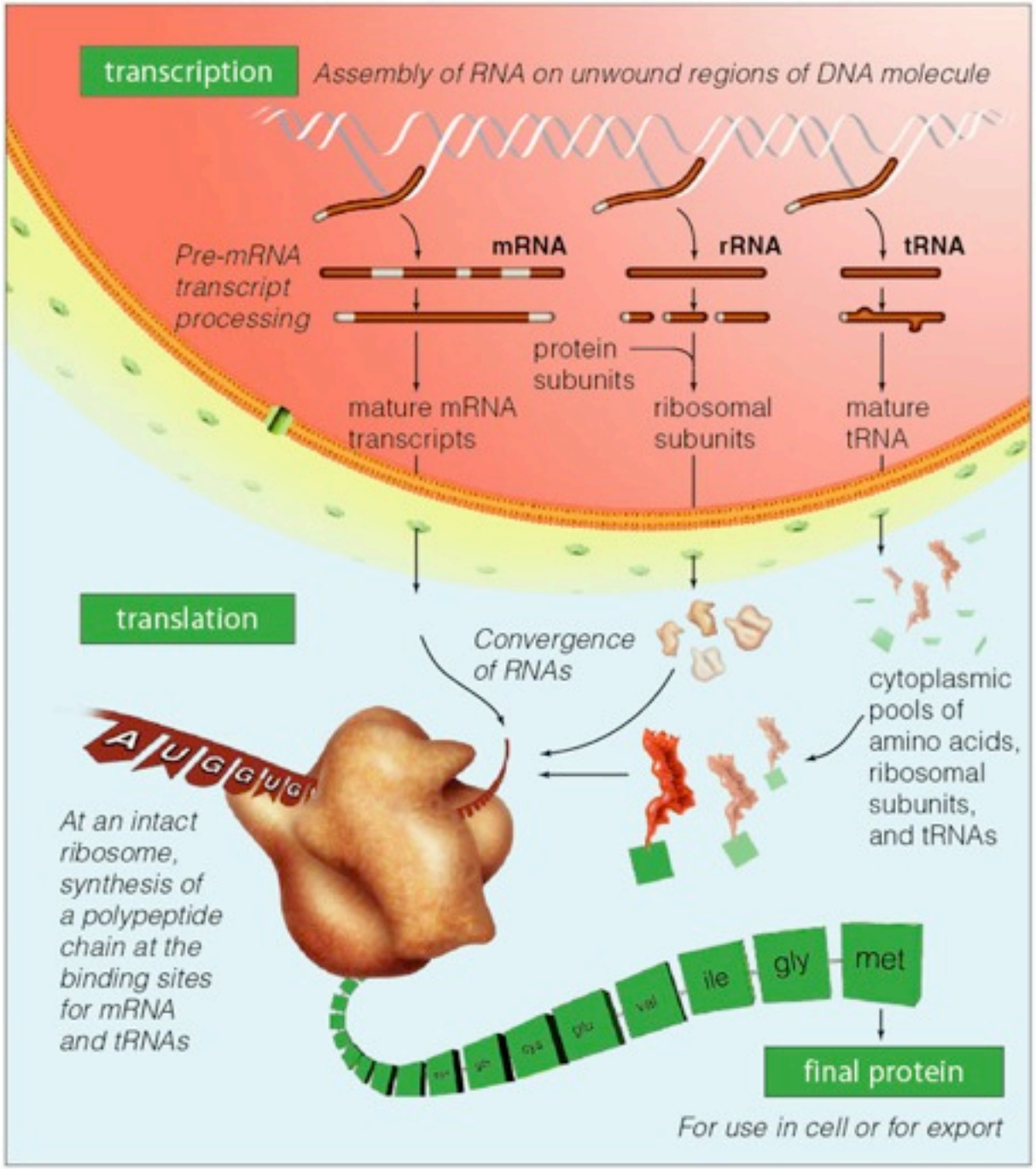
© 2006 Thomson Higher Education



© 2006 Brooks/Cole - Thomson



© 2006 Brooks/Cole - Thomson



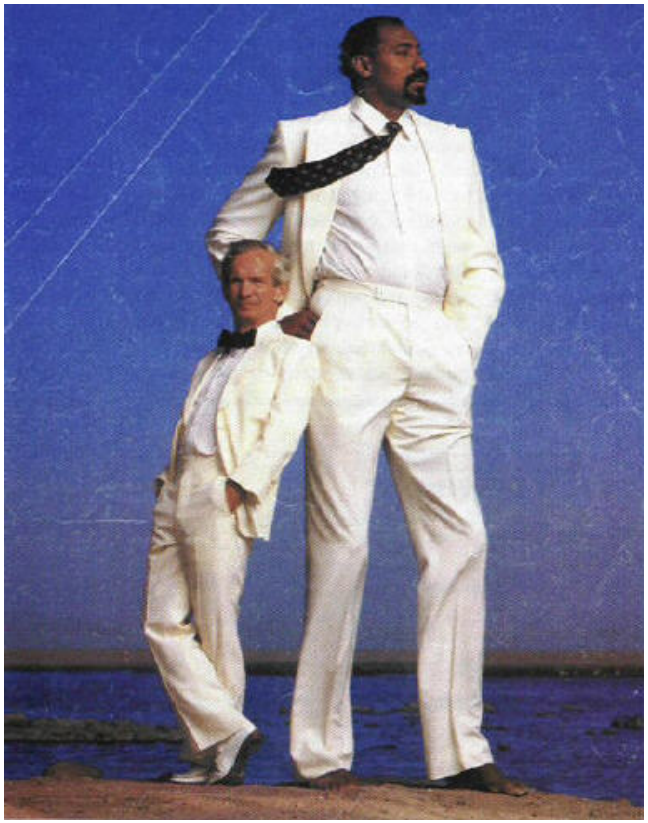
© 2006 Brooks/Cole - Thomson

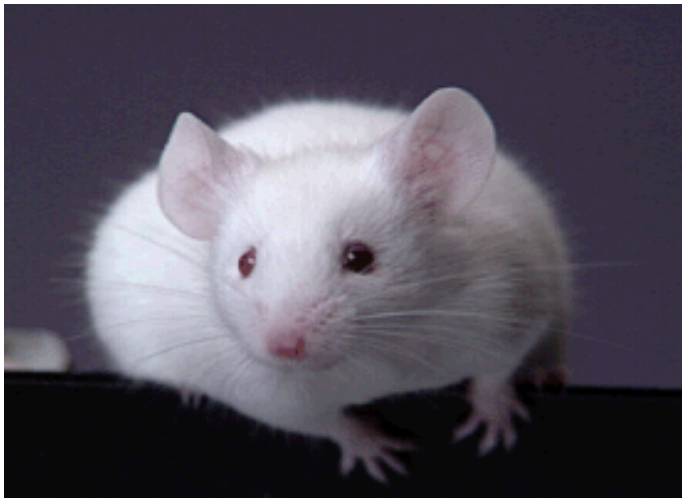
Questions for thought-

Why do we look and act different from each other?
(99.9% of our DNA is the same)

Why do we look and act different from other organisms?
(90% of our DNA is the same as in mice.)

What CAUSES these differences?





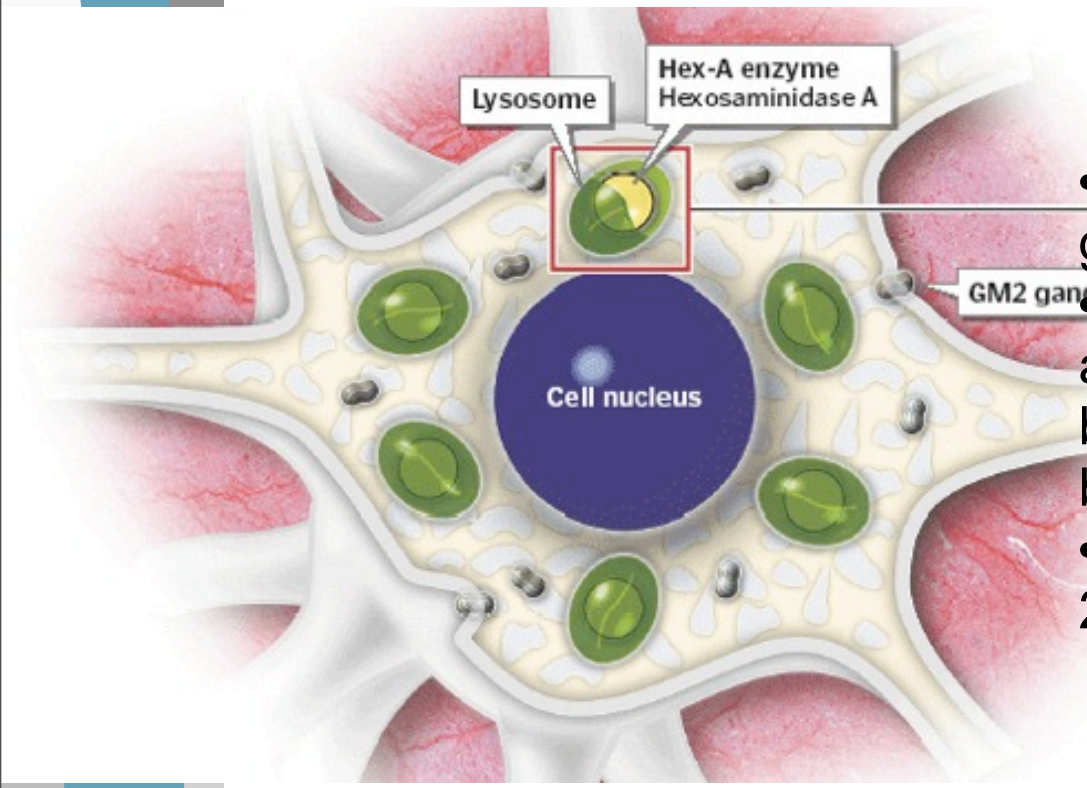
VI. Mutations-

A. Types of Gene or Point Mutations-

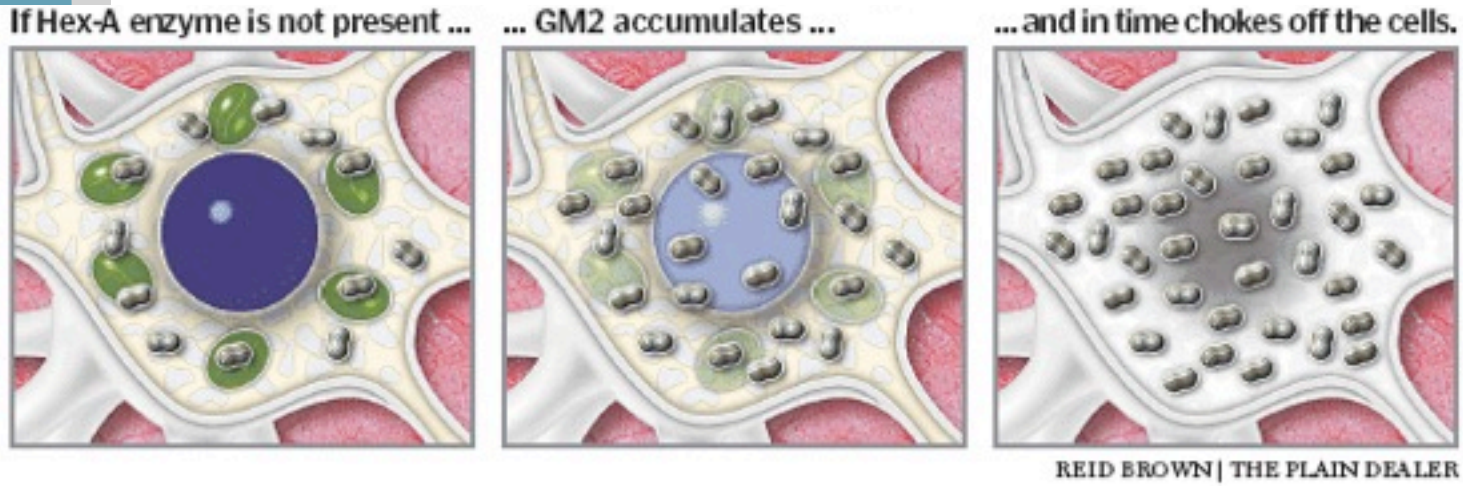
1. Insertion-

extra bases are inserted into the genetic code

ex. Tay-Sachs Disorder



- 4 base insertion in the Hex A gene causes Tay-Sachs
- The gene normally codes for an enzyme in lysosomes that breaks down the food that brain cells eat- GM2- a lipid
- Leads to slow brain death by 2 years of age

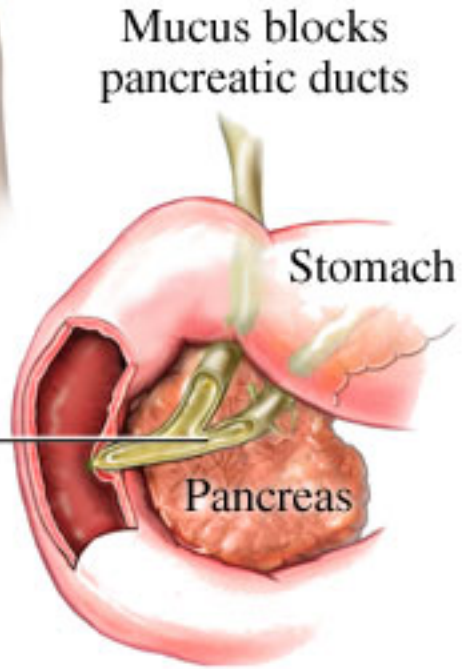


2. Deletion- extra bases are deleted from the genetic code

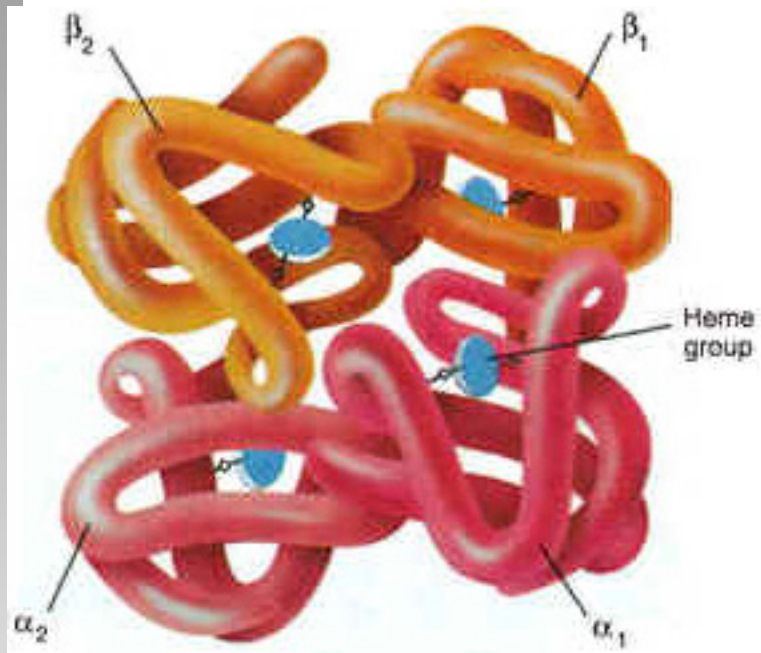
ex. Cystic fibrosis

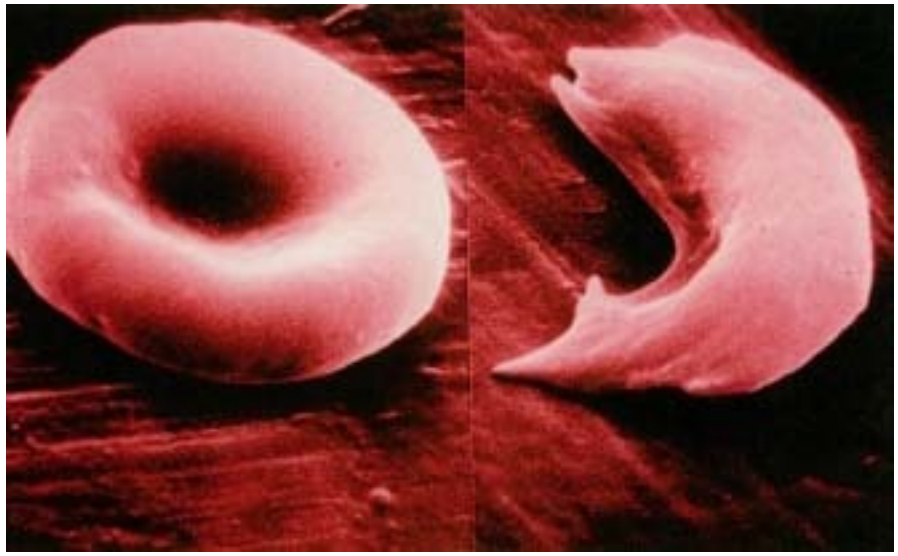
- 3 base deletion in gene for a Cl- transport protein
- The protein normally has 1480 amino acids
- 1/20 Caucasians are carriers

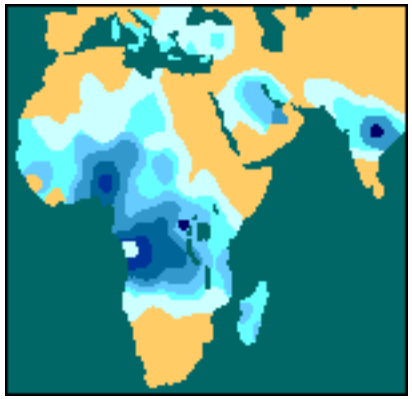
Mucus blocks air sacs (alveoli) in the lungs



3. Substitution-a base or many bases are swapped in the DNA code
   ex. Sickle-cell disease



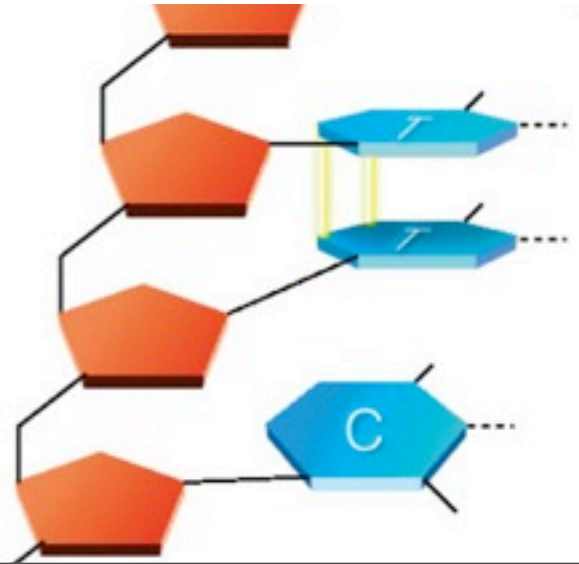




- 6th codon CTC ➔ CAC in beta-globin gene
- 1/12 African Americans are carriers

B. Causes

1. Radiation- nuclear, UV, x-ray
2. Viruses and other microorganisms
3. Environmental poisons- formaldehyde, nicotine, asbestos
4. Alcohol and diet?
5. Random mistakes



C. Effects

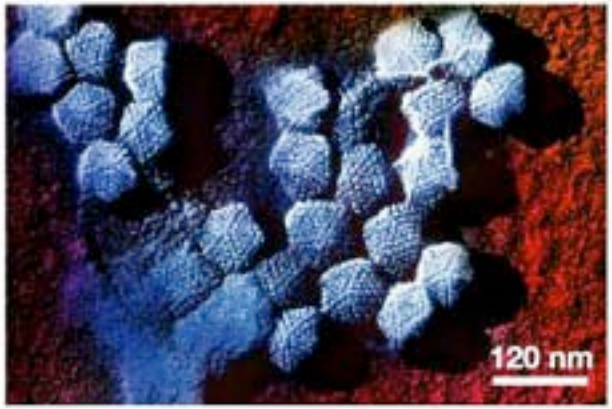
1. Harmful
2. Neutral
3. Beneficial

VII. Viruses

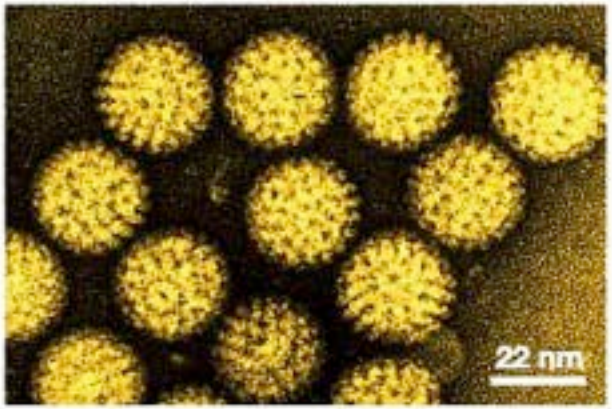
NON-CELLULAR

Ebola virus

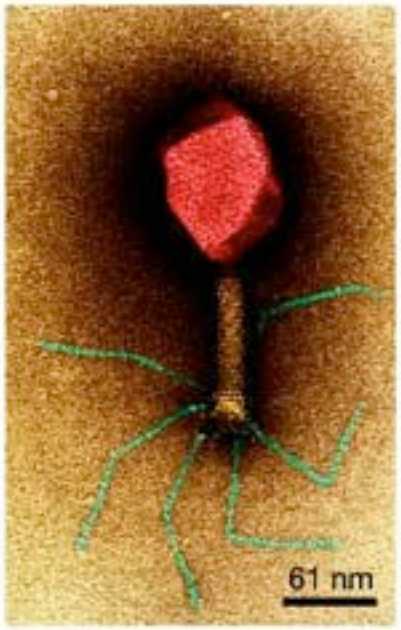
tobacco mosaic virus



adenovirus

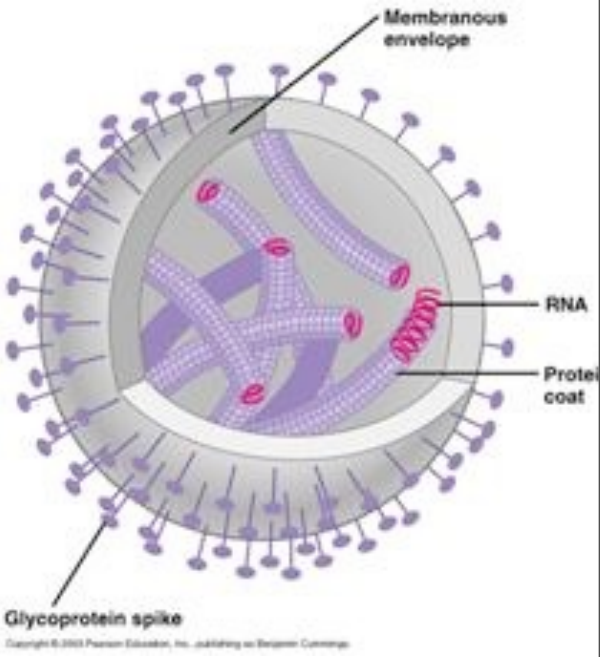


influenza virus



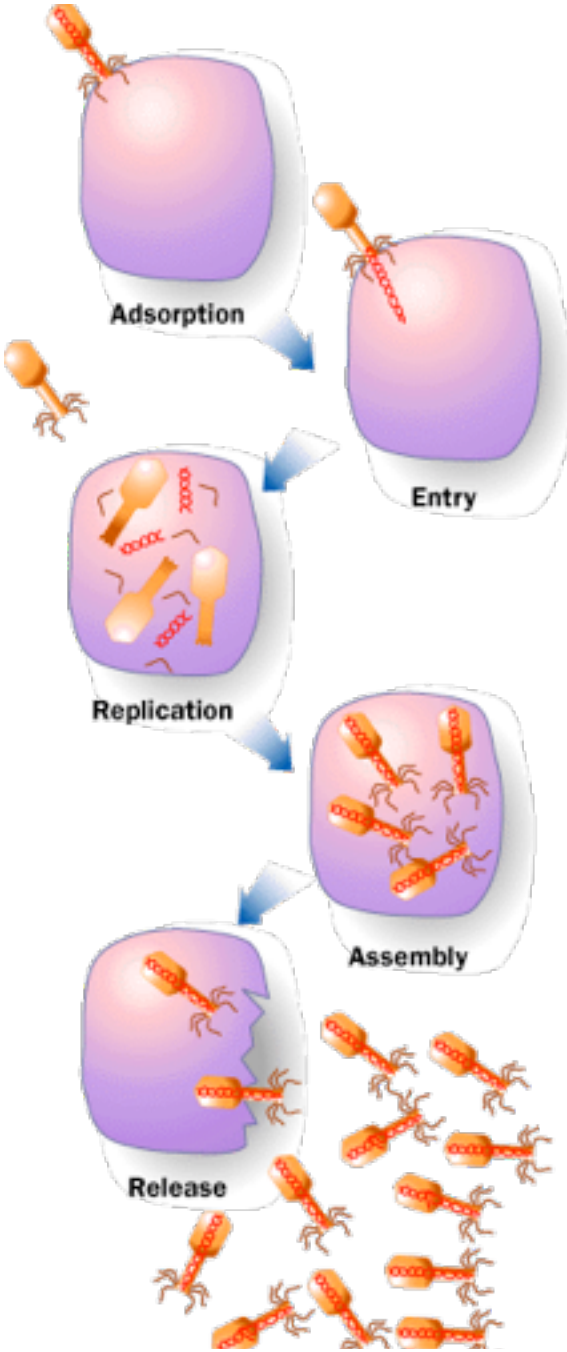
bacteriophage T4

A. Characteristics
   1. Protein capsule and nucleic acid (DNA or RNA) core
   2. Obligate parasite-
      is a parasite that cannot complete its life cycle without exploiting a suitable host.

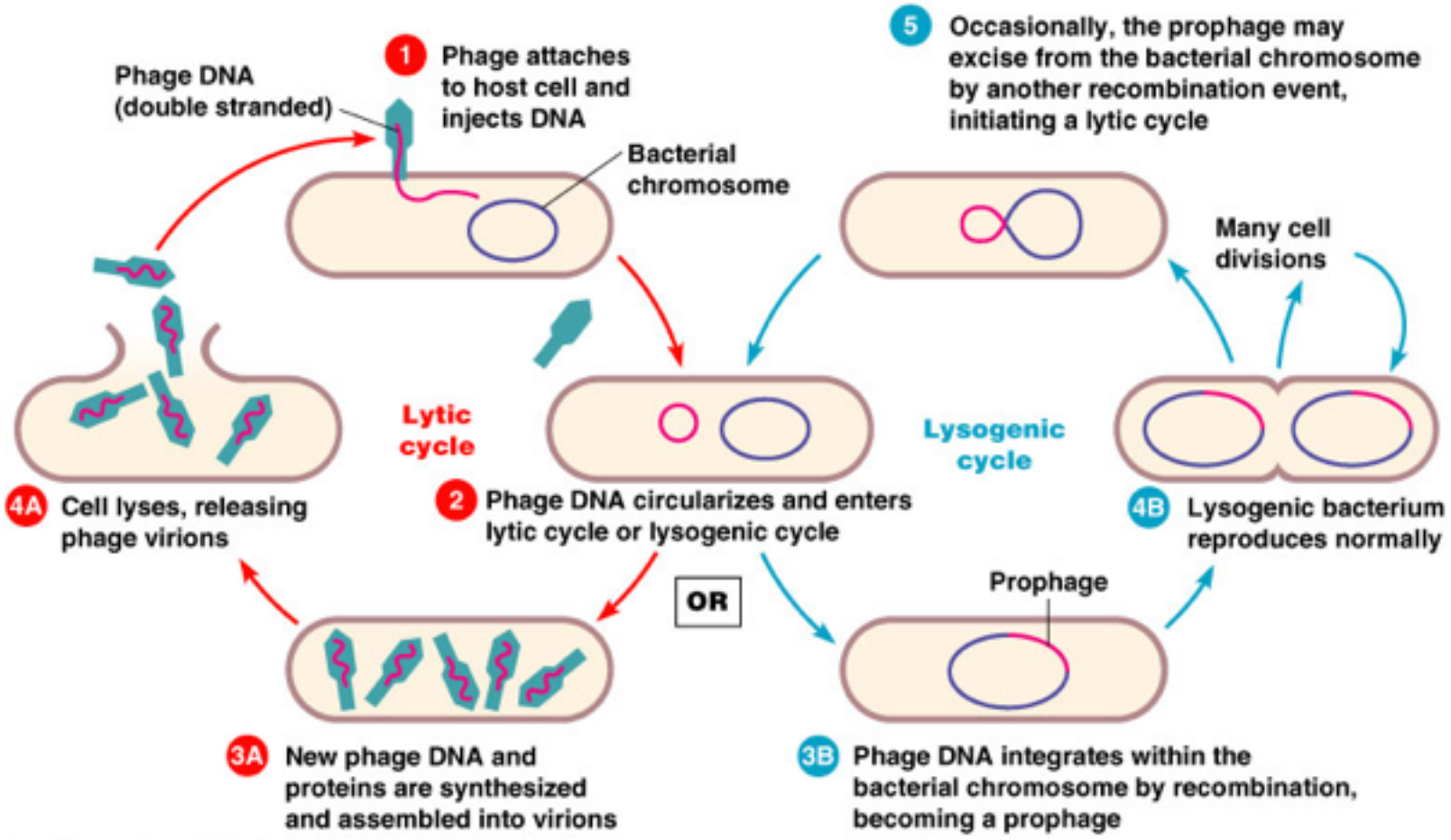


B. Actions in Host Cells
   1. Lytic Cycle- *get ready to draw* ☺
   2. Lysogenic Cycle-

Lytic Pathway:

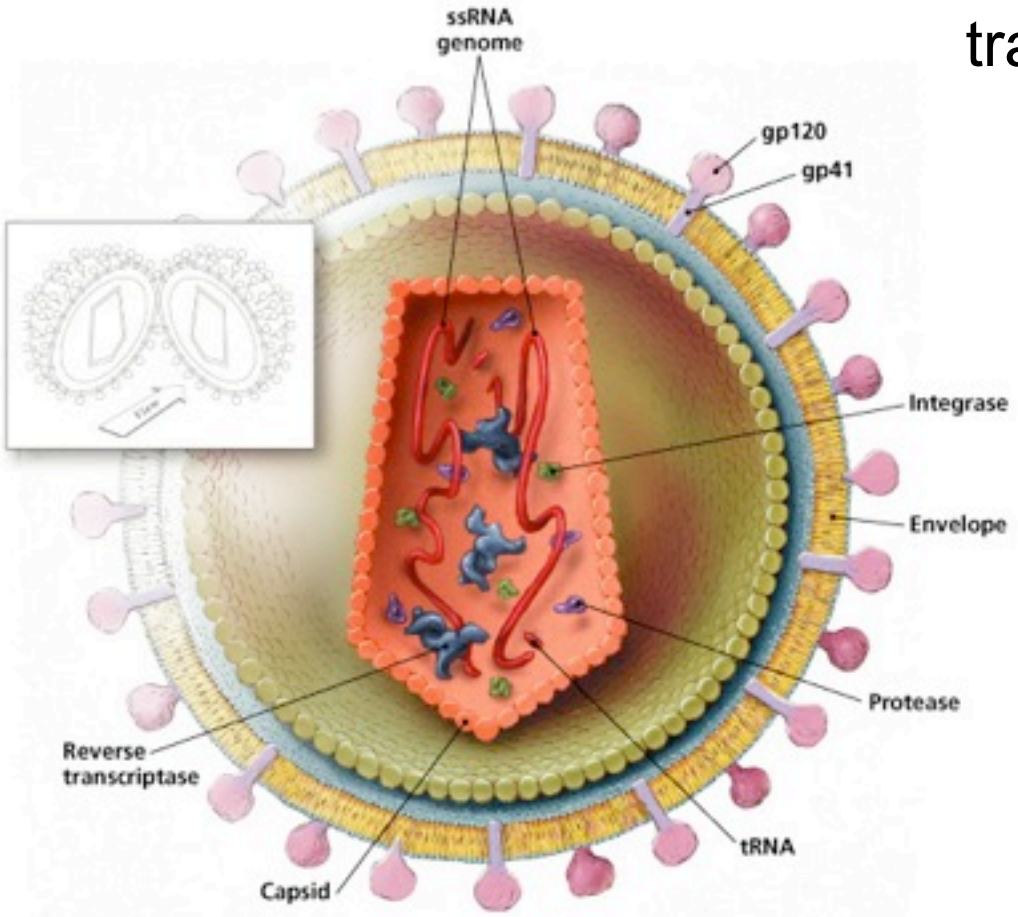


Lytic and Lysogenic Pathway

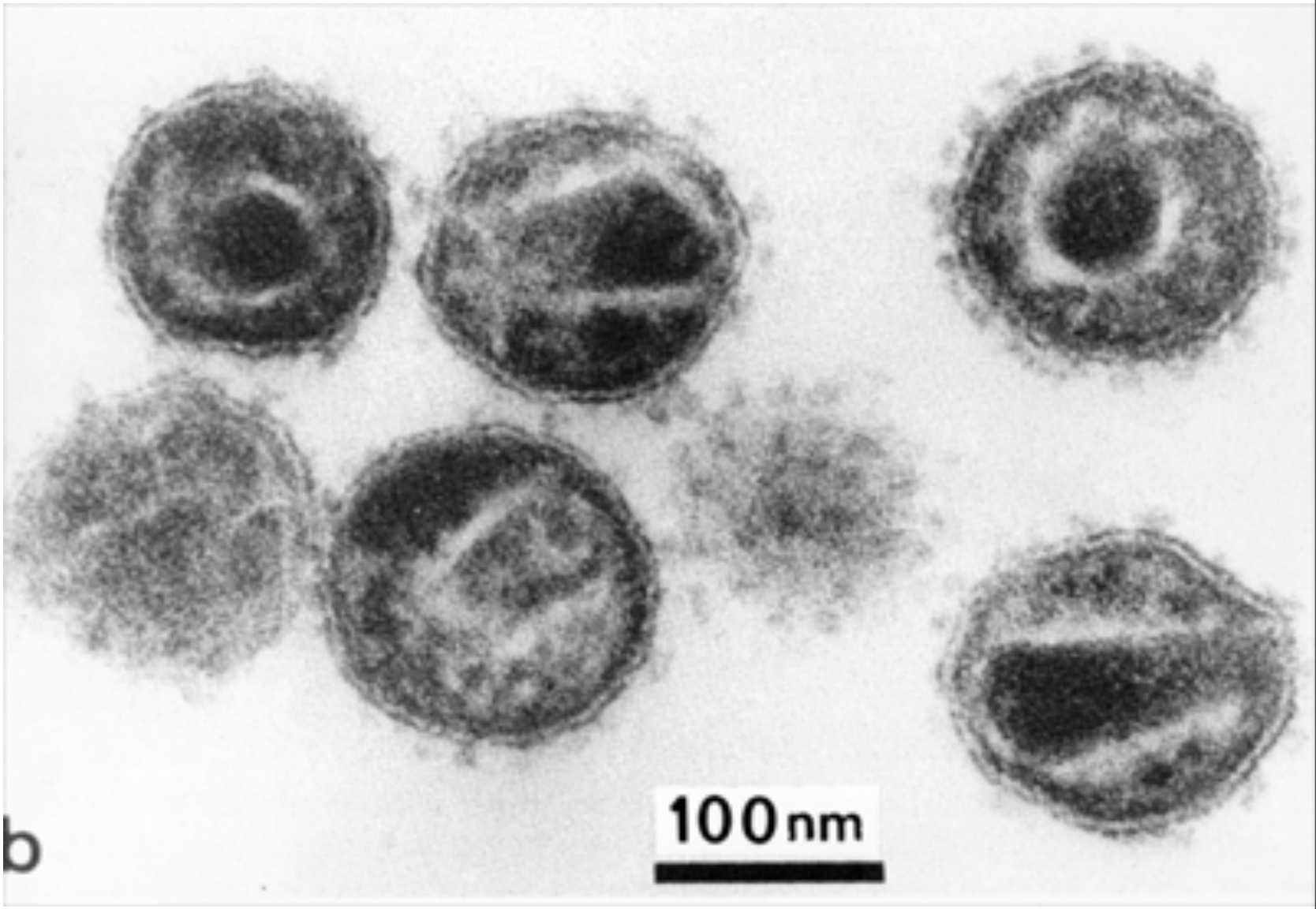


Copyright © 2004 Pearson Education, Inc., publishing as Benjamin Cummings.

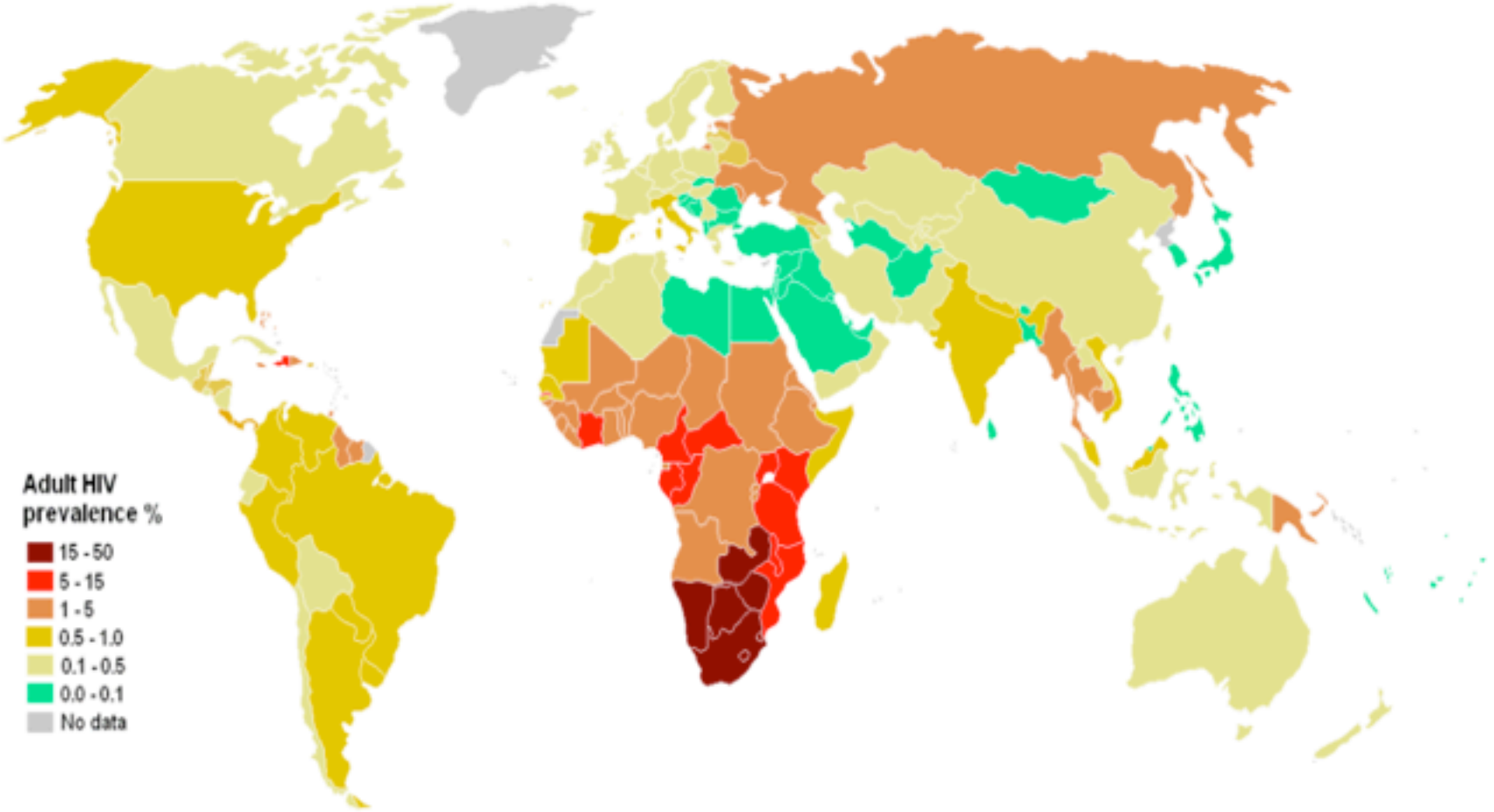
C. Special Case- HIV- retrovirus

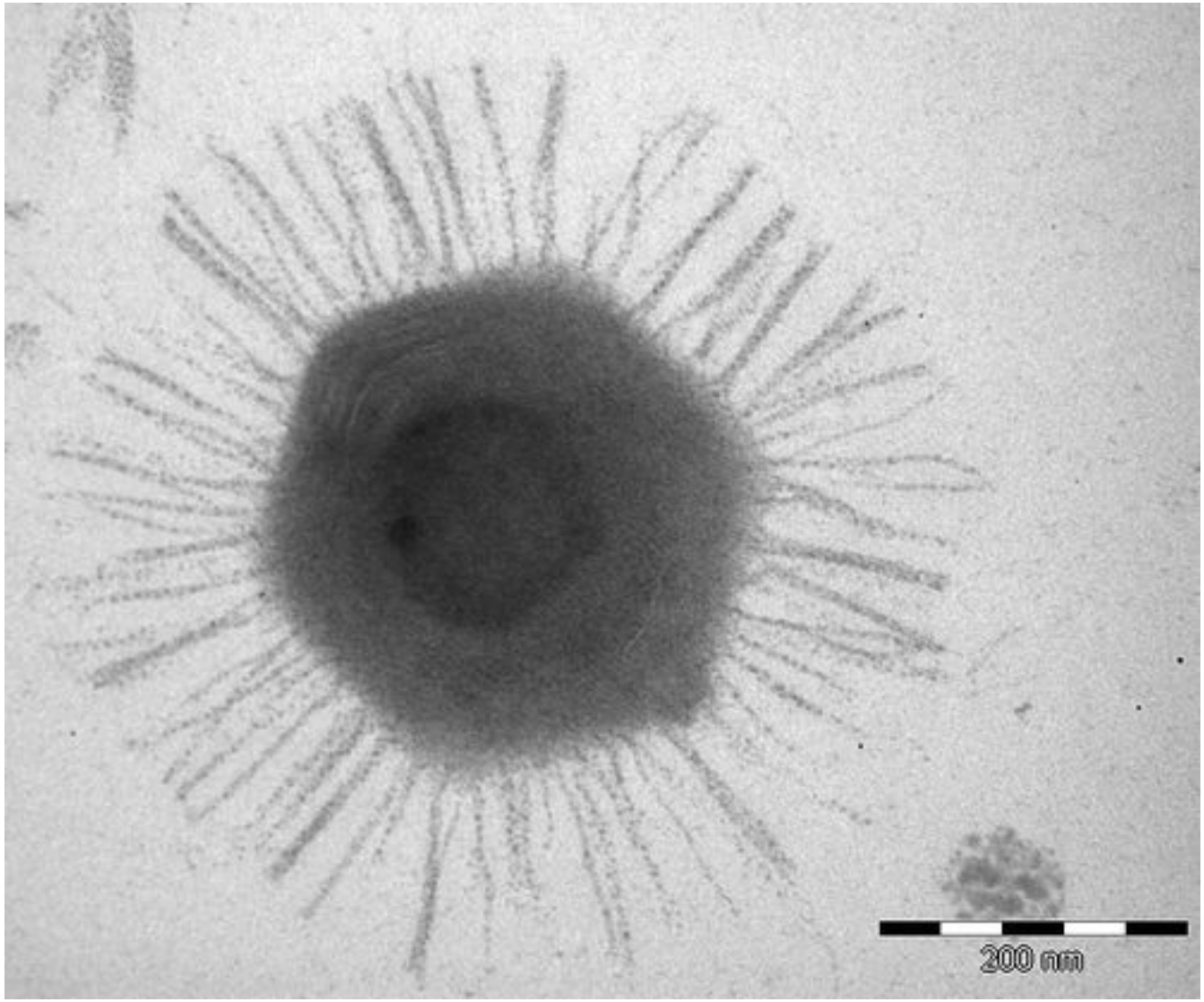


Features: Reverse transcriptase


b
100 nm

6. Epidemiology-





Mimivirus…….