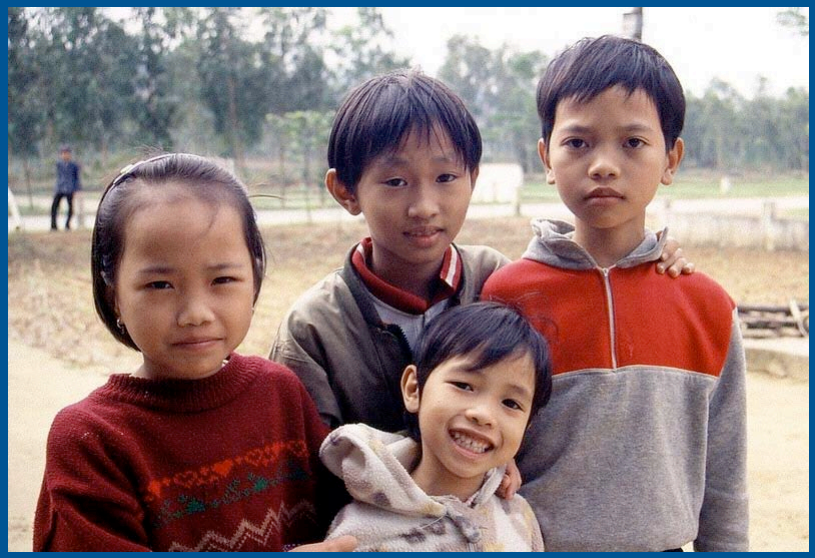
Comparing Humans From Different Places

Ethiopia

Vietnam



India

Iraq

Comparing External Structures

Fruit Fly

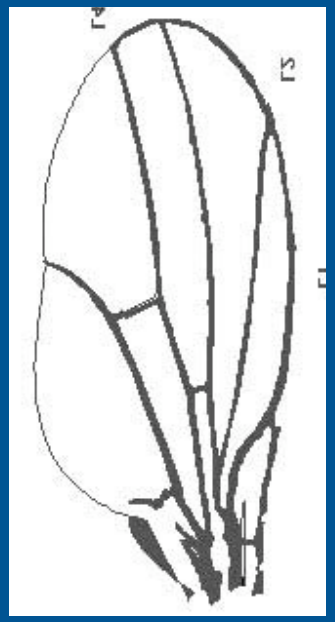
Mouse

Human

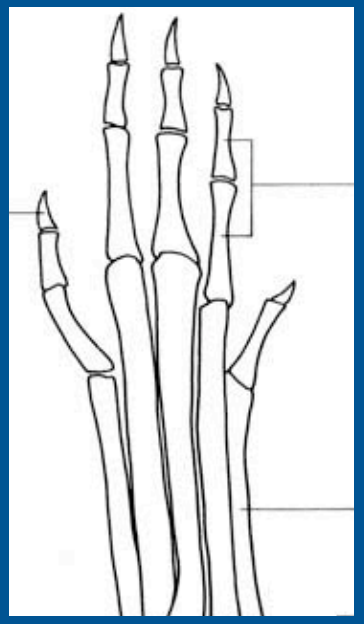
Chimpanzee

Comparing Limbs

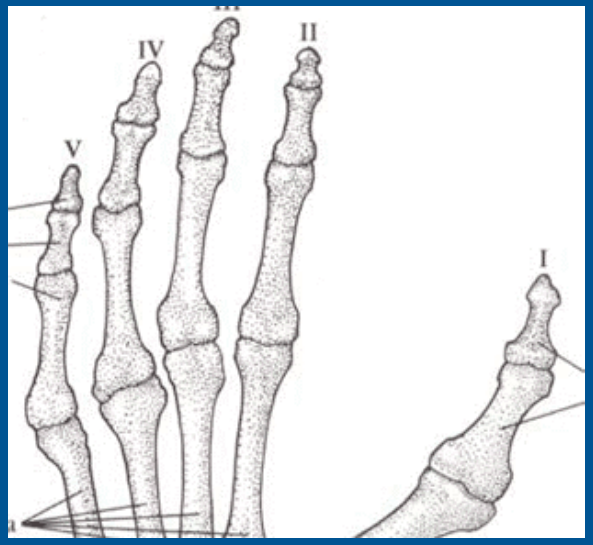
Fruit fly wing



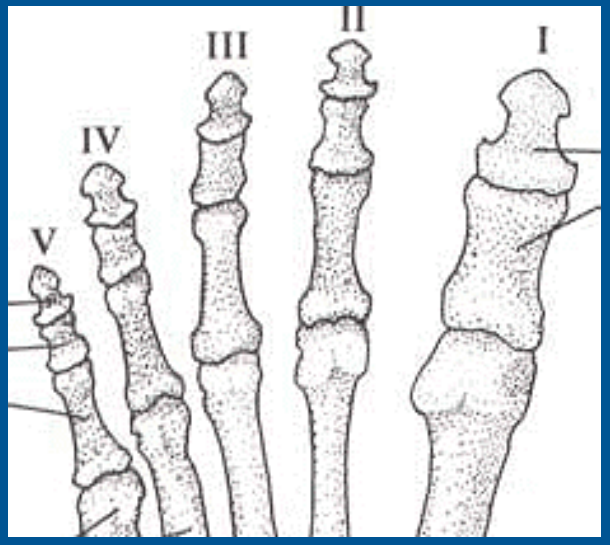
Mouse hind foot



Chimpanzee foot



Human foot

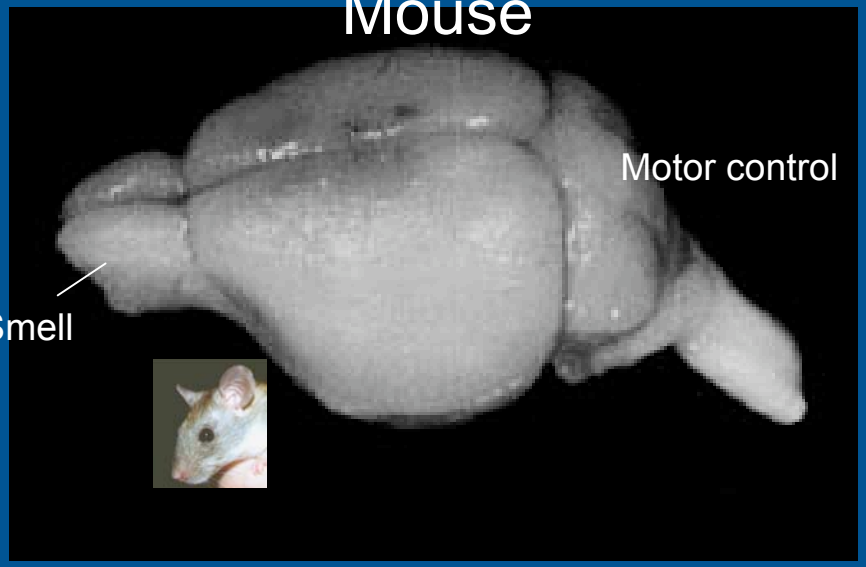


Not to scale!

Comparing Brains

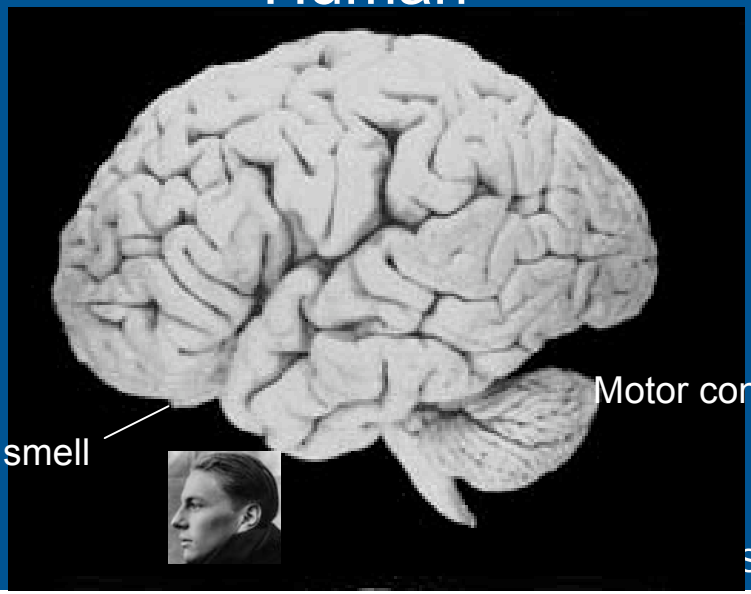
Fly

Mouse



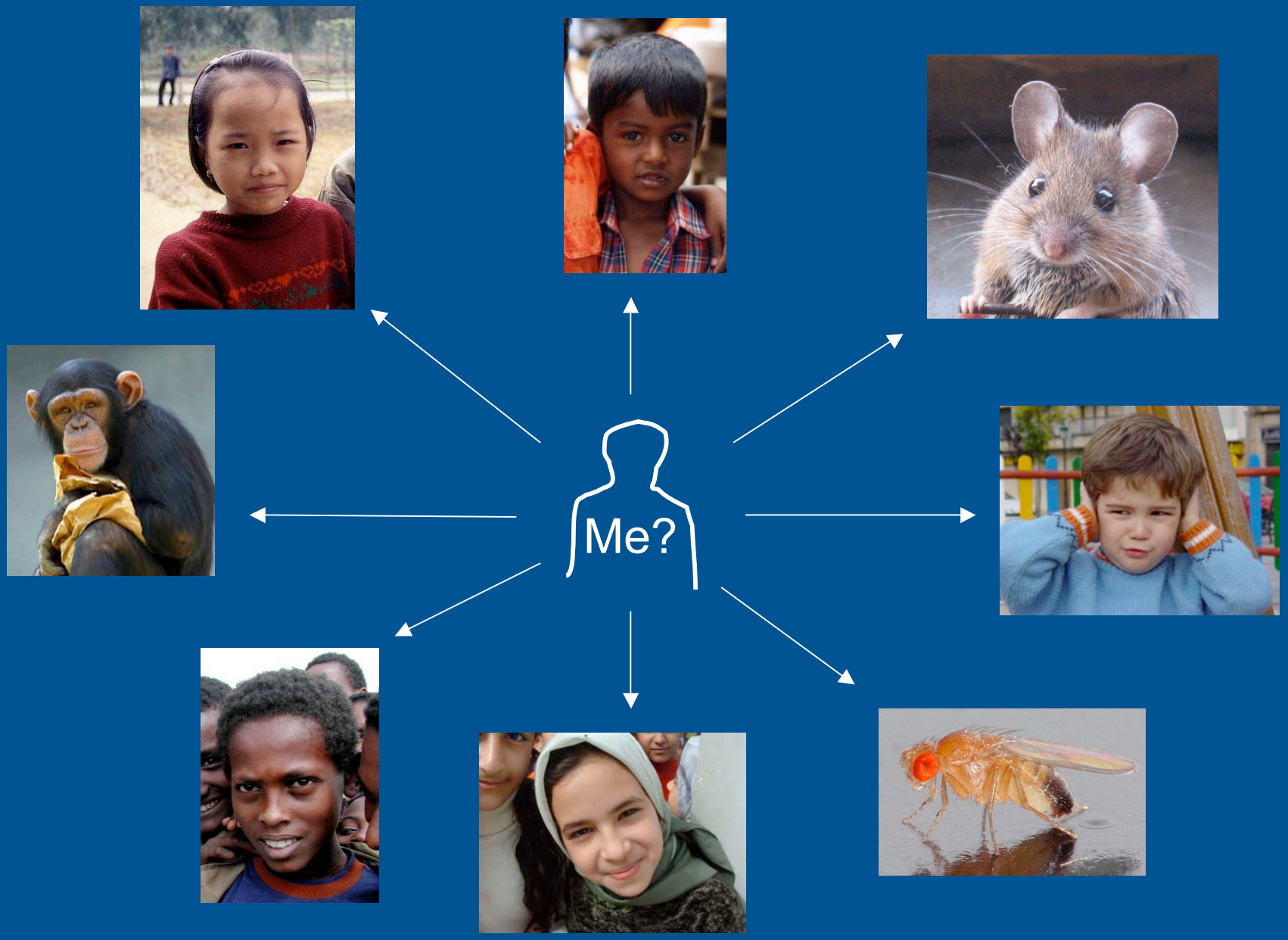
Chimpanzee

Human

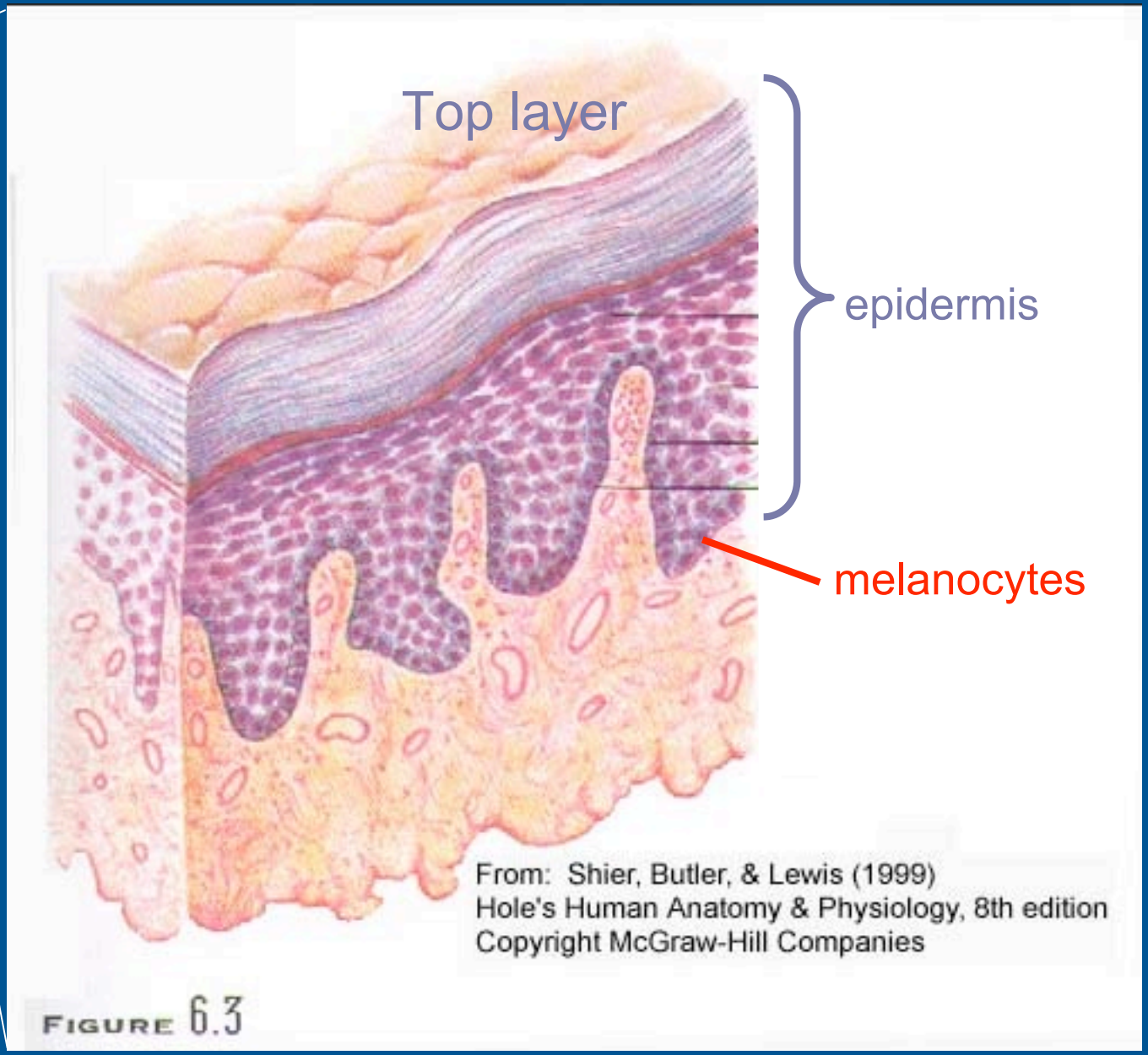


Not to scale!

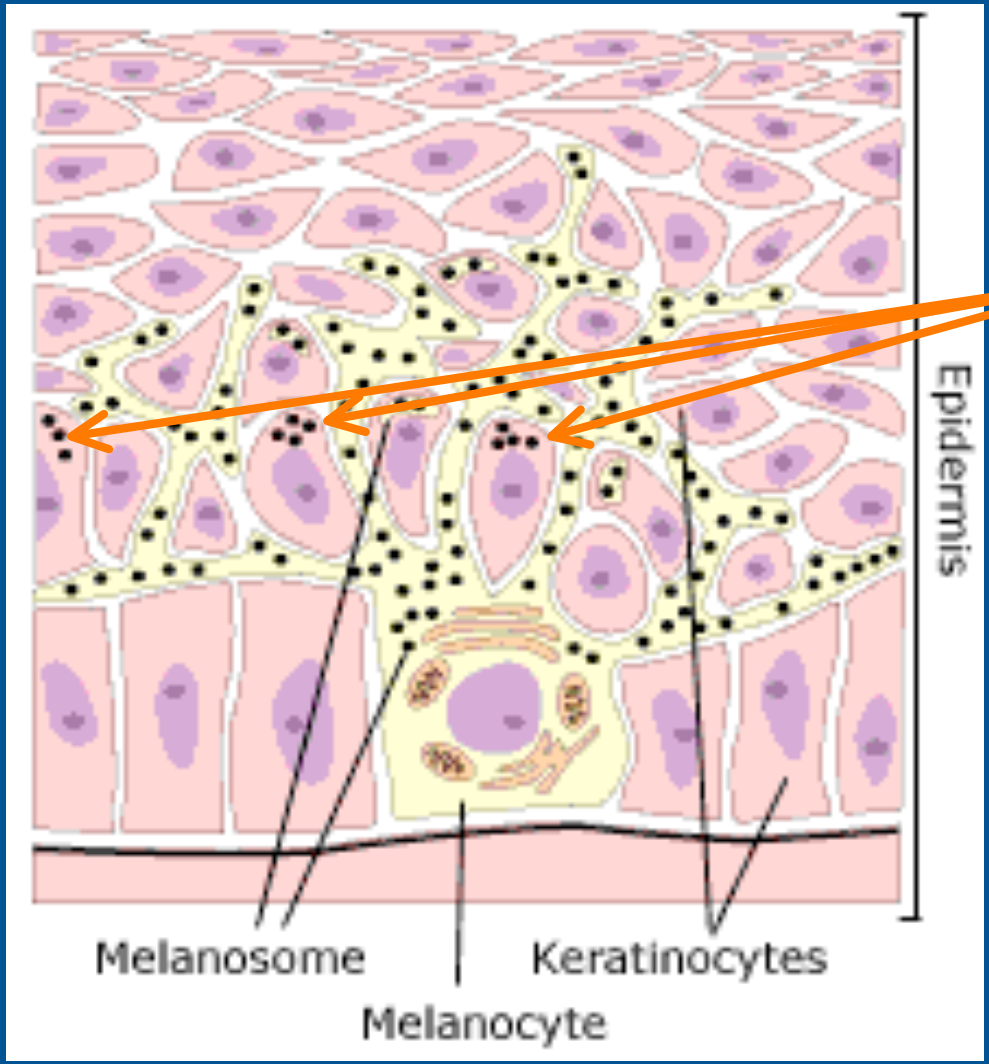
How Similar or Different are We From Each Other?



Cross Section of Skin



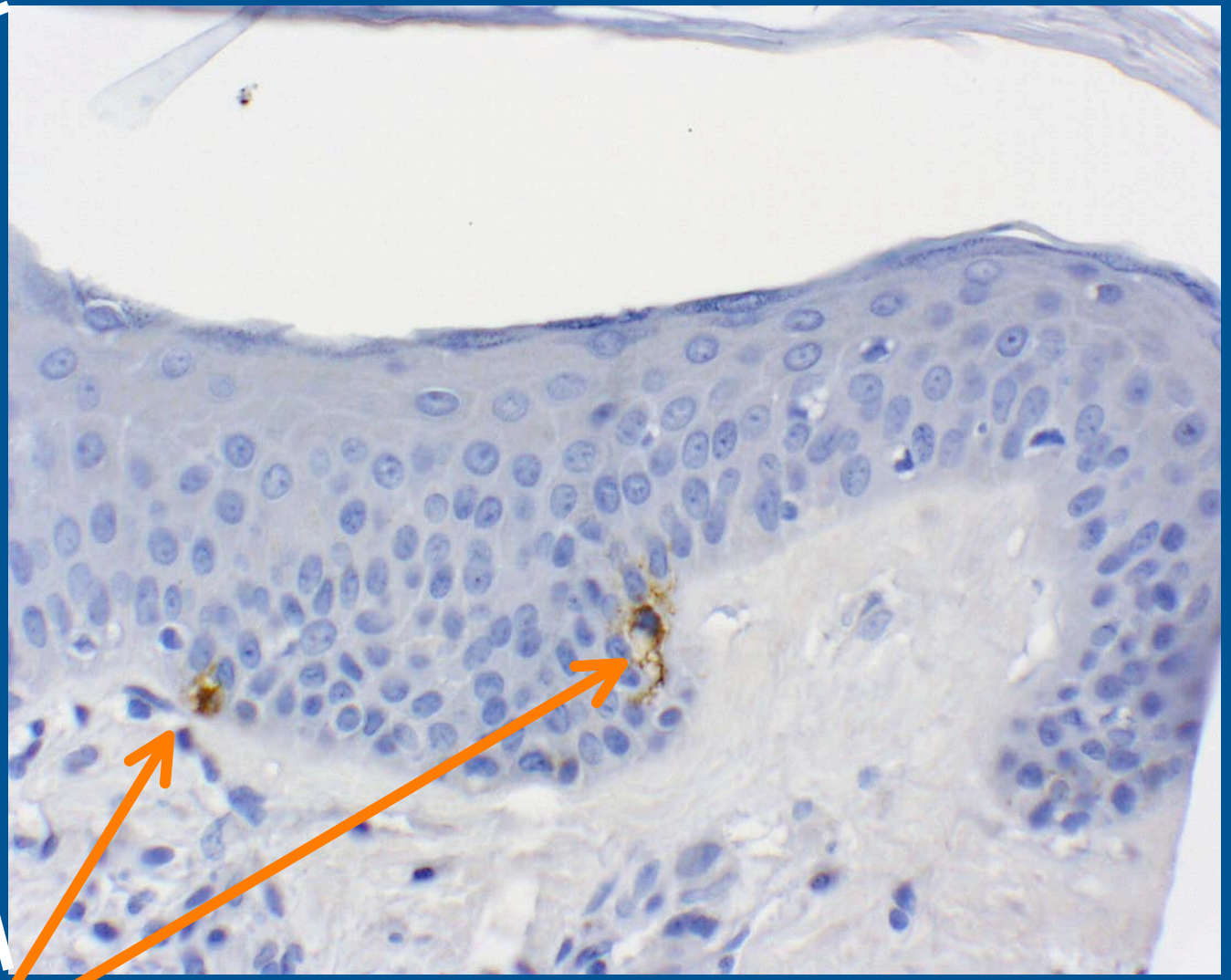
Cross section of Epidermis: Blow up



Melanin taken up by keratinocytes

Based on what you know about skin cells, predict what could be the difference between light skin and dark skin.

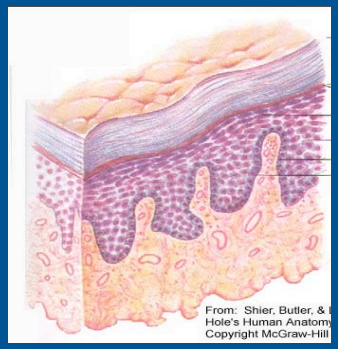
Melanocytes



courtesy of Laura P. Hale, M.D. Ph.D., Duke University

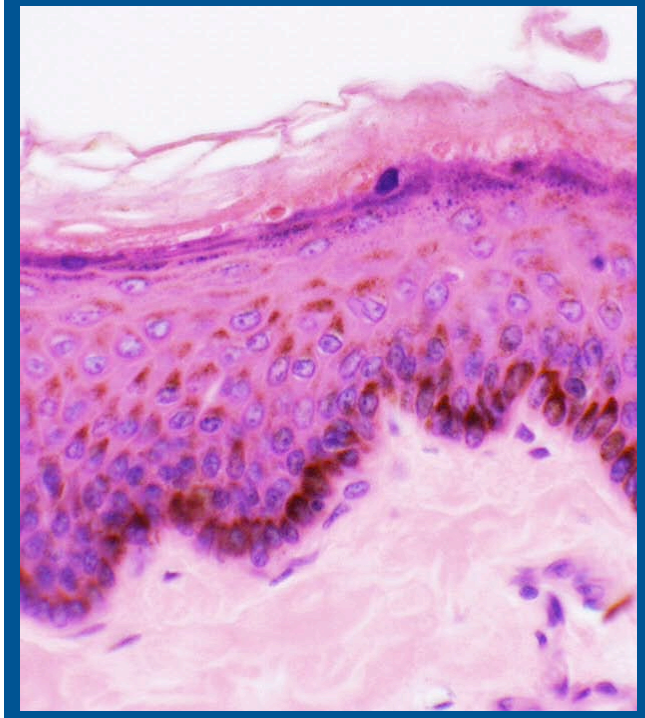
melanocytes

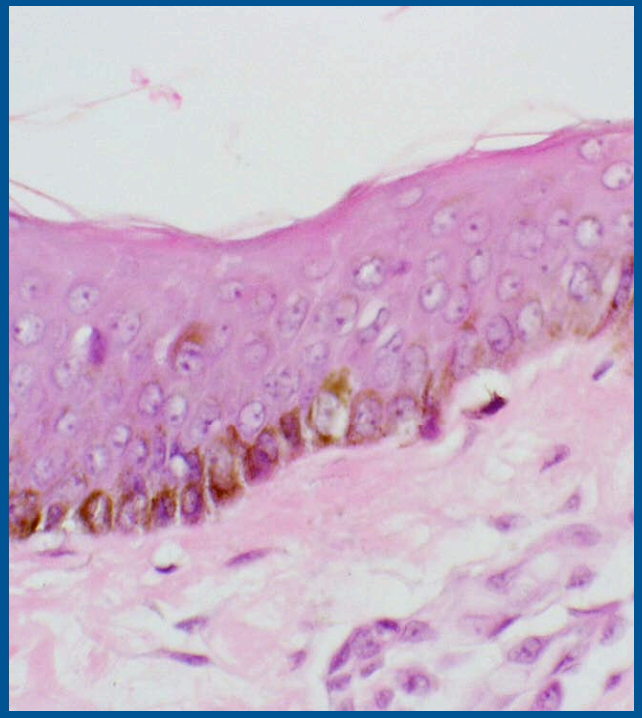
Skin Samples

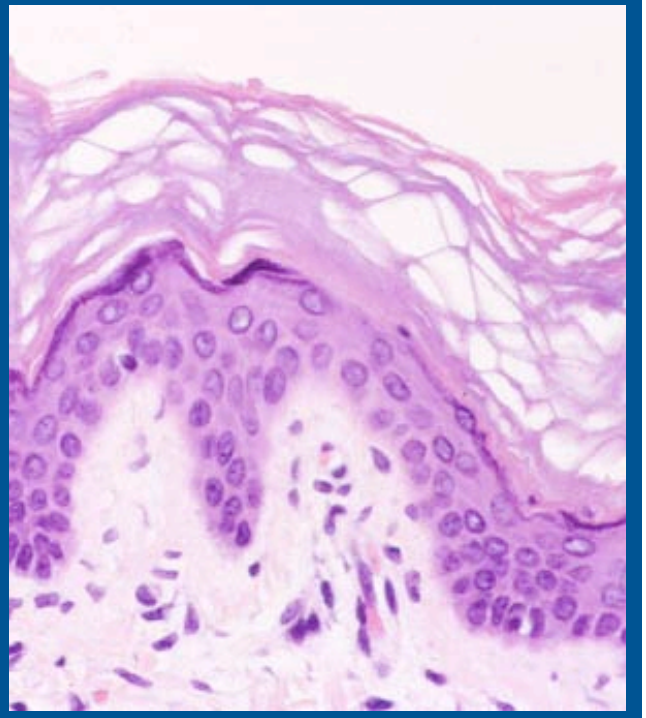


darkest skin color

lightest skin color



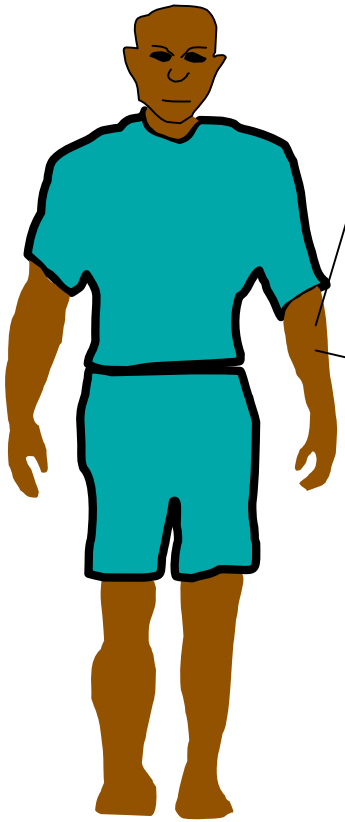




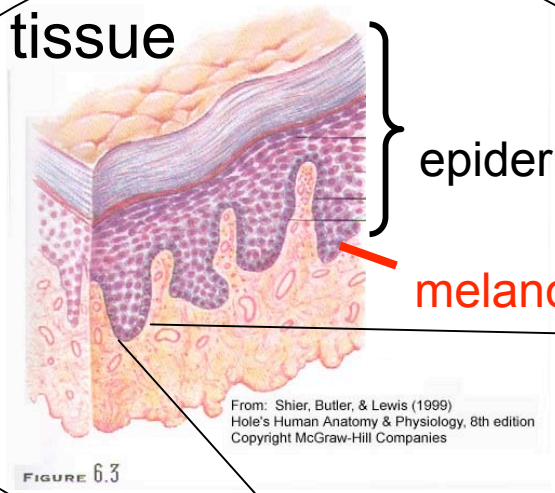
courtesy of Laura P. Hale, M.D. Ph.D., Duke University

Special Skin Cells Make Melanin

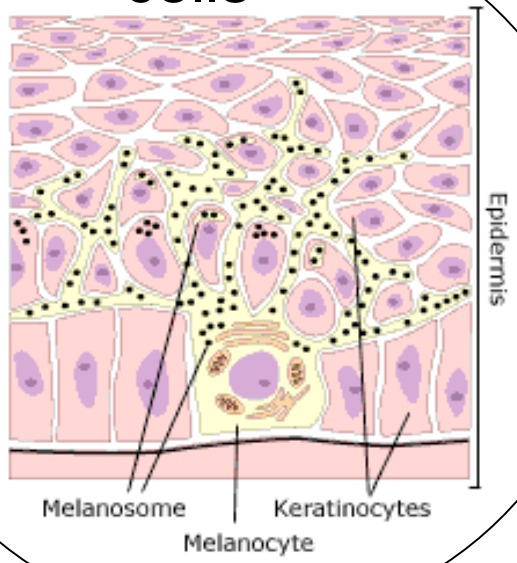
body



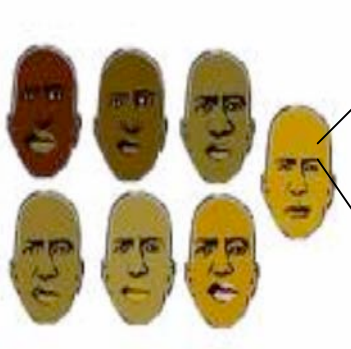
tissue



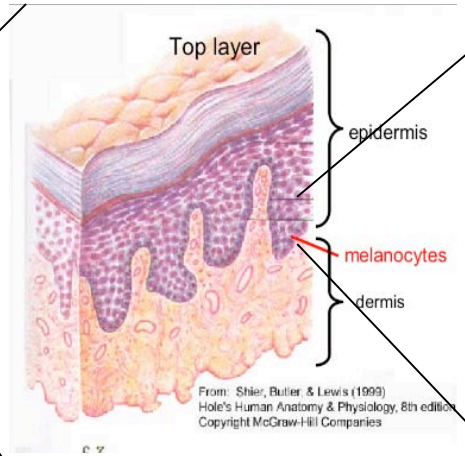
cells



How is melanin made inside the melanocytes?

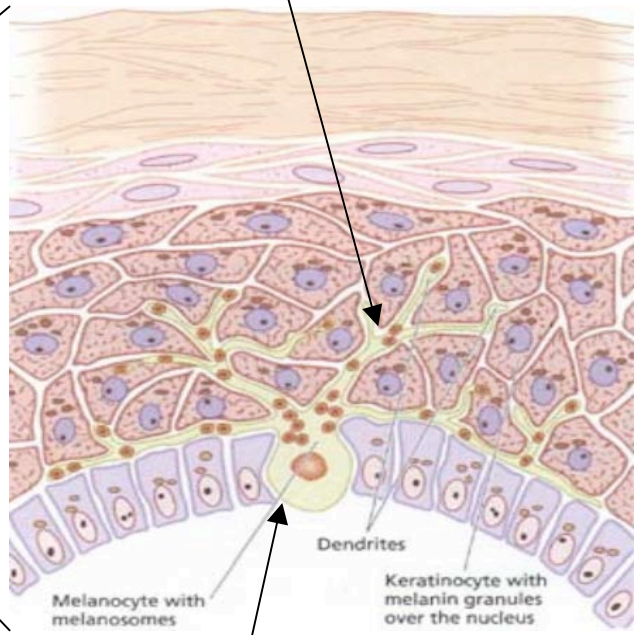


Skin Colors



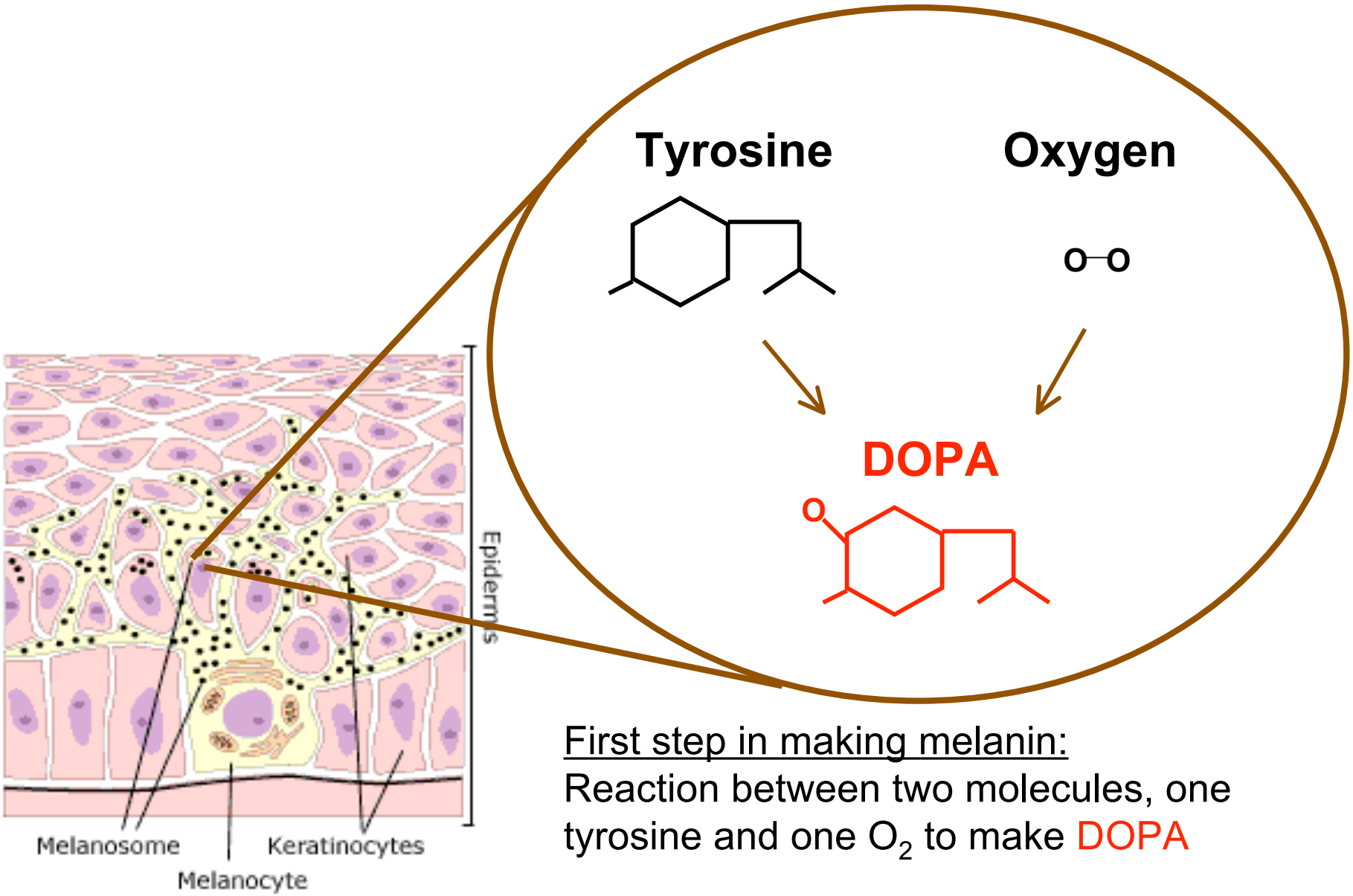
Cross Section of Skin Tissue

Melanin

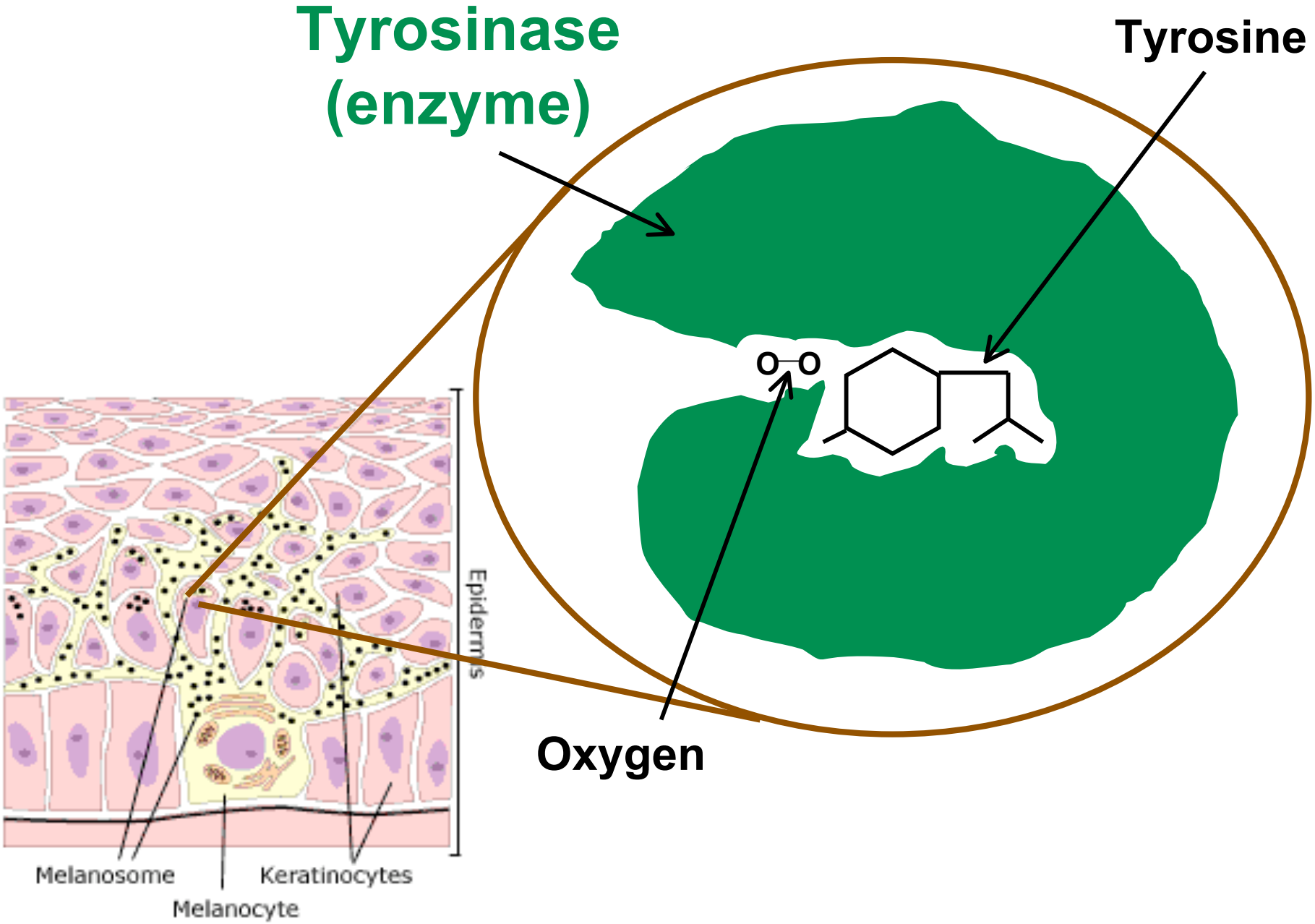


Melanocyte

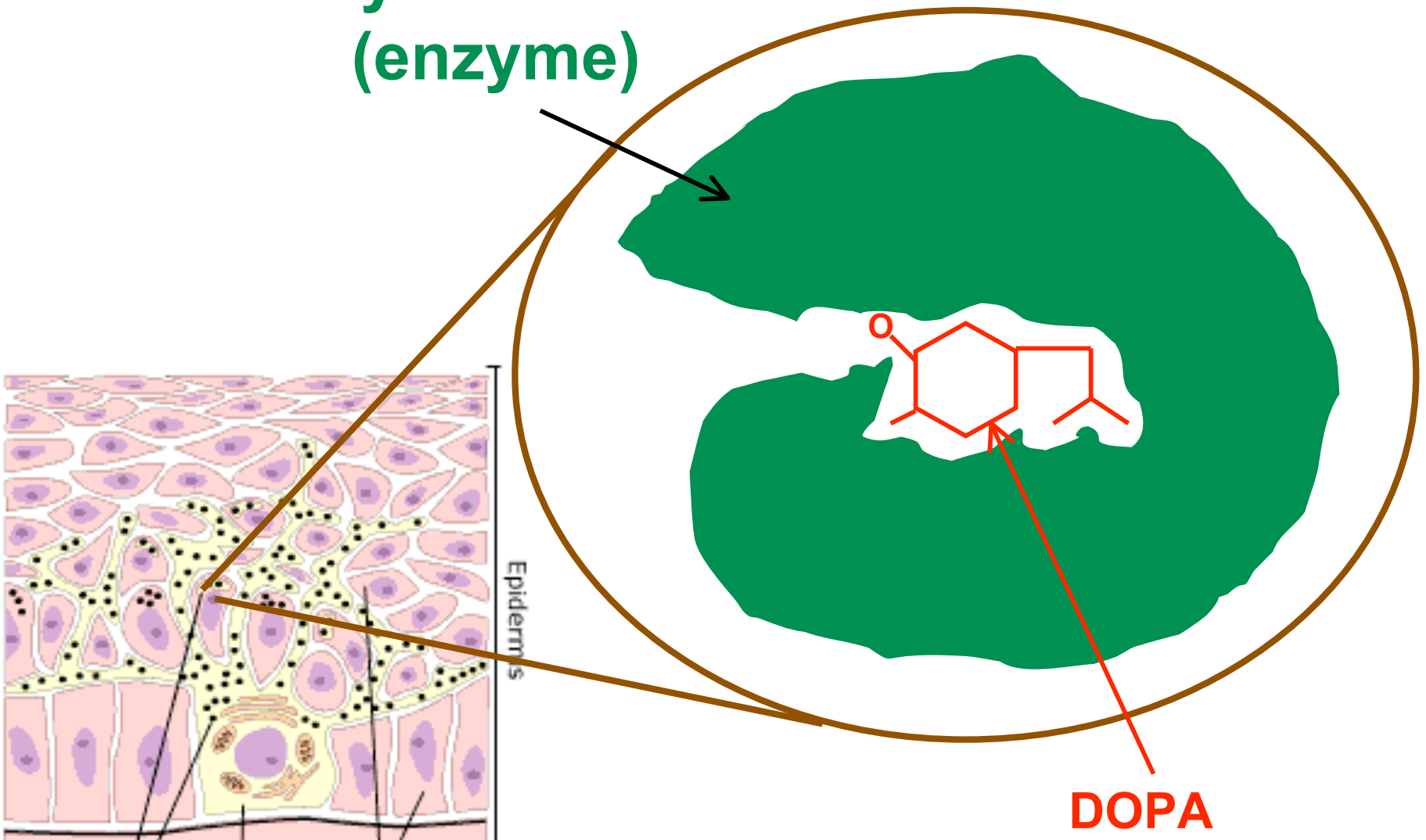
Looking inside a melanosome



<u>First step in making melanin:</u>
Reaction between two molecules, one tyrosine and one O_2 to make DOPA


Tyrosinase
(enzyme)
Tyrosine
Oxygen
Epiderms
Melanosome
Melanocyte
Keratinocytes

Tyrosinase (enzyme)

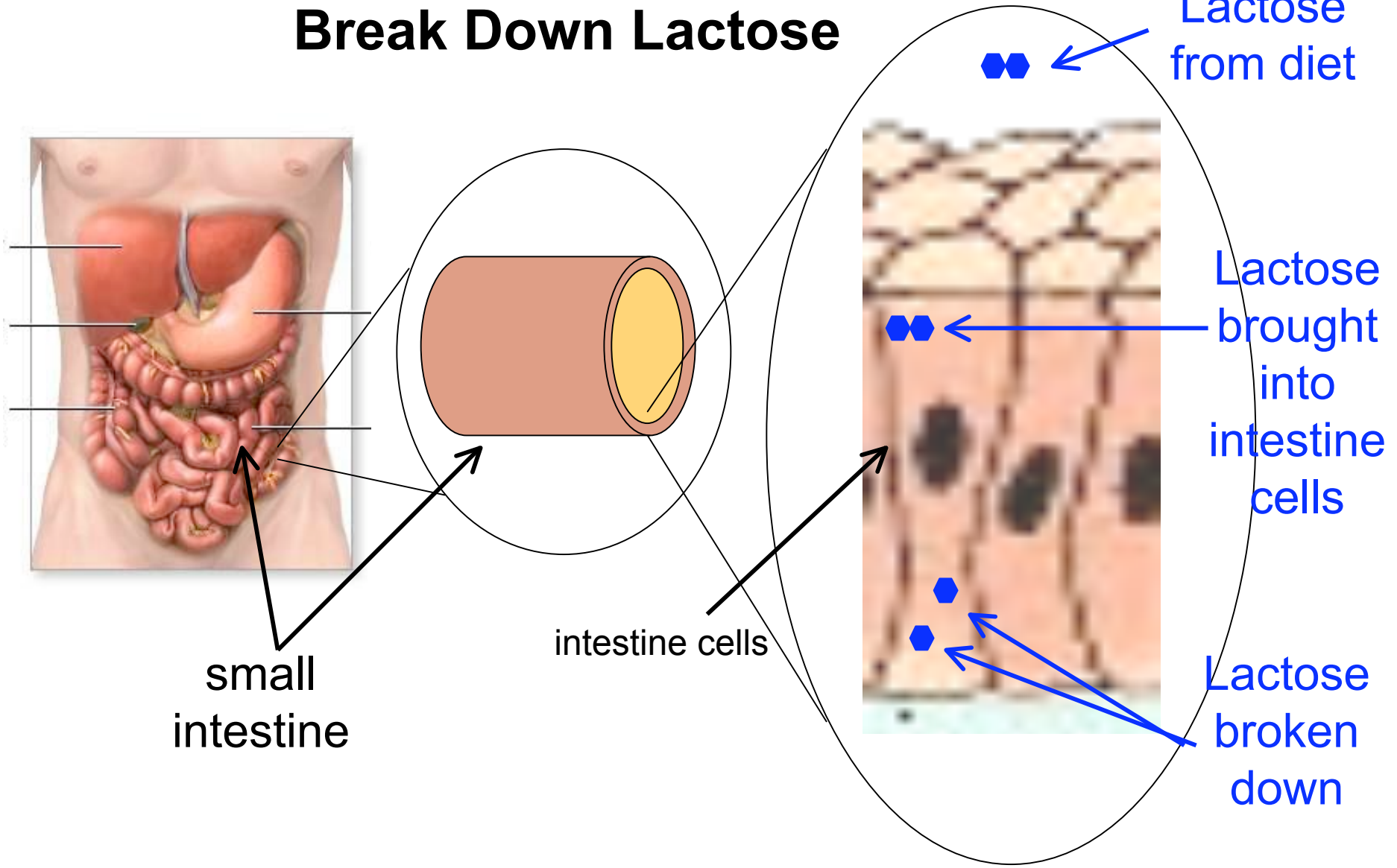


Other enzymes turn help turn DOPA into melanin.

Lactose intolerance

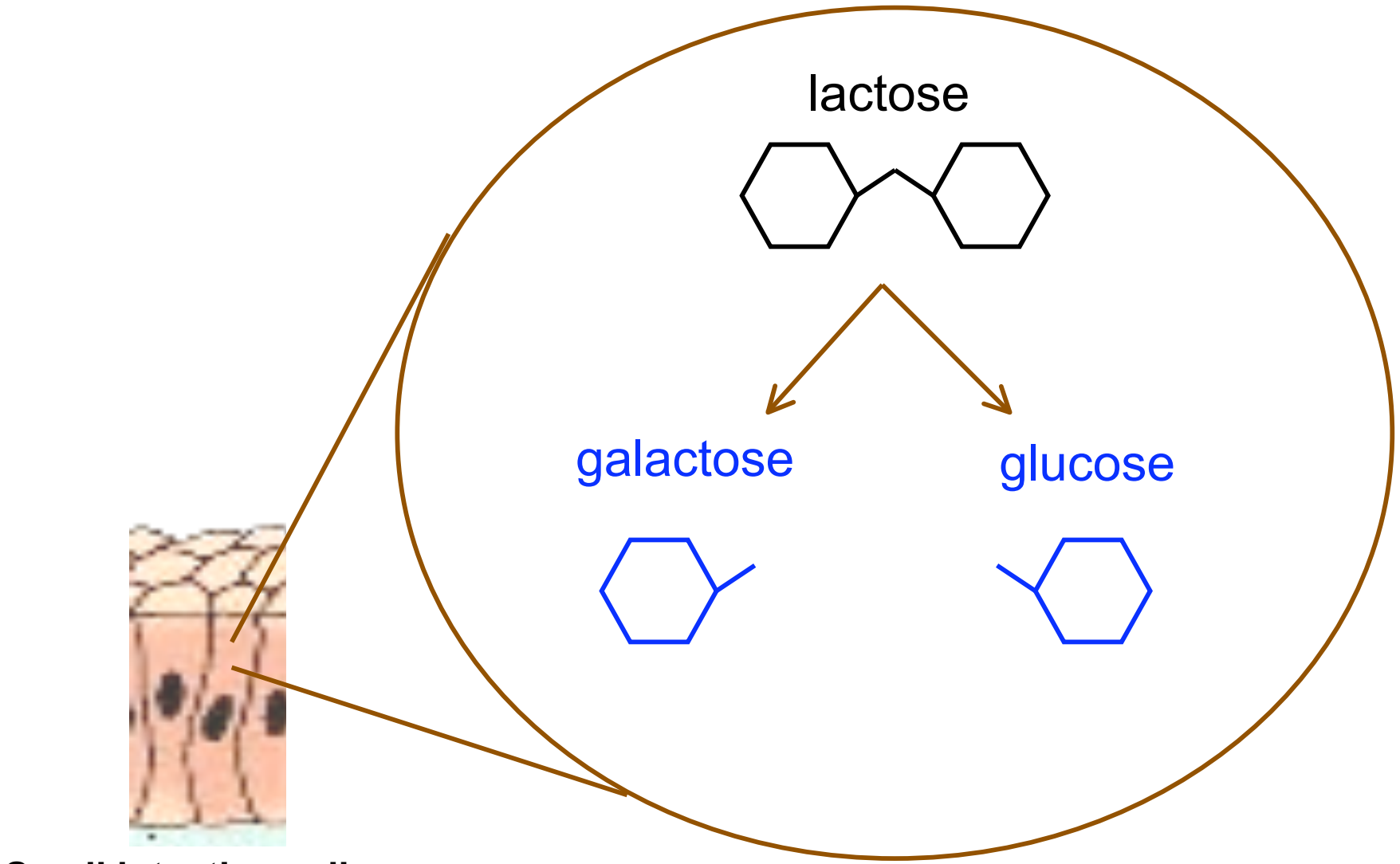
- Cannot break down lactose, a disaccharide found in dairy products
- Instead, bacteria in the intestine break down the lactose, producing gas
- Most children can break down lactose
- Most adults in the world cannot break down lactose - making them *lactose intolerant*

Cells in Small Intestine Break Down Lactose



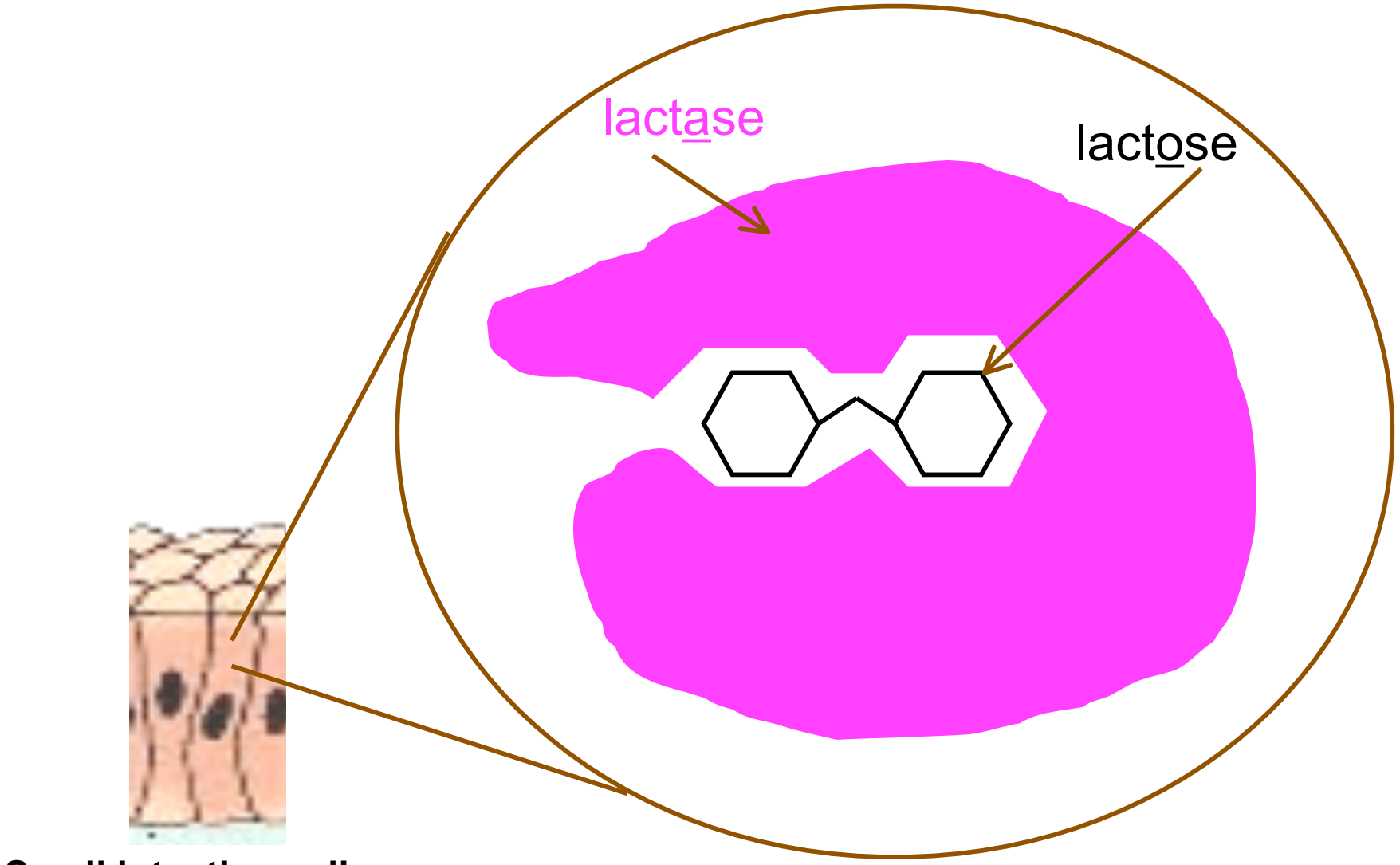
How is lactose broken down in intestine cells?

Looking inside small intestine cells



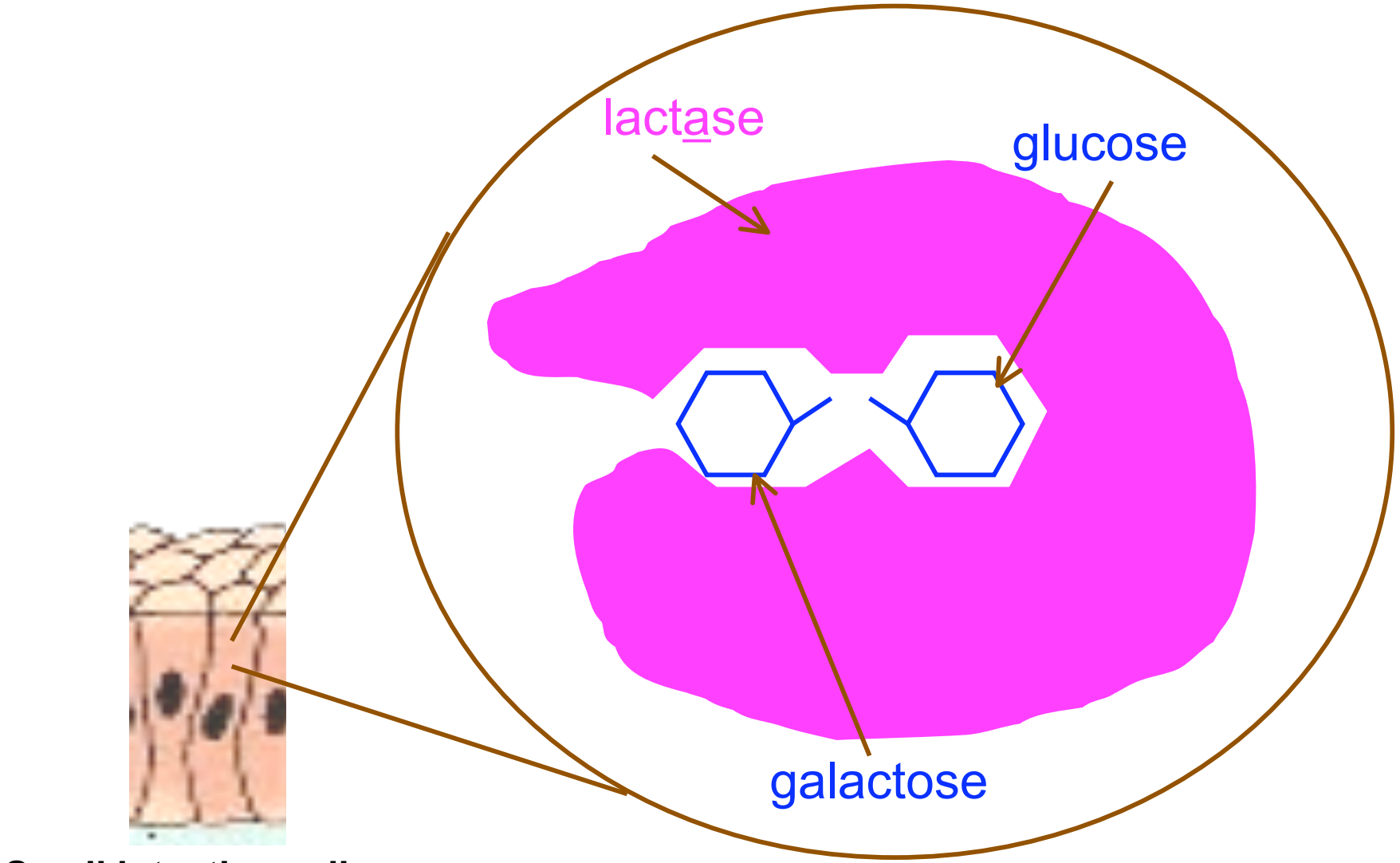
Small intestine cells

Looking inside small intestine cells



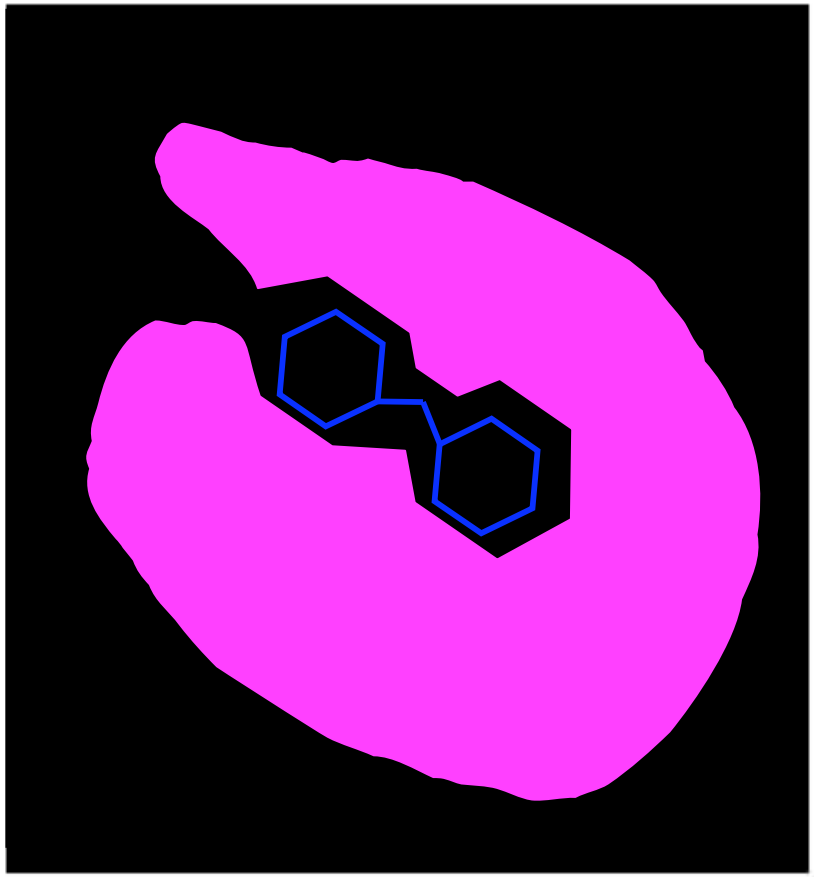
Small intestine cells

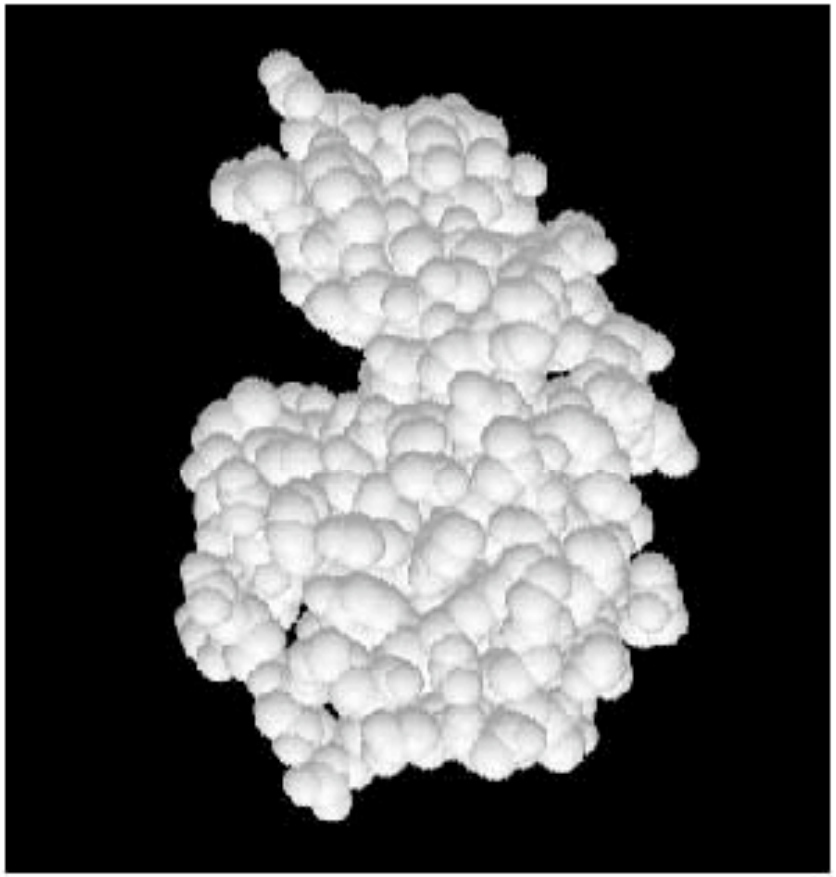
Looking inside small intestine cells



Small intestine cells

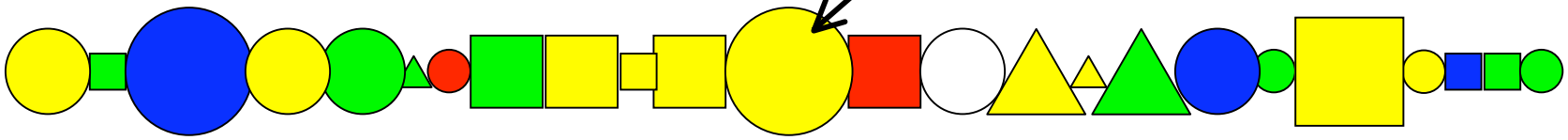
Lactase



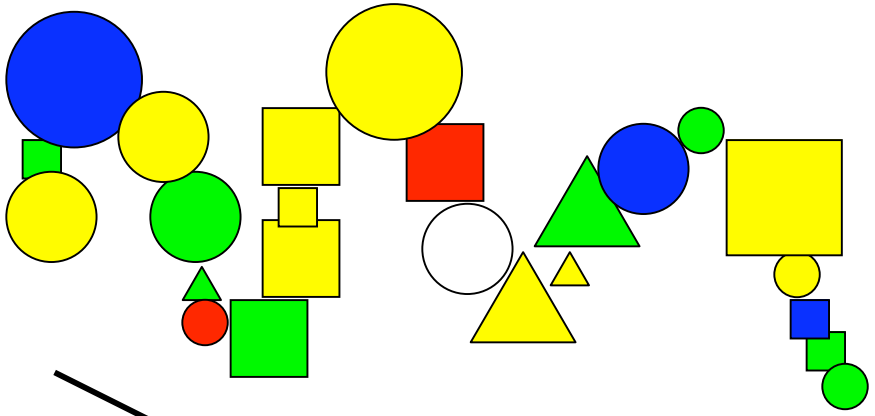


Protein Structure

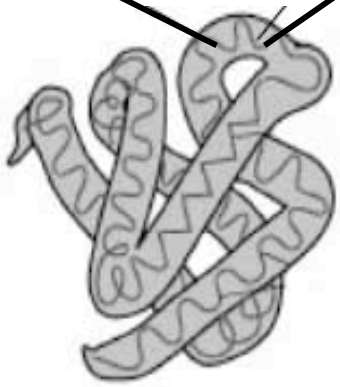
Chain of amino acids



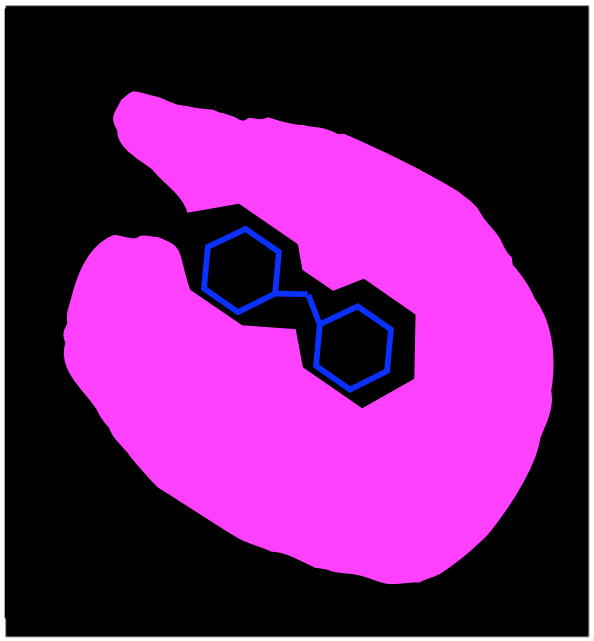
Folded chain of amino acids



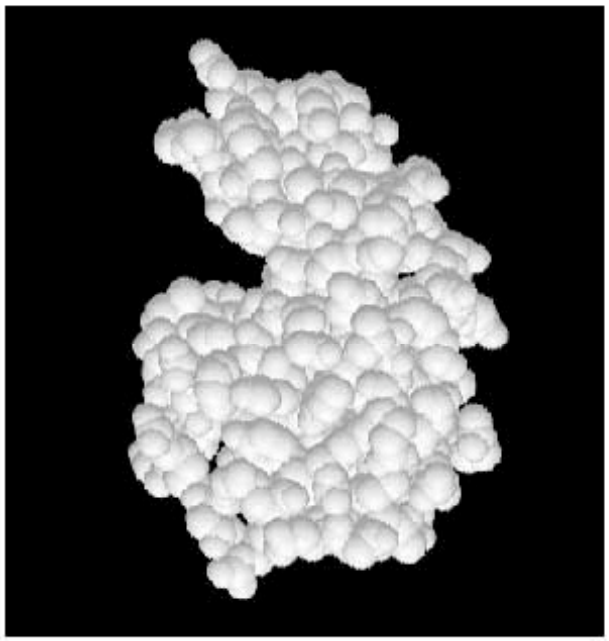
Whole protein



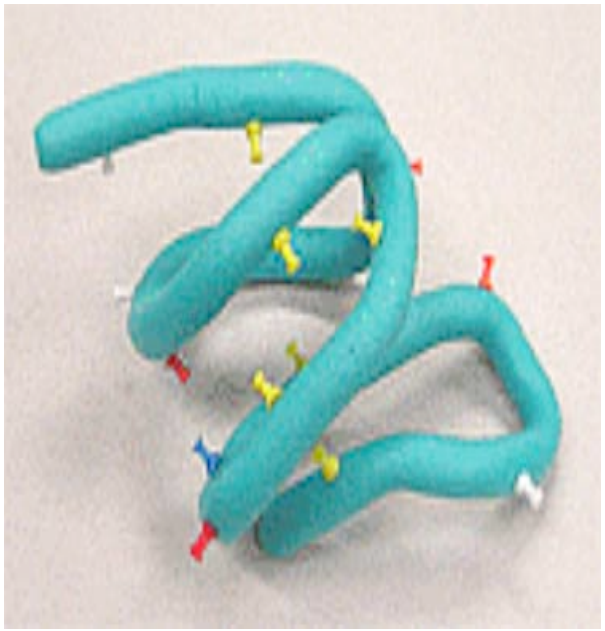
Protein Models



Cartoon model

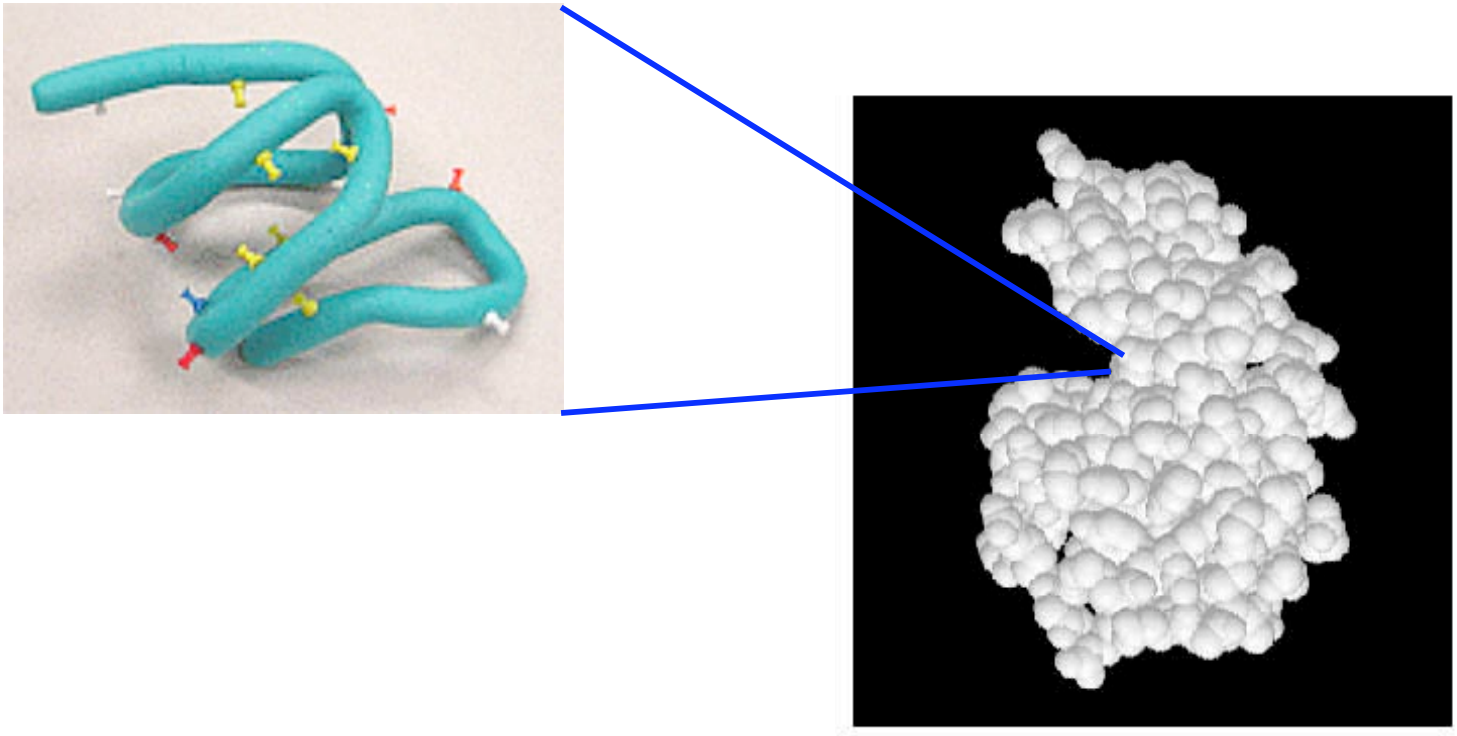


Space-filling model



Toober model

Modeling Lactase



Key to Toobers

Blue=positive charge (+)

K, R, H

Red=negative charge (-)

D, E

Yellow=hydrophobic

A, V, L, I, P, M, F, W

Green=hydrophilic

G, S, T, N, Q, Y

White = cysteine

C

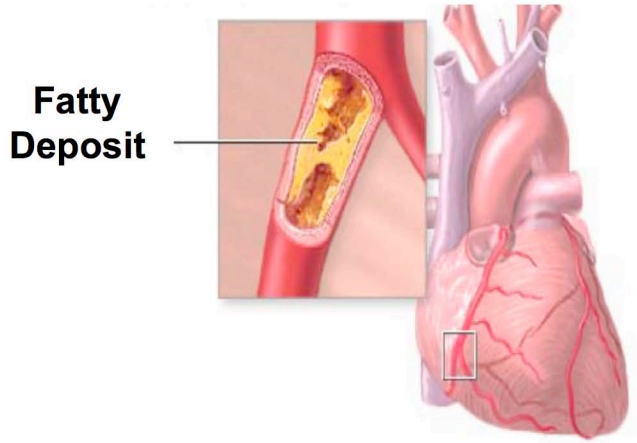
What might cause this disease?

Familial Hypercholesterolemia (FH) Symptoms

- Very high cholesterol in blood
- Chest pain and heart attacks at a young age
- Build up of fatty deposits on under skin and in arteries

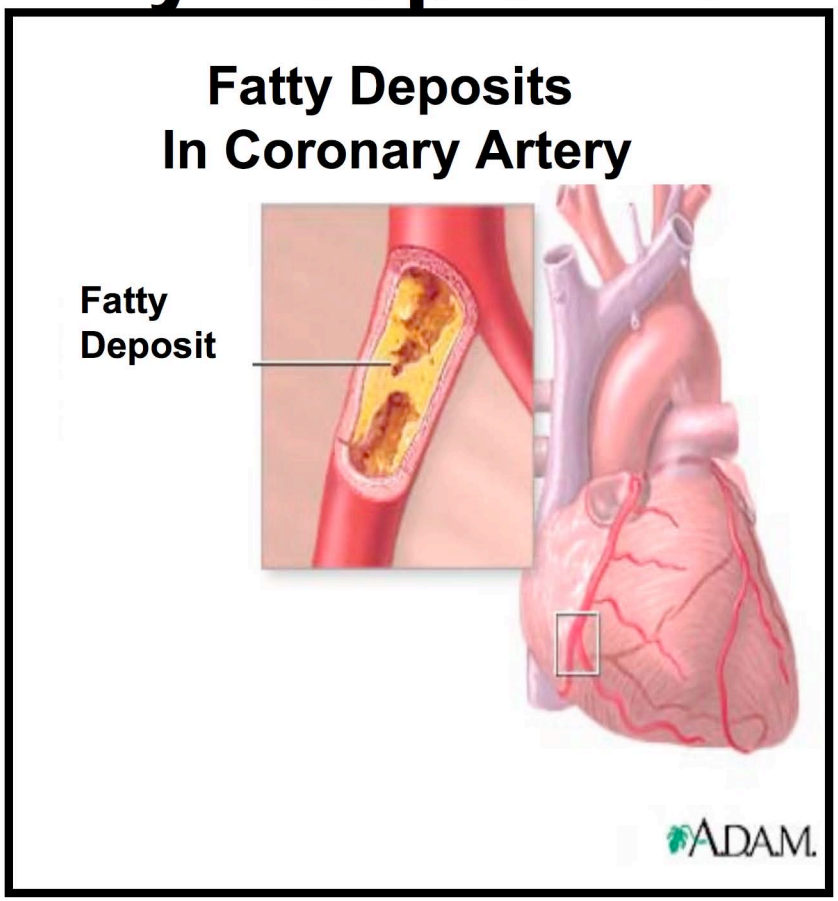
Knees and Fingers

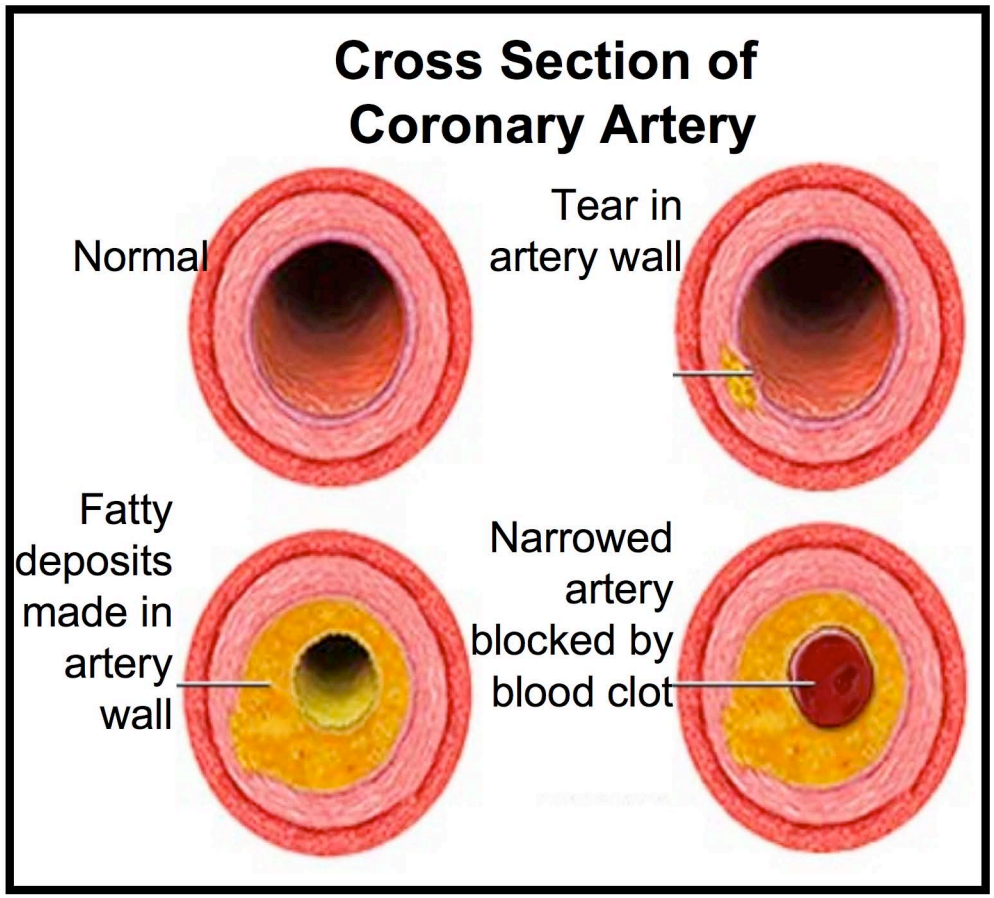
Coronary Artery: a heart artery



A.D.A.M.

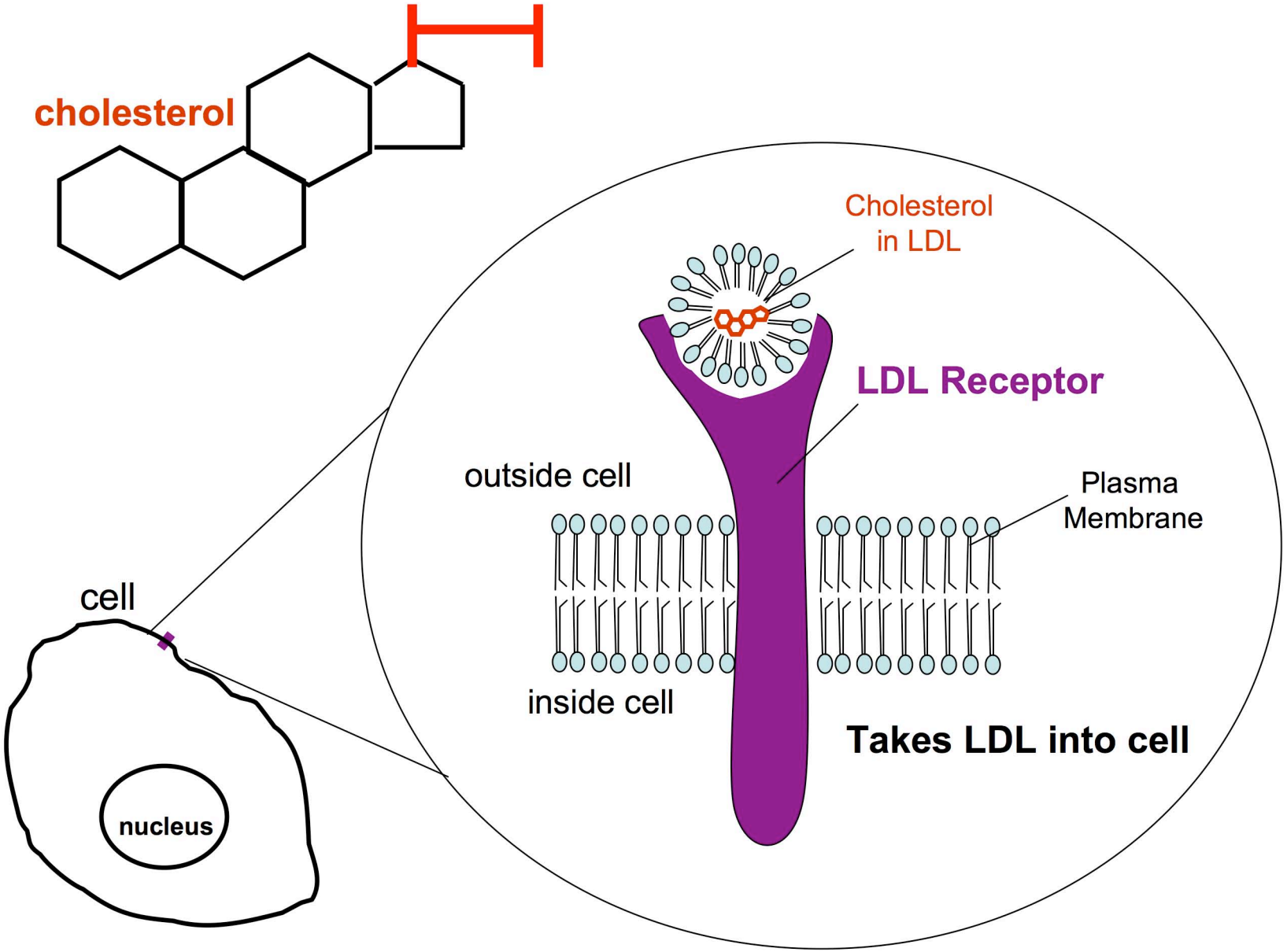
Why People With FH Have Heart Attacks



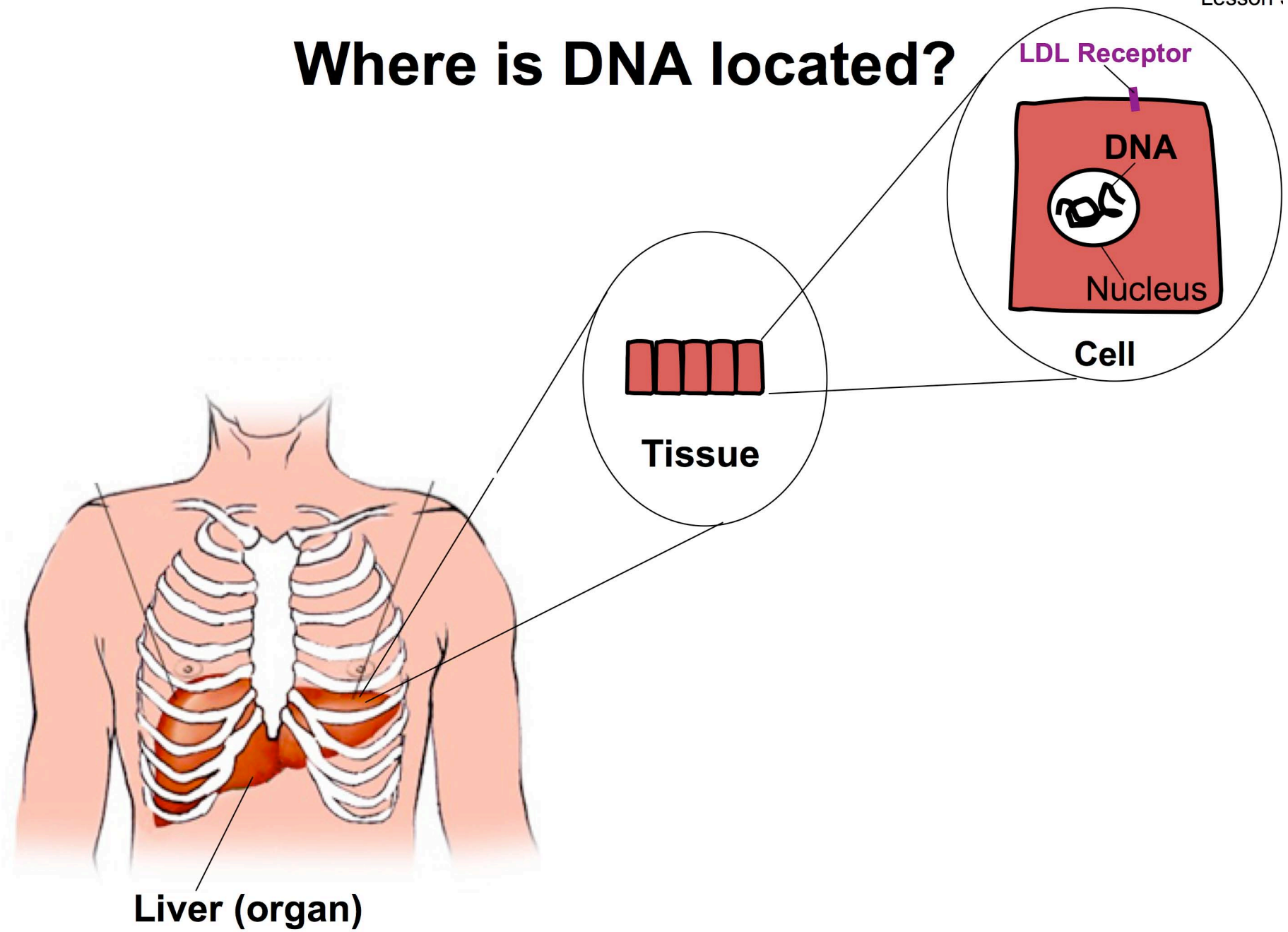


- **Artery wall injured by toxins from smoking, high blood pressure**
- **Arteries harden and narrow due to fat accumulation**
- **Blood flow is reduced**
- **Oxygen supply to heart reduced**
- **Can cause chest pain heart attack or death in severe cases**

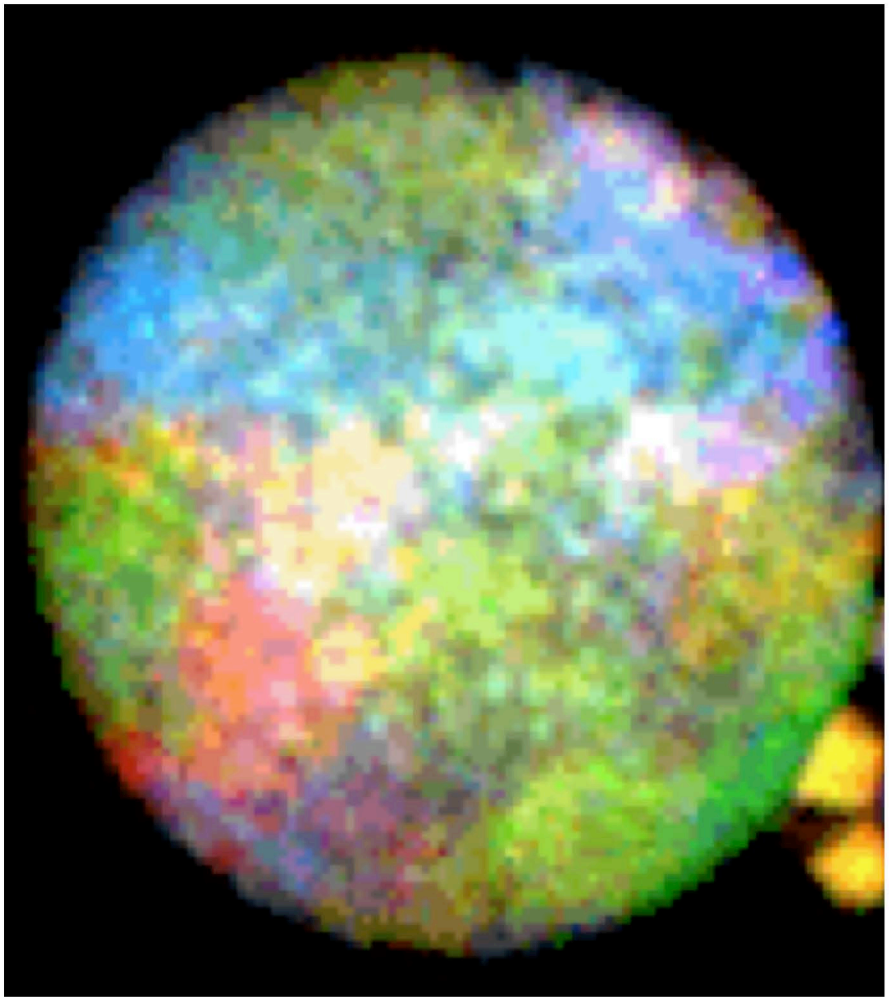
Low density lipoprotein (LDL) Receptor



Where is DNA located?



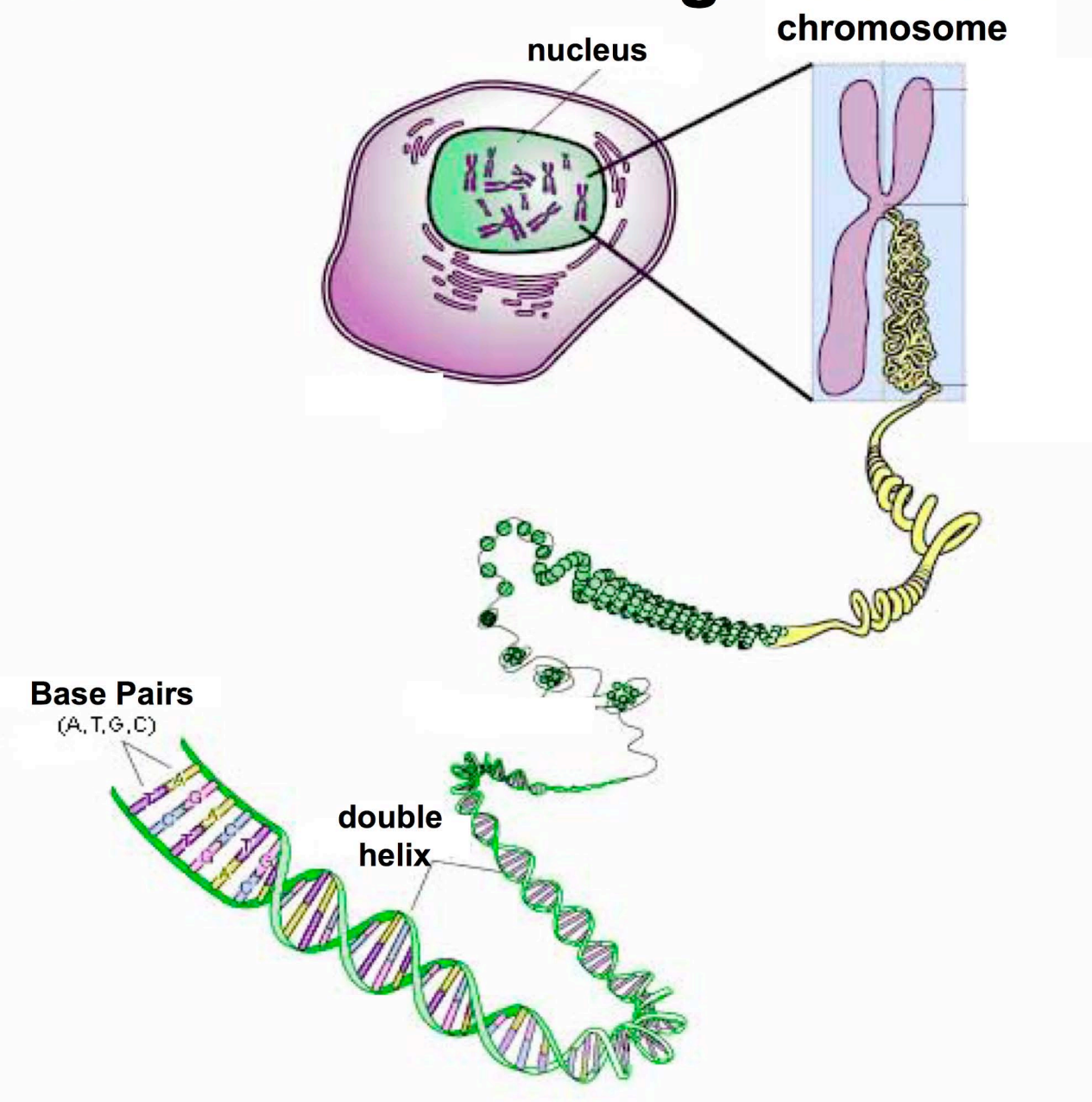
Chromosomes



From a cell not dividing
UNPACKED

From a just divided cell
PACKED

Chromosomes are Single Pieces of DNA



How do genes provide instructions for building proteins?

From DNA sequence to Protein overview

http://www-class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a1.html

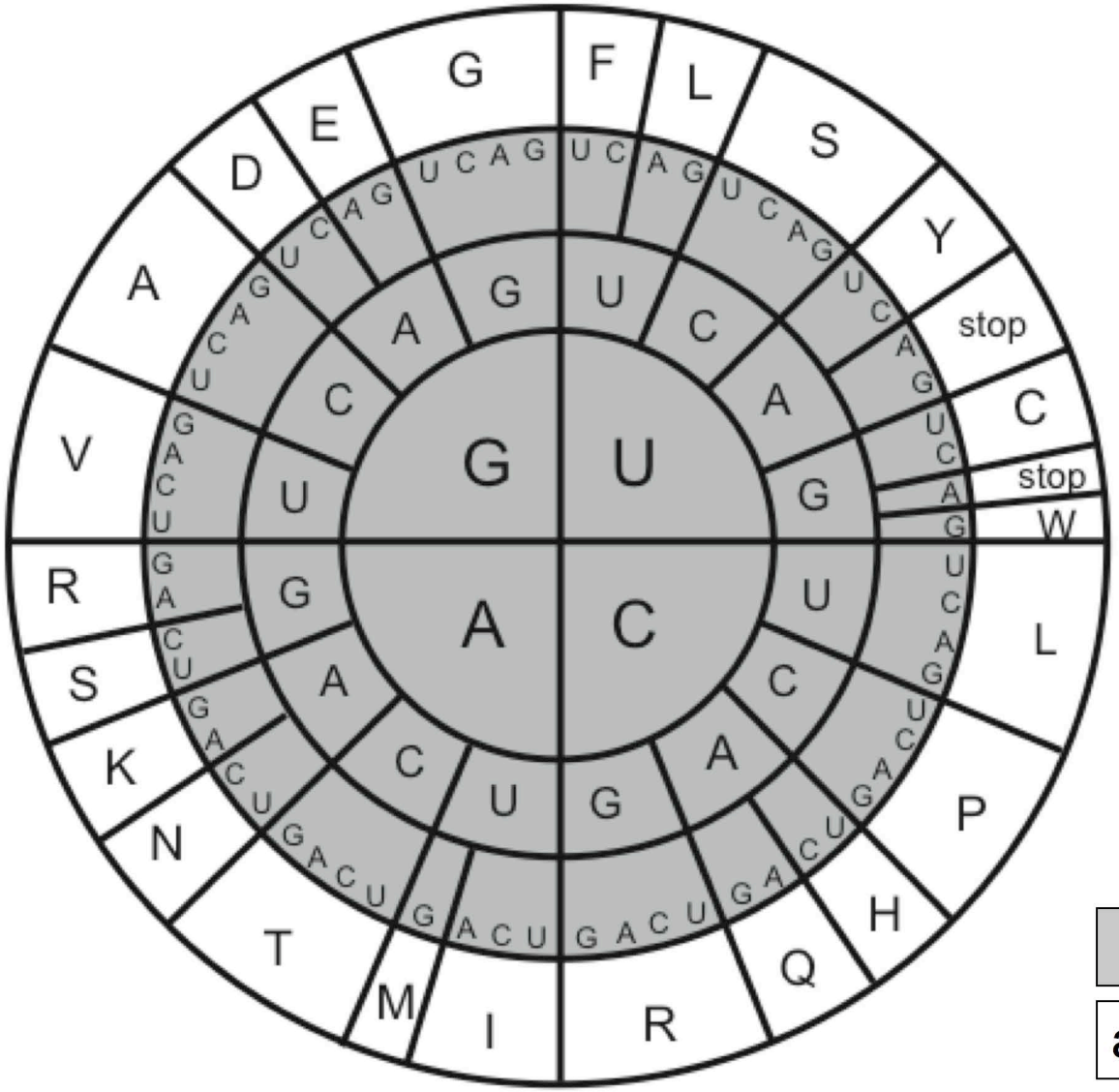
From DNA to RNA - more detail

http://www-class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a2.html

From RNA sequence to protein - more detail

http://www-class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a3.html

Coding Amino Acids



RNA

amino acid

Key to Toobers

Blue=positive charge (+)

K, R, H

Red=negative charge (-)

D, E

Yellow=hydrophobic

A, V, L, I, P, M, F, W

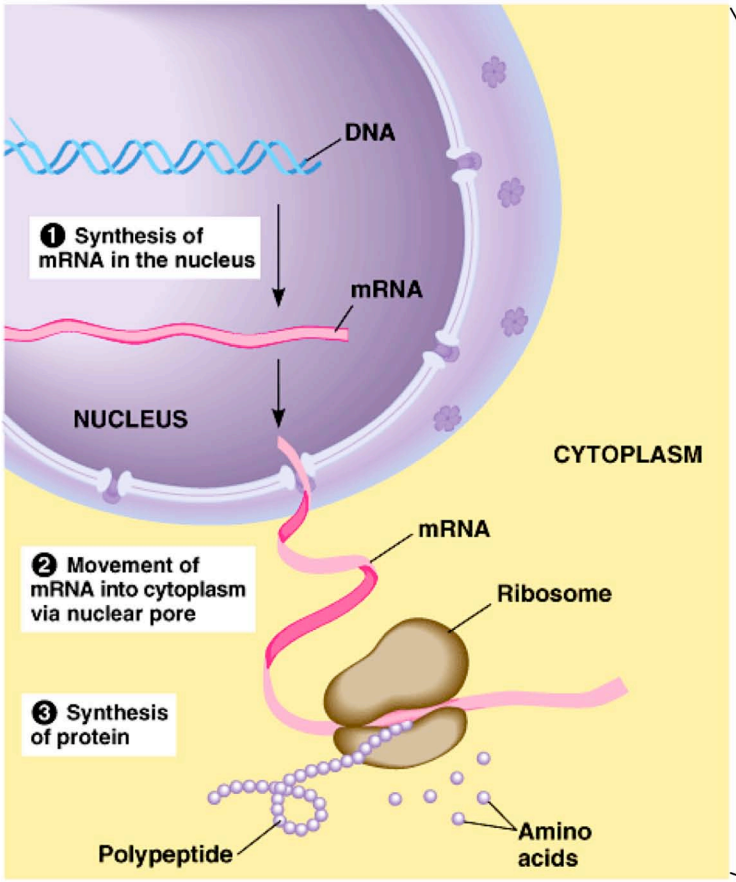
Green=hydrophilic

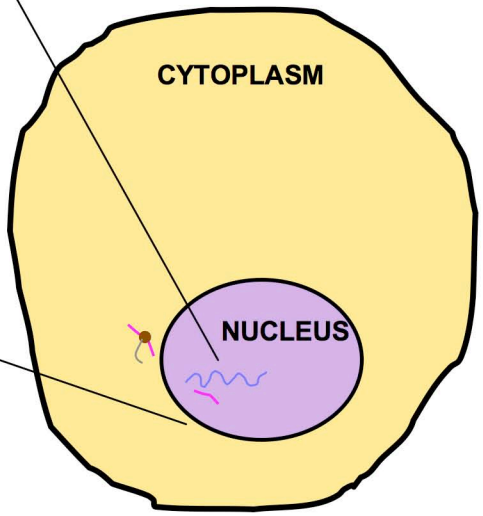
G, S, T, N, Q, Y

White = cysteine

C

Summary: DNA to protein





From Cells to DNA movie

View slide to play movie

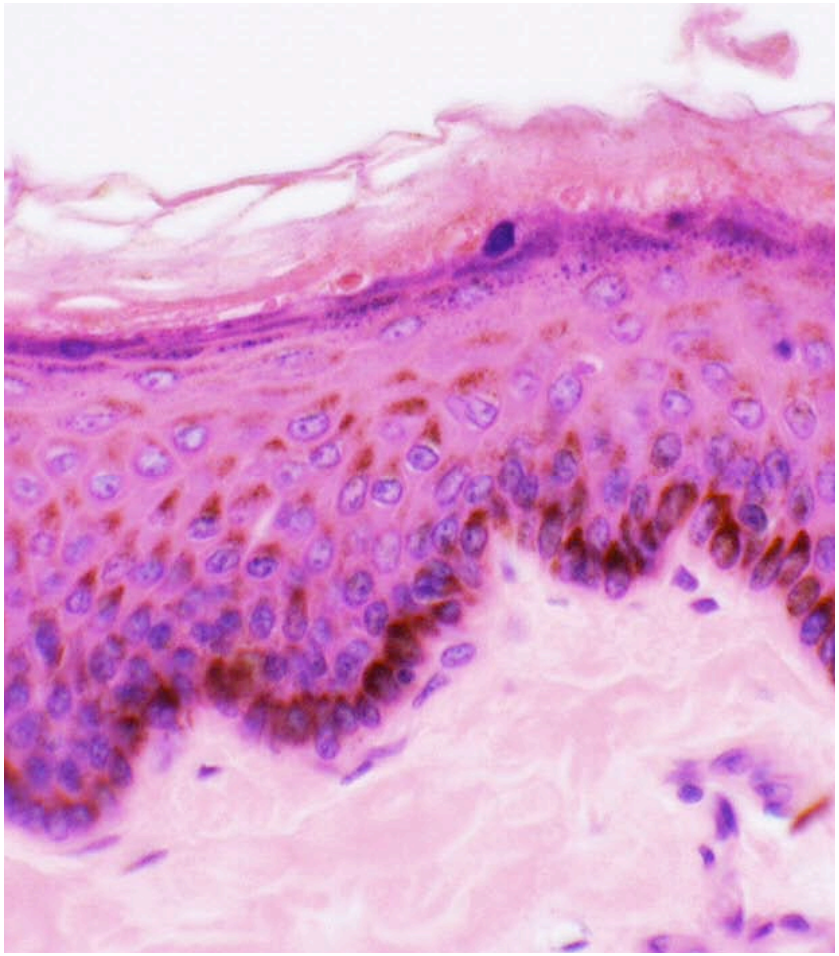
Click for another representation of DNA

From Cells to DNA movie

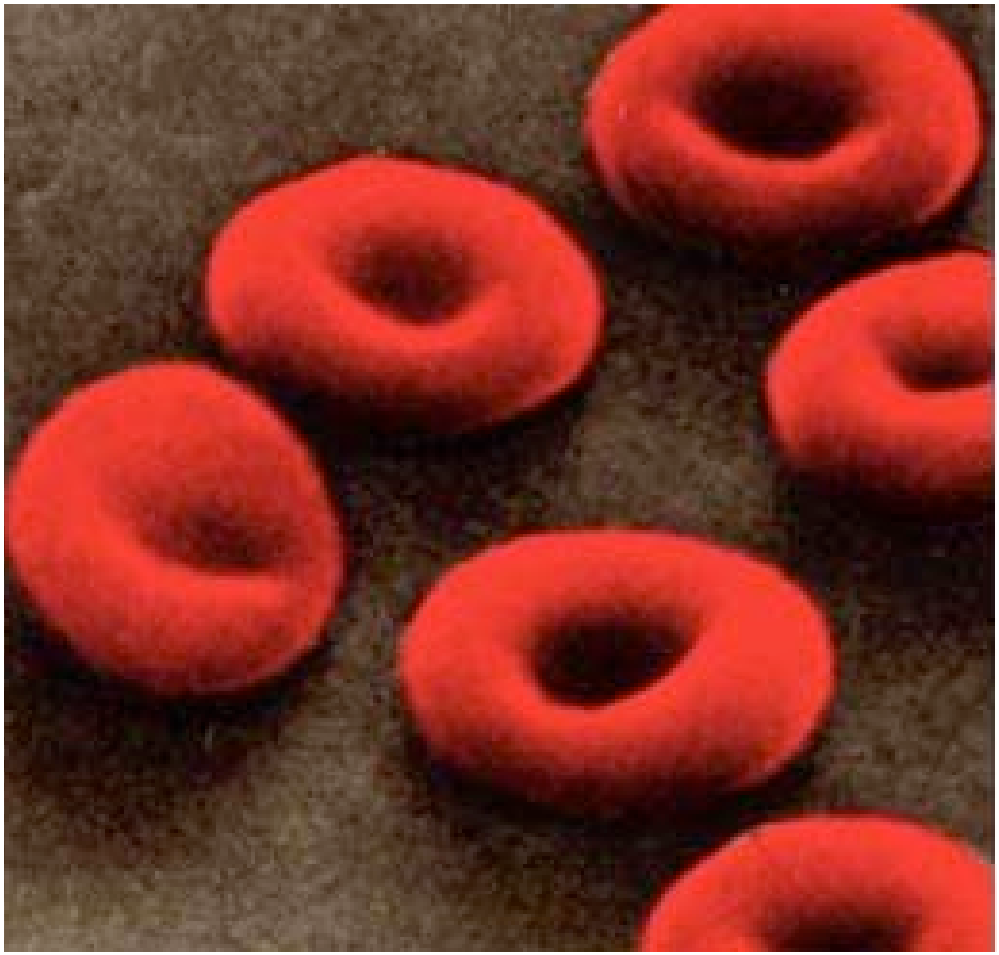
View slide to play movie

Click for another representation of DNA

How similar or different are cells?



Skin cells



Blood cells

1) Prepare gel

Holes for samples to be tested

gel

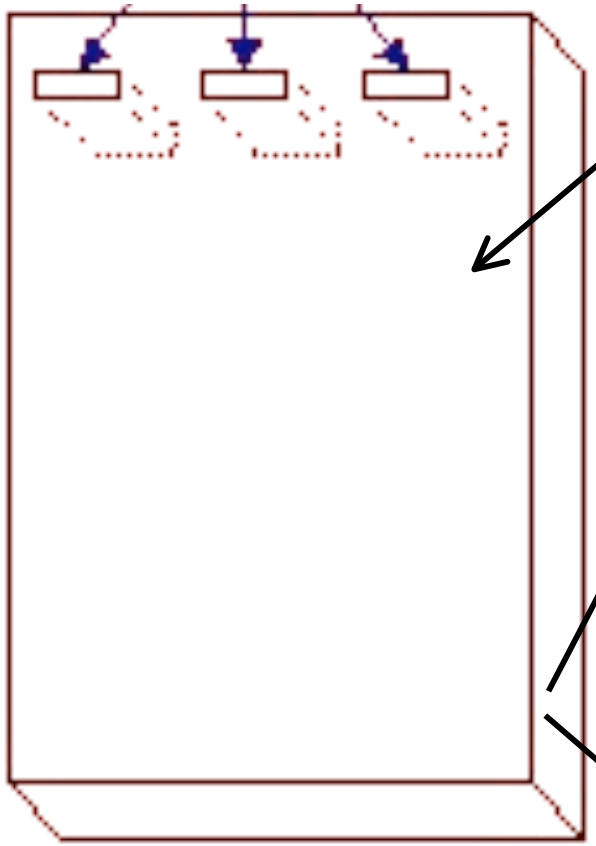
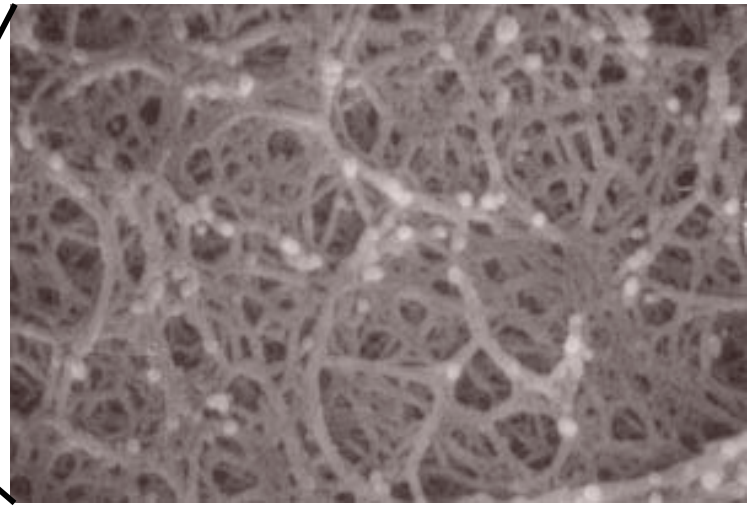
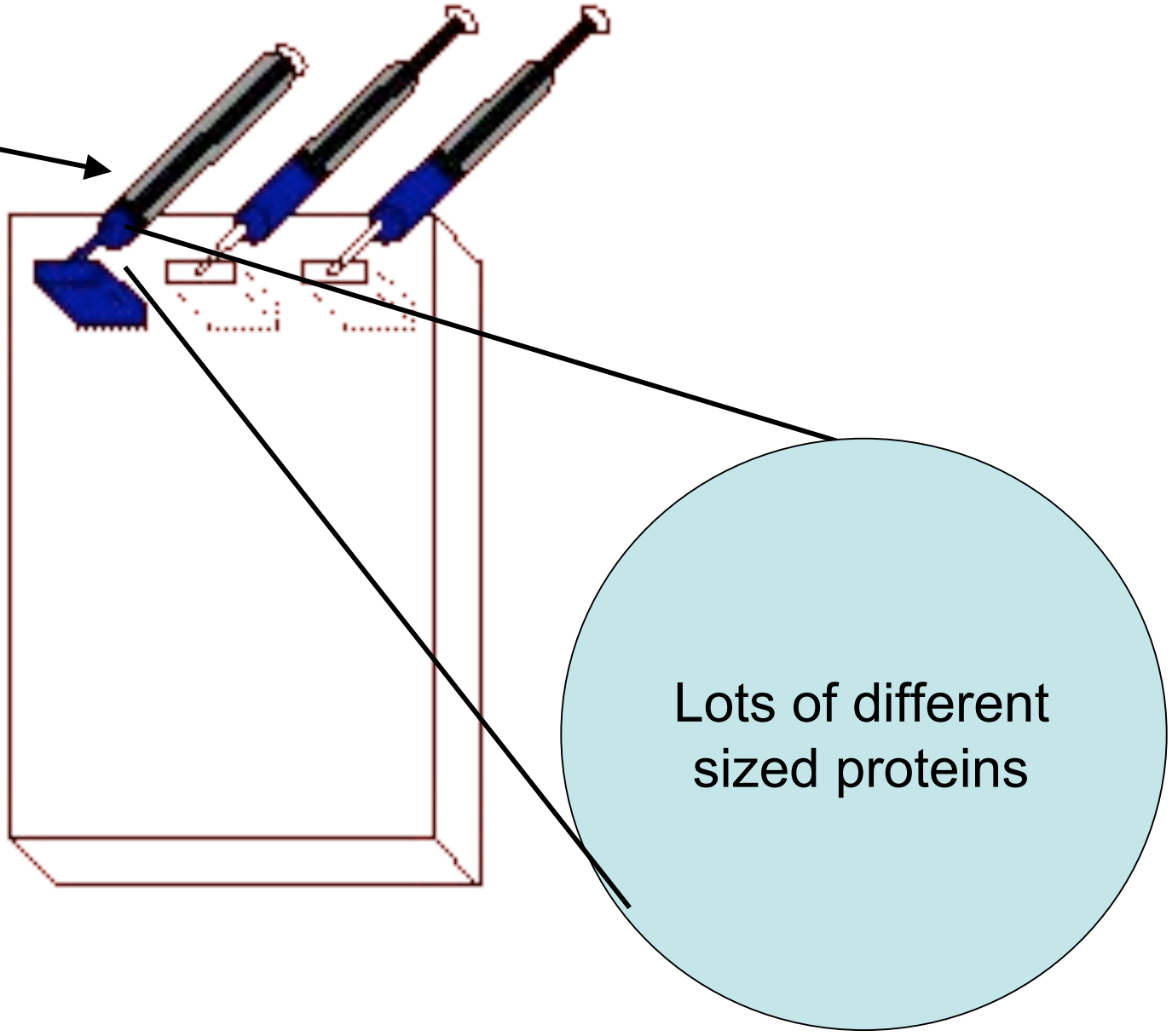


Image from powerful microscope

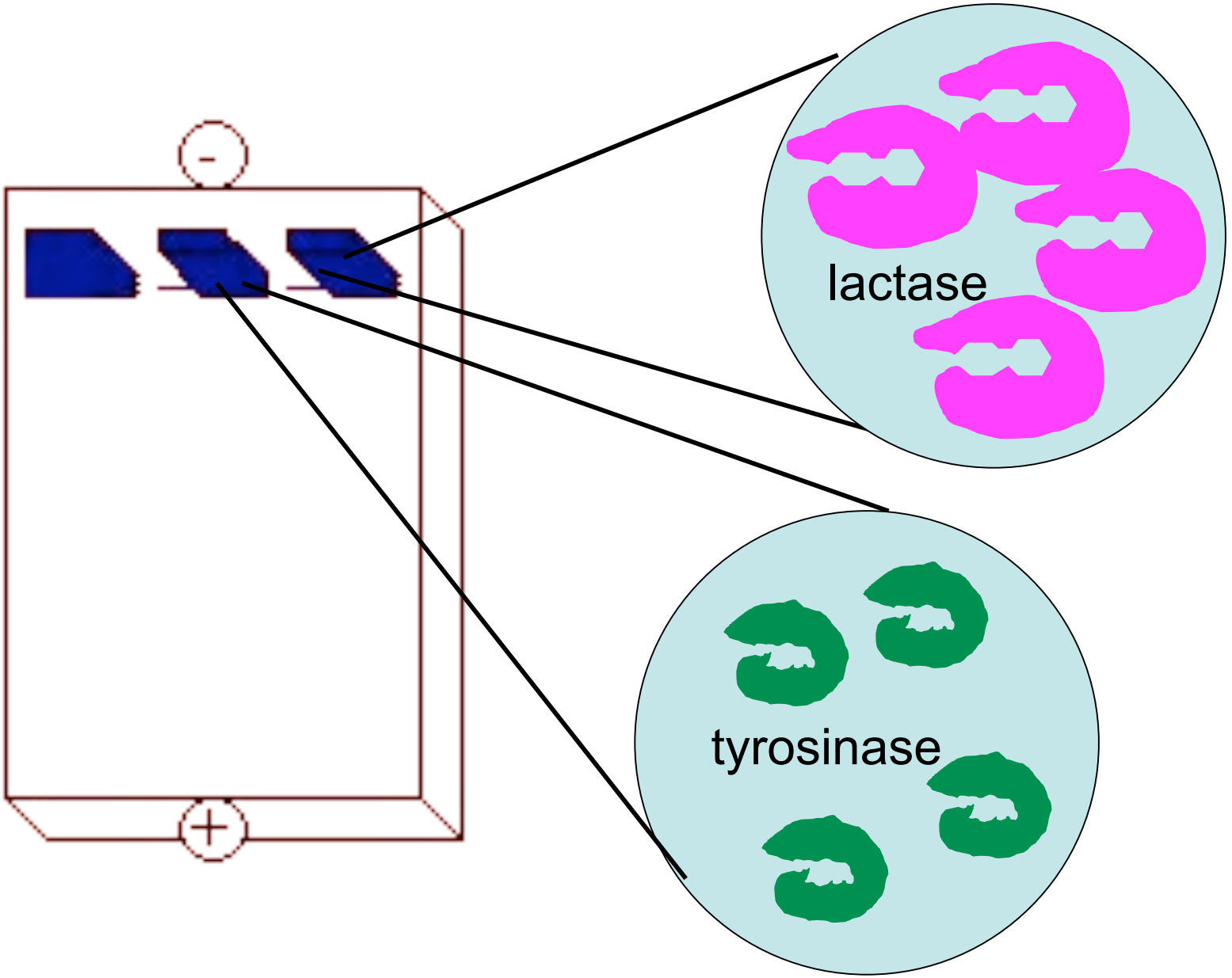


2) Put protein sample in hole

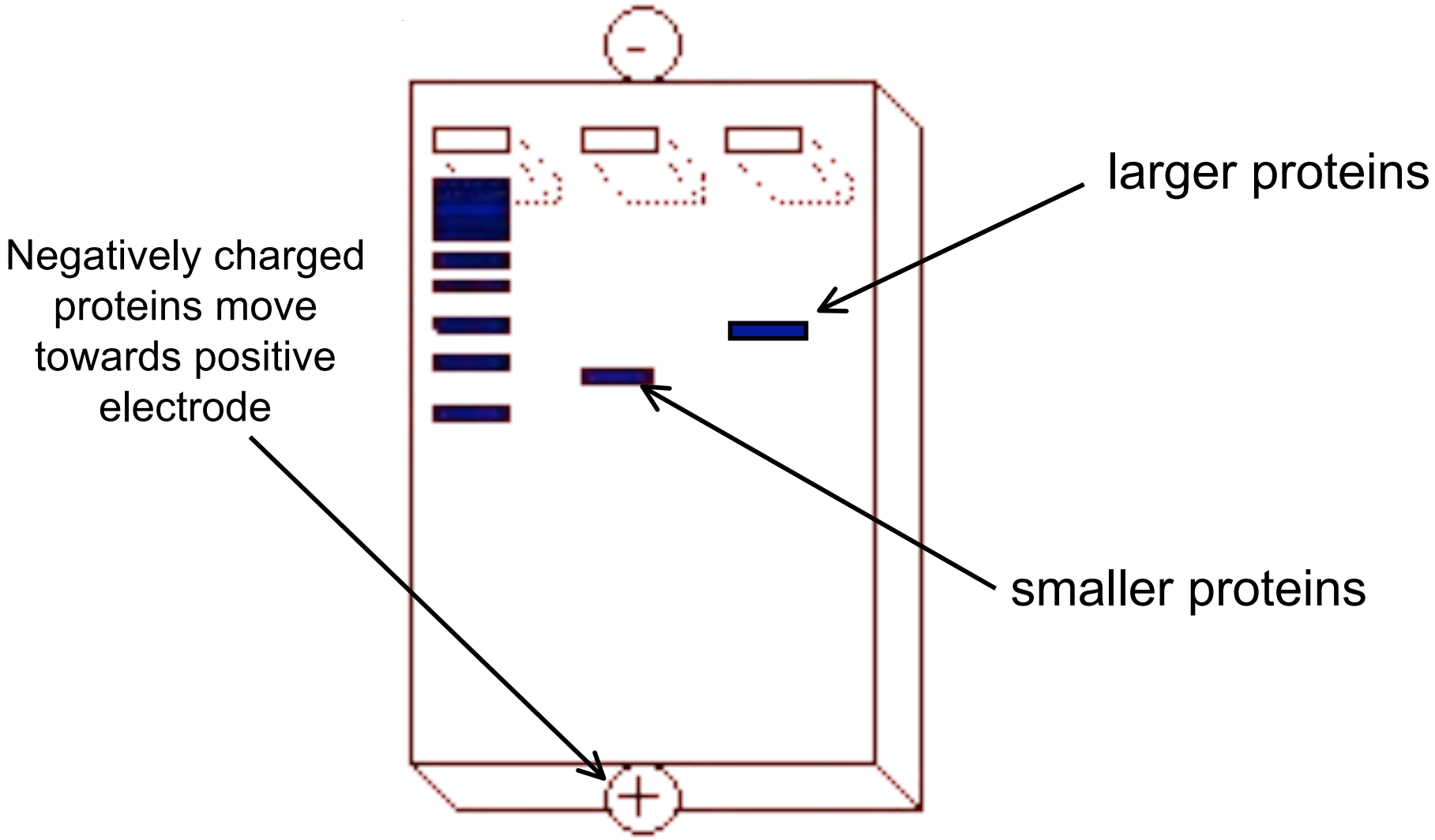
Pipet with solution of proteins



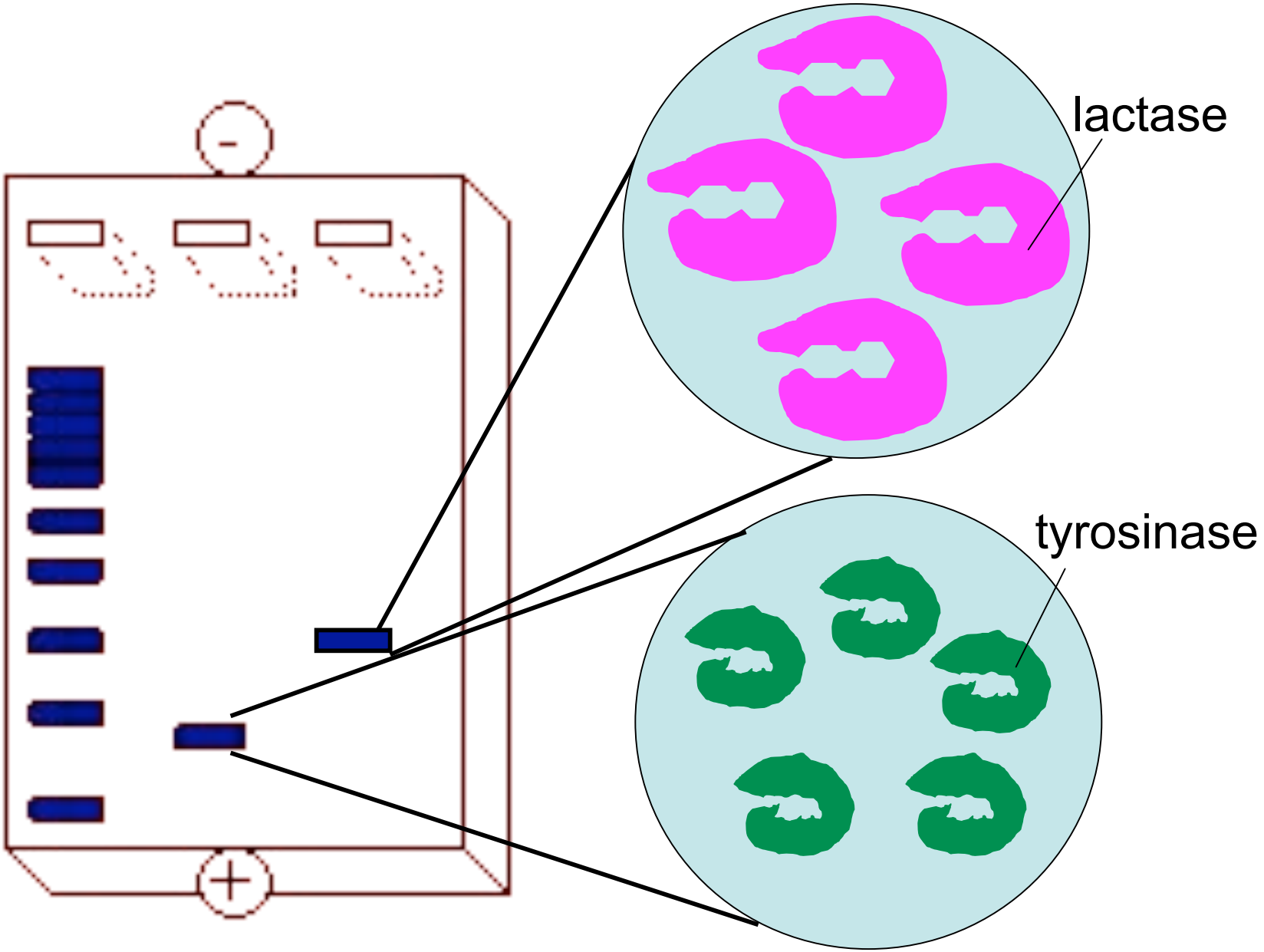
3) Include all the samples you want to test



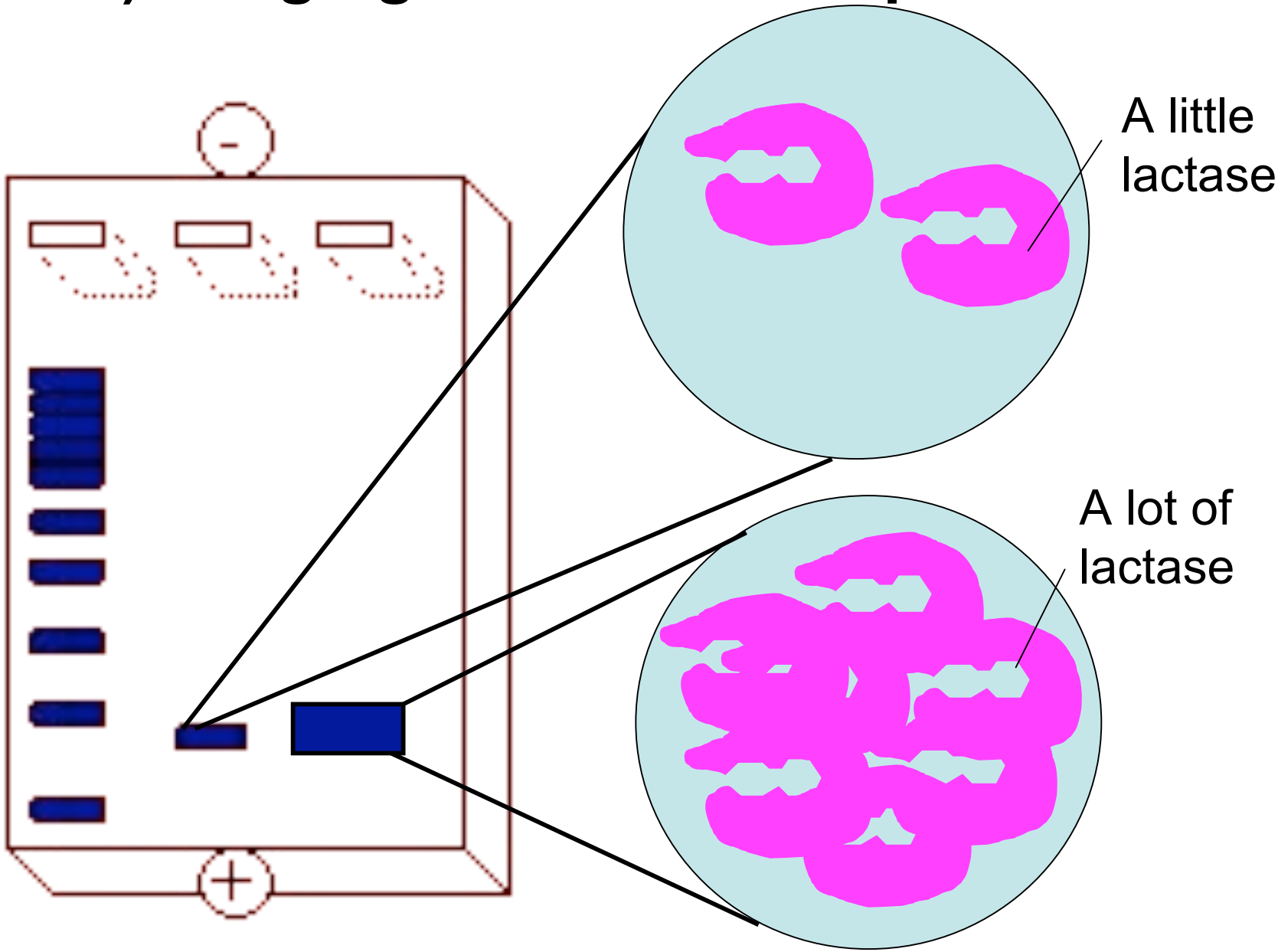
4) Provide power to the electrodes



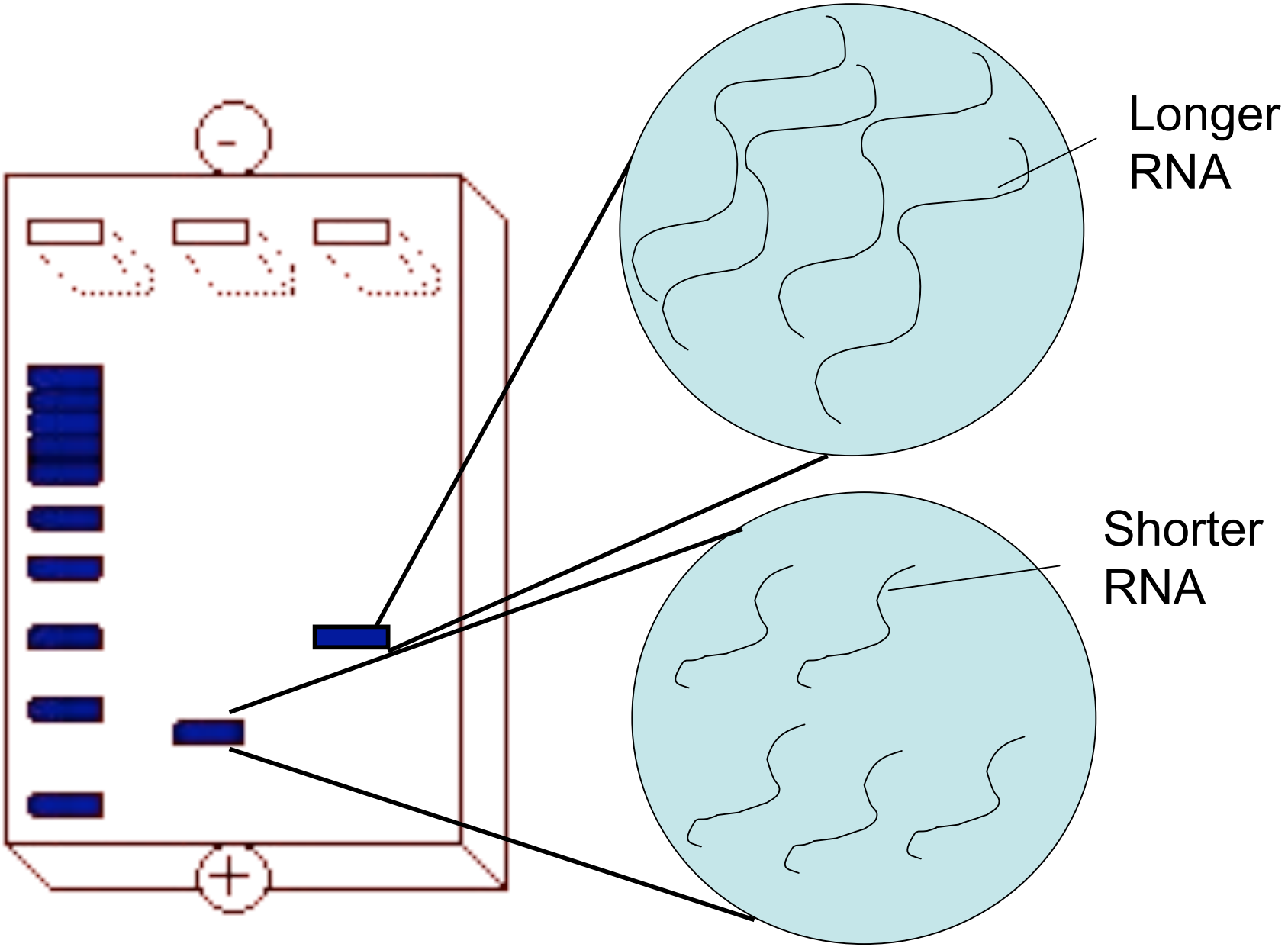
5a) Proteins separate based on size



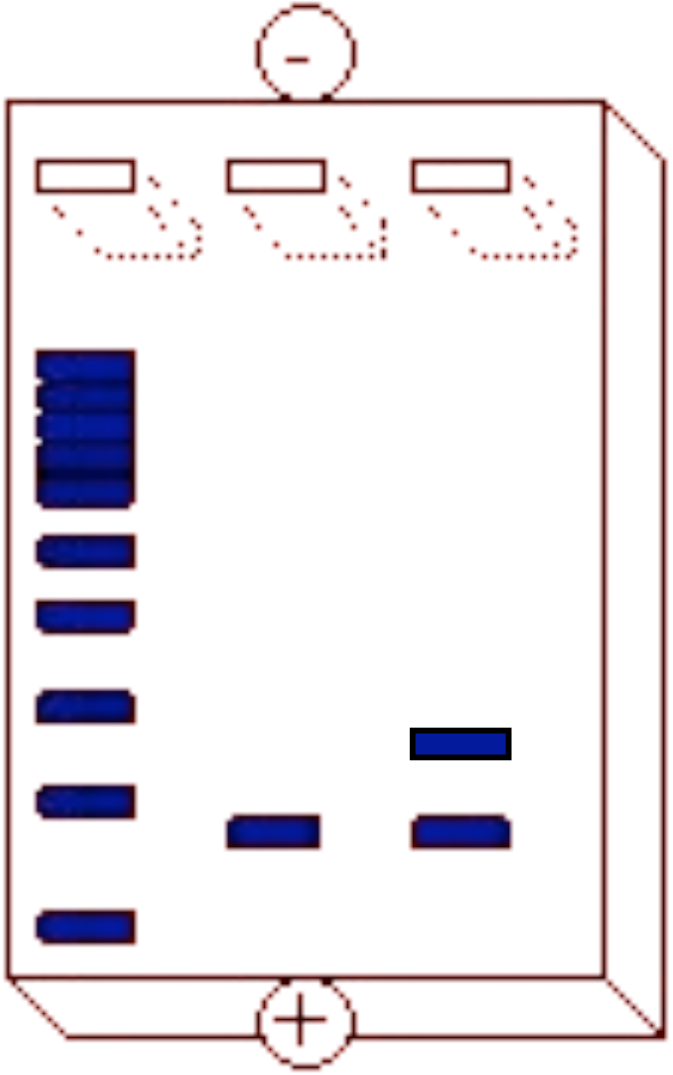
5b) Judging the amount of protein

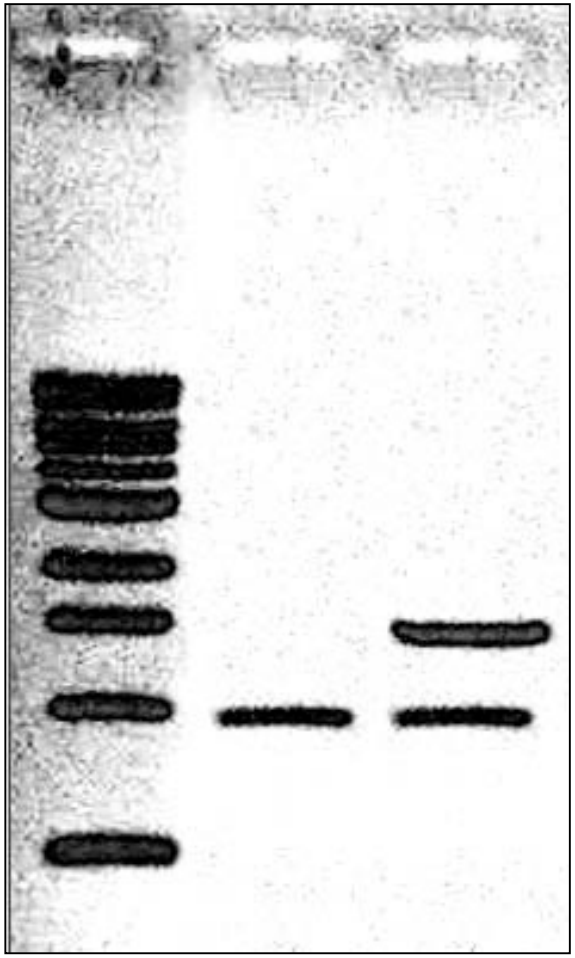


5c) Analyzing RNA



6) Take a picture to record your work





Lactose intolerance in Jason's family

Lactose intolerance:

1) No (Mom)

2) Yes (Jason)

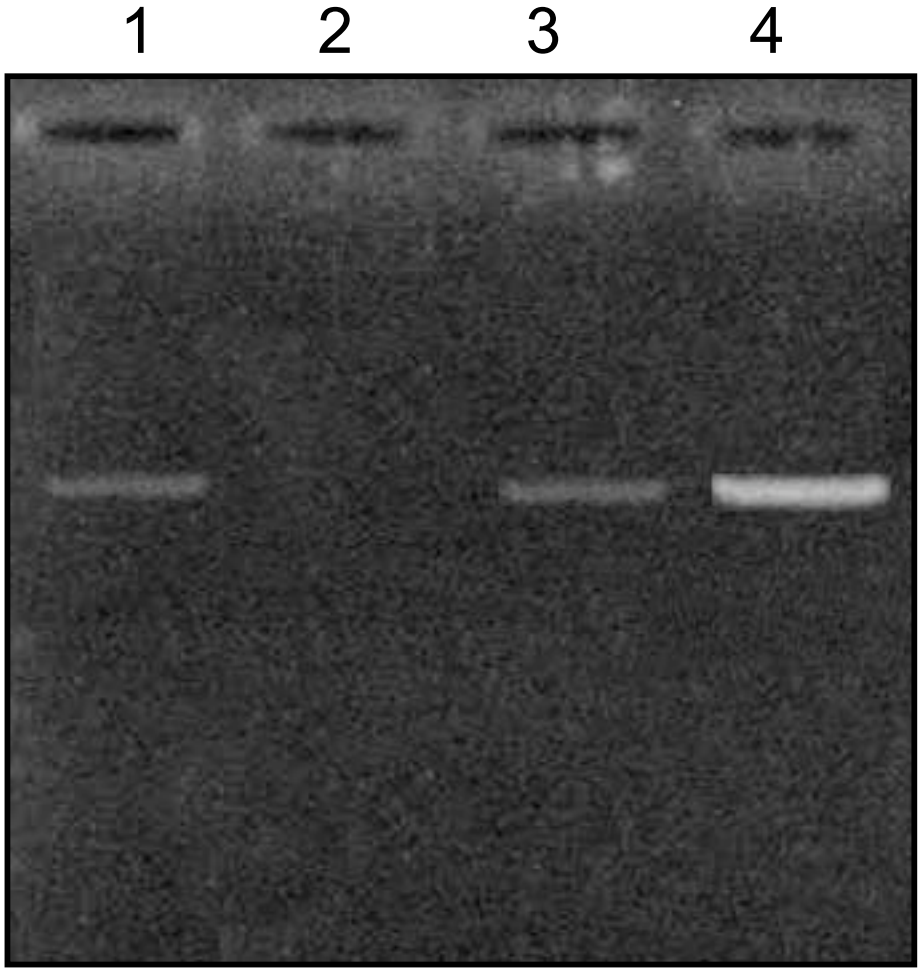
3) No (Chelsea)

4) No (Maya)

Results: DNA sequence analysis of lactase gene:

Mom:	no mutations in lactase genes
Jason:	no mutations in lactase genes
Chelsea:	no mutations in lactase genes
Maya:	no mutations in lactase genes

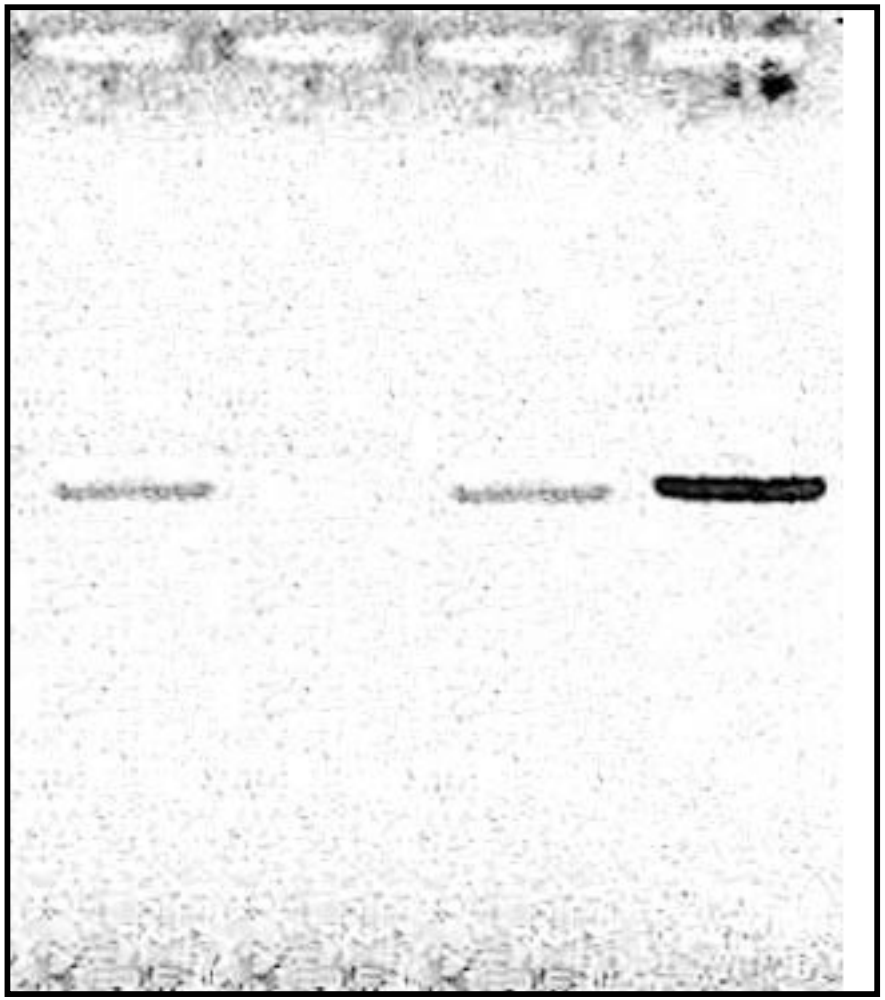
Results: RNA analysis of lactase gene



Lactose intolerance:

1) No (Mom)
2) Yes (Jason)
3) No (Chelsea)
4) No (Maya)

Gel electrophoresis: Lactase samples from 4 people



Lactose intolerance:

1) No (Mom)
2) Yes (Jason)
3) No (Chelsea)
4) No (Maya)

Why does Jason have no protein?
Why Mom and Chelsea have less protein?

Results: DNA sequence of area near the lactase gene

Mom: ATTTGC |||||| TAAACG ATCTGC |||||| TAGACG	Jason: ATCTGC |||||| TAGACG ATCTGC |||||| TAGACG
Chelsea: ATCTGC |||||| TAGACG ATTTGC |||||| TAAACG	Maya: ATTTGC |||||| TAAACG ATTTGC |||||| TAAACG

Erythropoietin (EPO)

Lots of oxygen

O-O O-O O-O O-O O-O O-O O-O O-O O-O

environment

Small amount of oxygen

O-O O-O O-O

gene

AGCTTCCCGGGATGAGGGCCC
TCGAAGGGCCCTACTCCCGGG

gene "on" **some** of the time

AGCTTCCCGGGATGAGGGCCC
TCGAAGGGCCCTACTCCCGGG

gene "on" **most** of the time

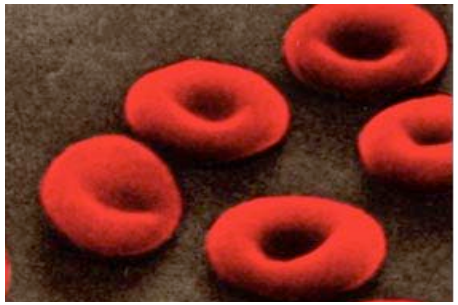
protein

some protein

lots of protein

some cells

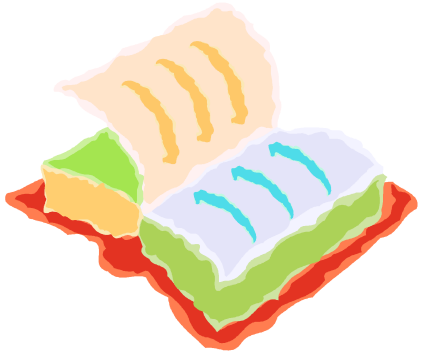
cells



lots of cells

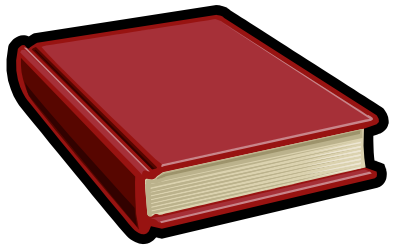
Gene organization

gene



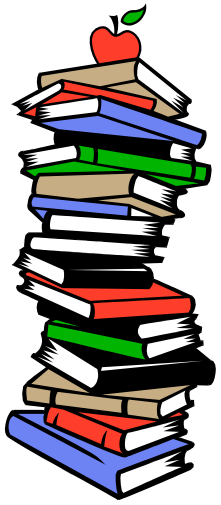
1 set of instructions for how to make 1 protein

chromosome



Thousands of sets of instructions for how to make thousands of proteins (1 book)

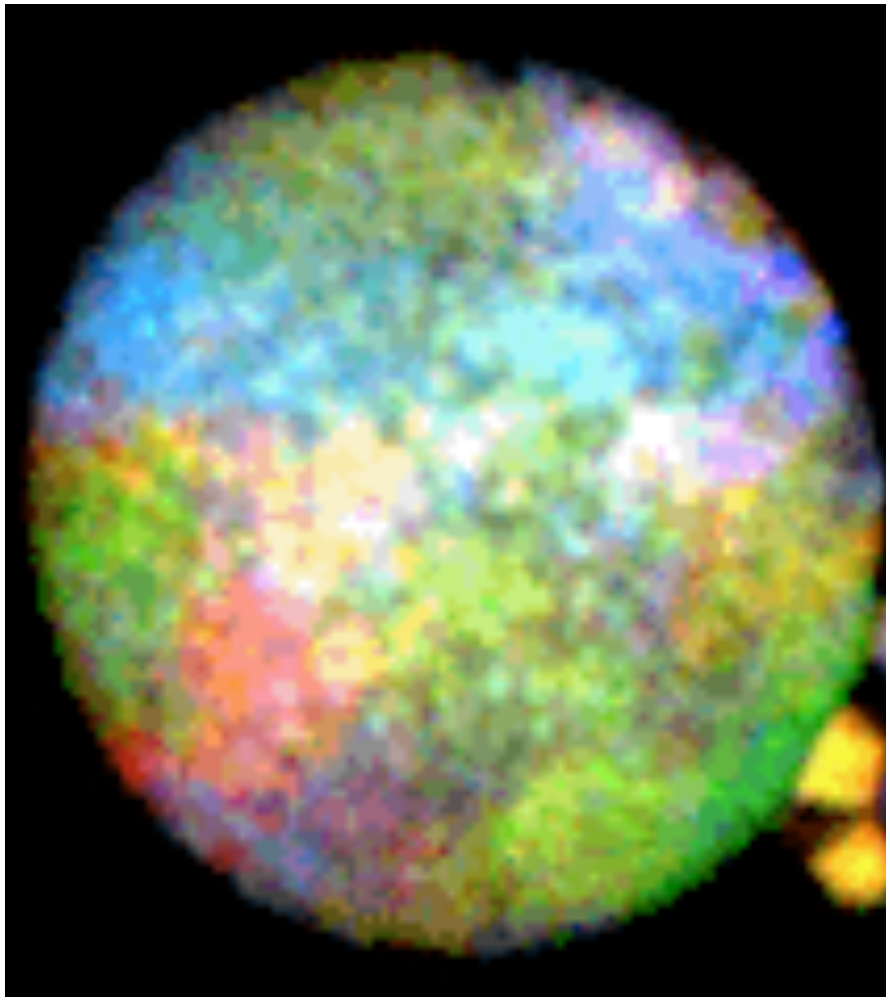
genome



All the sets of instructions for how to make all the proteins we need (23 “books” x 2)

All are written in the same alphabet - DNA

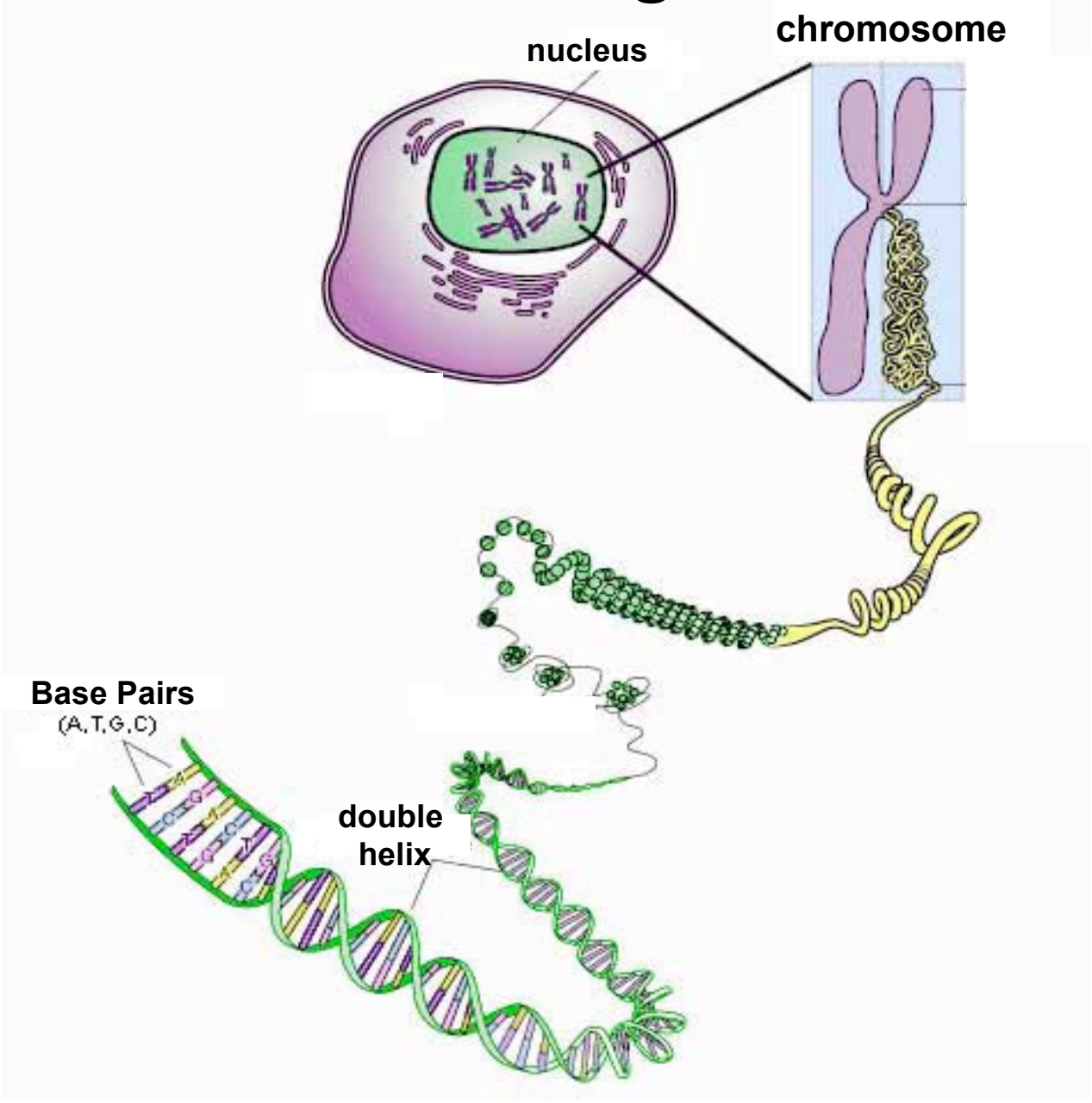
Chromosomes: Interphase vs. metaphase



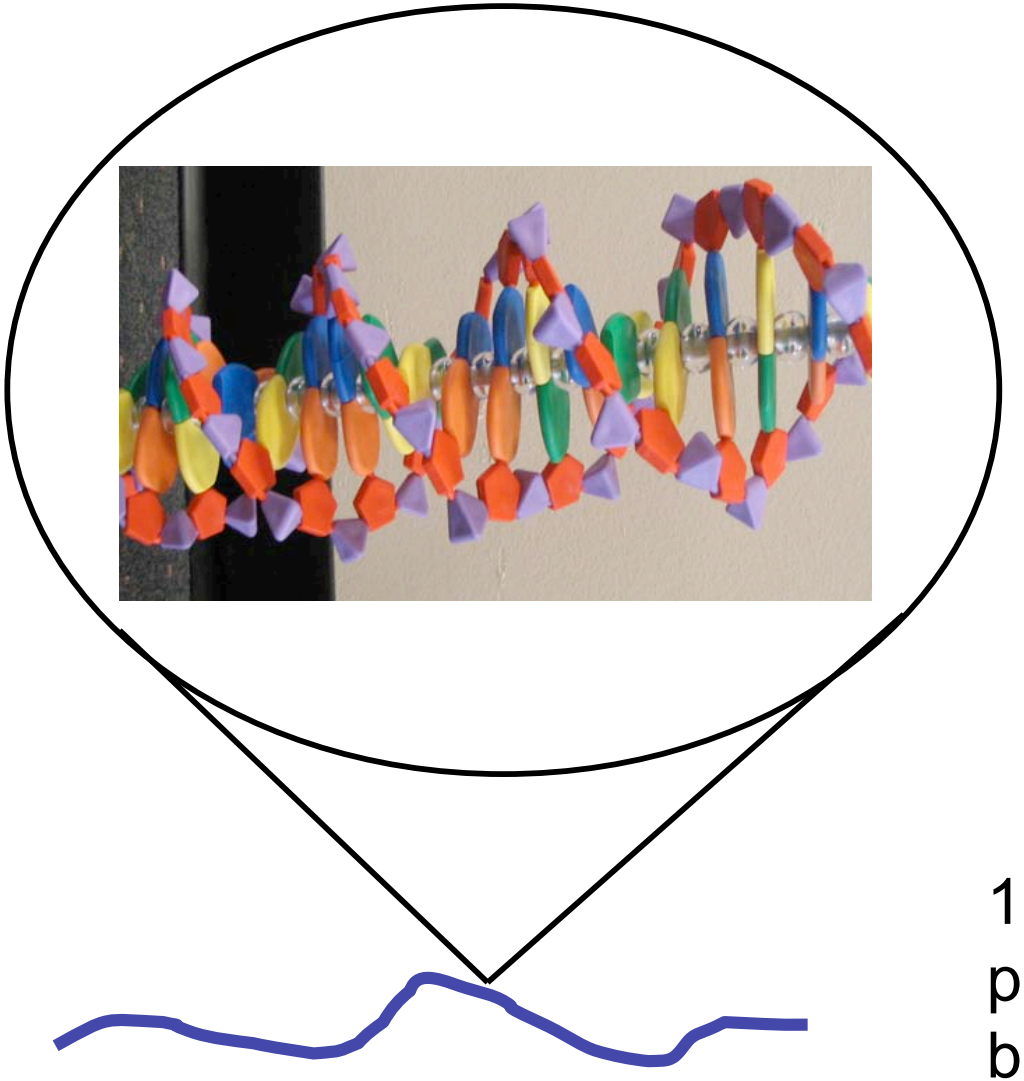
Interphase chromosomes
UNPACKED

Metaphase Chromosome
PACKED

Chromosomes are single strands of DNA



Size of DNA



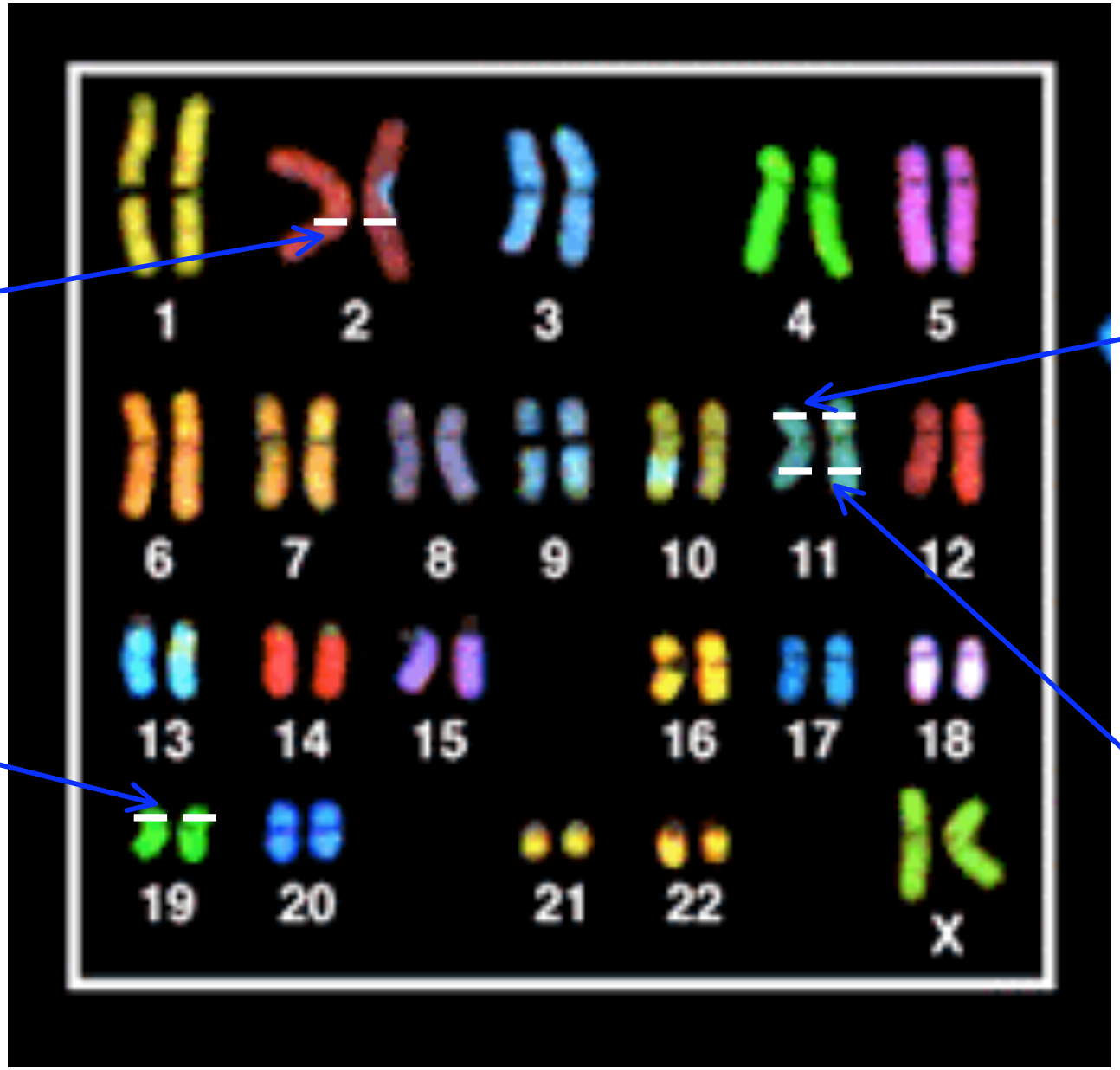
Small piece of DNA

14 pairs of DNA bases = 0.0000035 millimeters

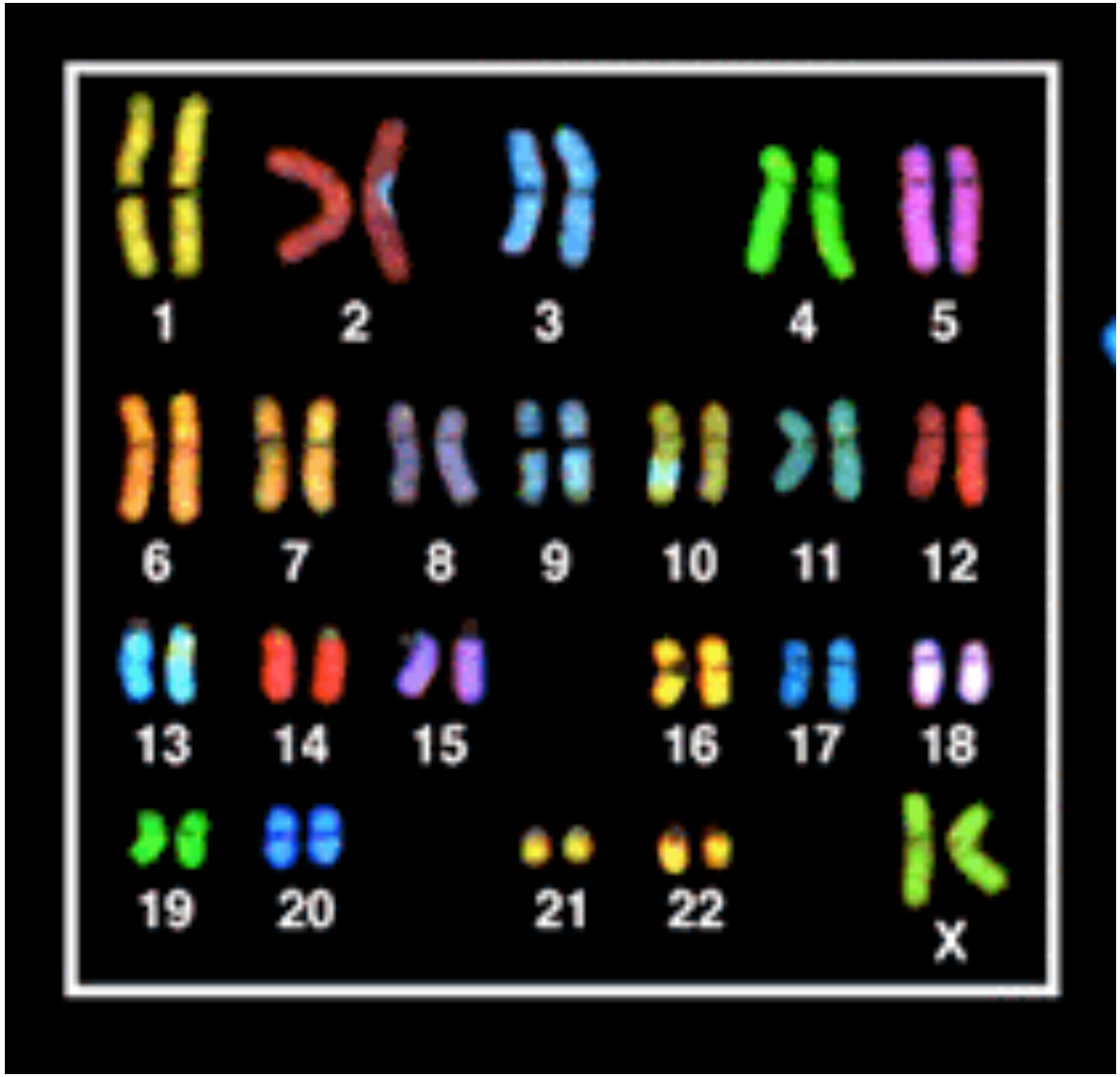
Chromosome 11

135,000,000 pairs of DNA bases = 41 millimeters

Genes in Chromosomes



Human Chromosomes: 23 pairs (one from mom, one from dad)



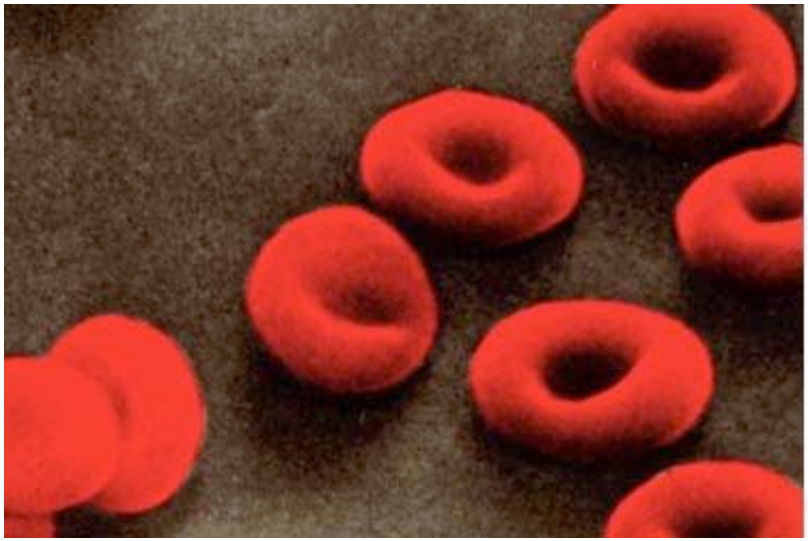
How similar are two DNA sequences?

Example of comparing DNA sequences

Human DNA sequence: ATATTCCAAA
Chimp DNA sequence: ATATTAAAAA
* * * * * * * *

8/10 identical = 80% identical

Sickle Cell Disease

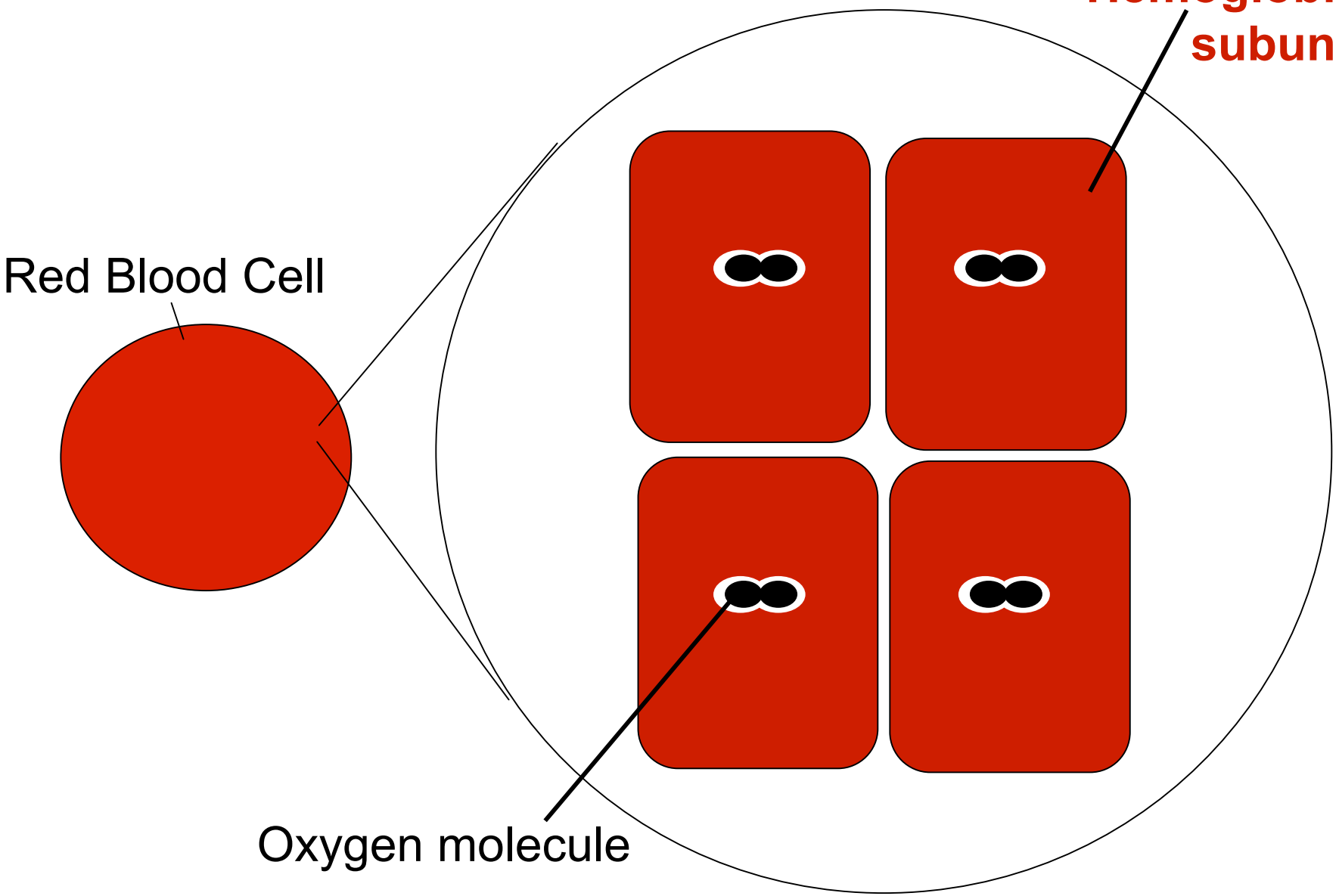


normal red blood cells

sickled red blood cells

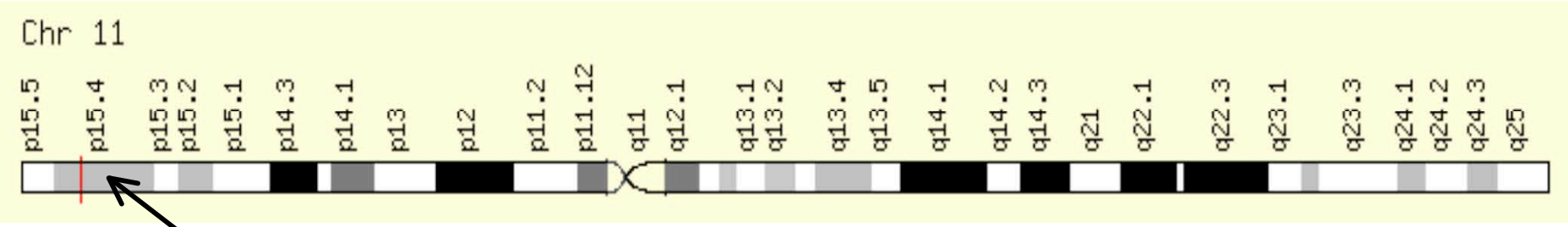
Interview with sickle cell patient: pain

Hemoglobin



Chromosomal location of Hemoglobin

Chromosome 11

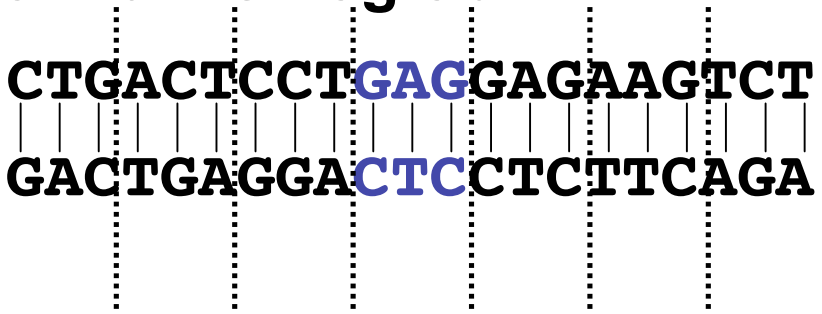


Hemoglobin gene

Mutation found in Hemoglobin

Sequence of normal hemoglobin

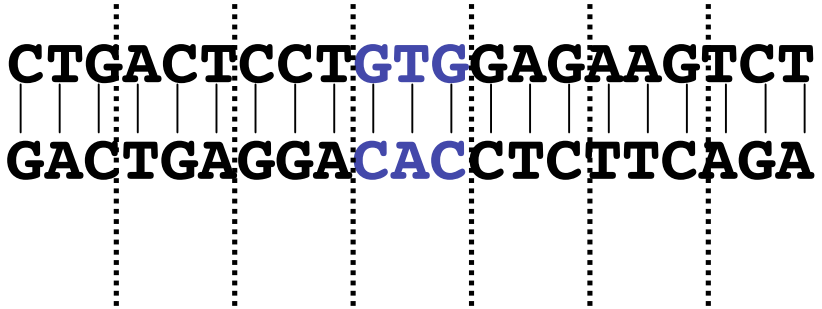
DNA:



Amino acids:

Sequence found in sickling hemoglobin

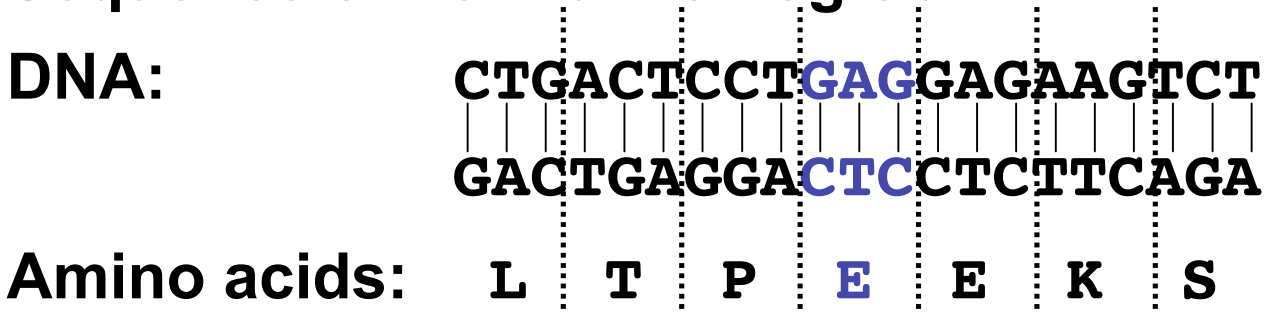
DNA:



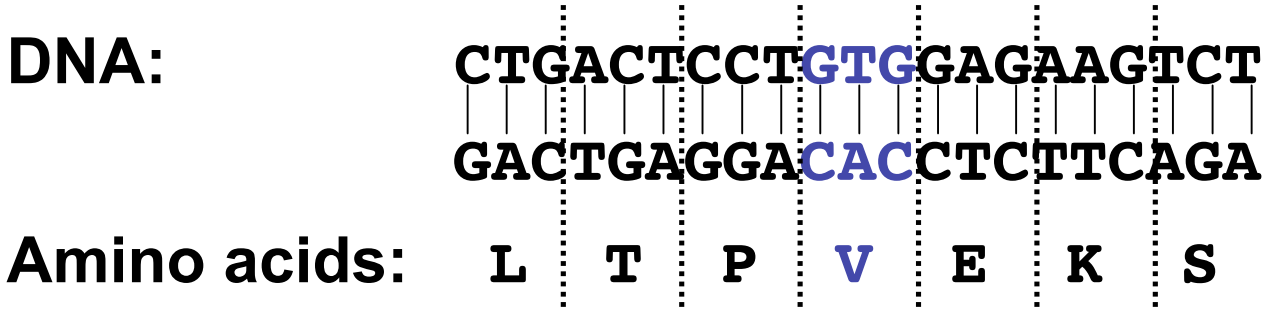
Amino acids:

Mutation found in Hemoglobin

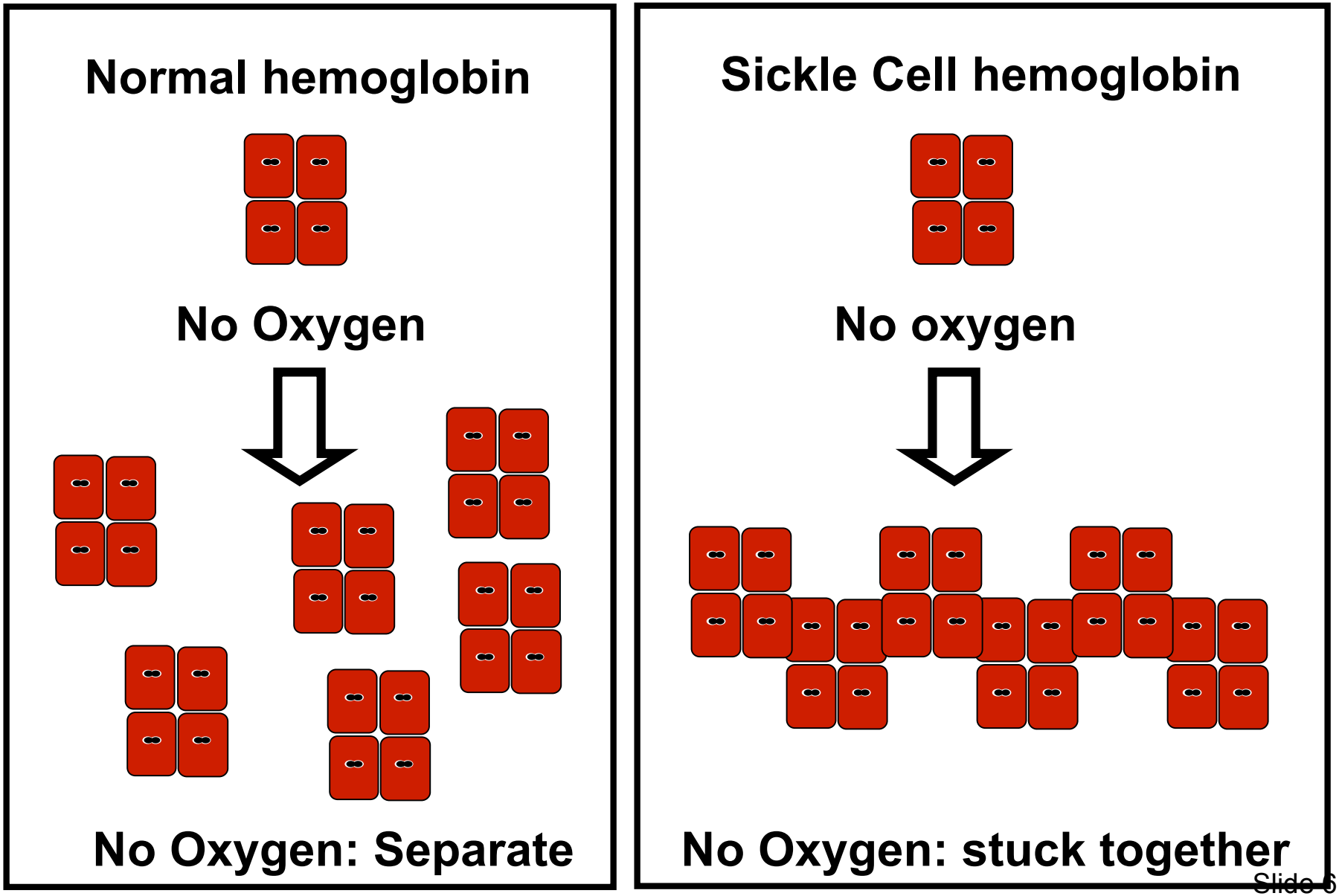
Sequence of normal hemoglobin



Sequence found in sickling hemoglobin



Sickle Cell Hemoglobins Stick Together



Effects of Sickle Cell Mutation

CTGACTCCTGAGGAGAAGTCT
GACTGAGGACTCCTCTTCAGA

CTGACTCCTGTGGAGAAGTCT
GACTGAGGACACCTCTTCAGA

DNA

↓

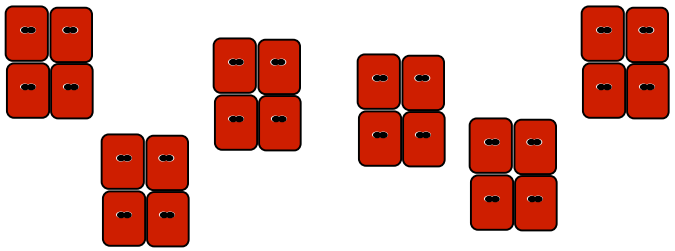
order of amino acids

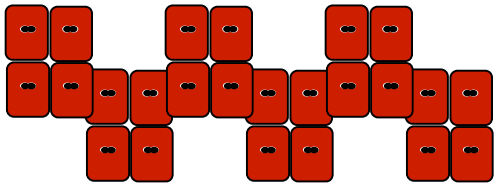
L T P E E K S

L T P V E K S

↓

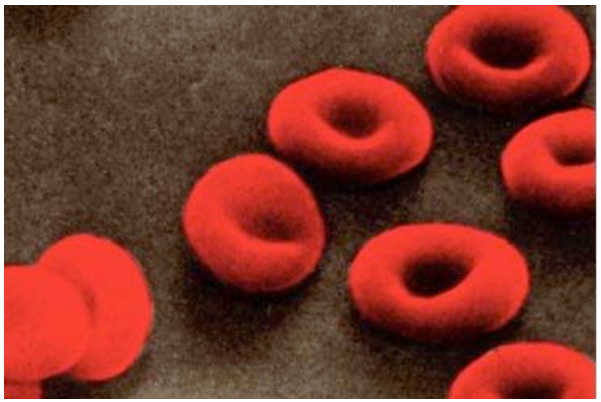
protein shape

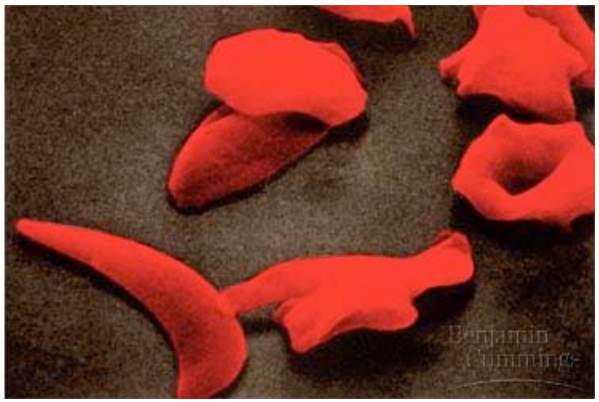




↓

cell function





Frequency of Sickle Cell Causing Mutation vs. Frequency of Malaria Causing Microbe