Cell Structure

Lecture 16

Life forms have life molecules

Modular chemicals; similar units linked together in chains.

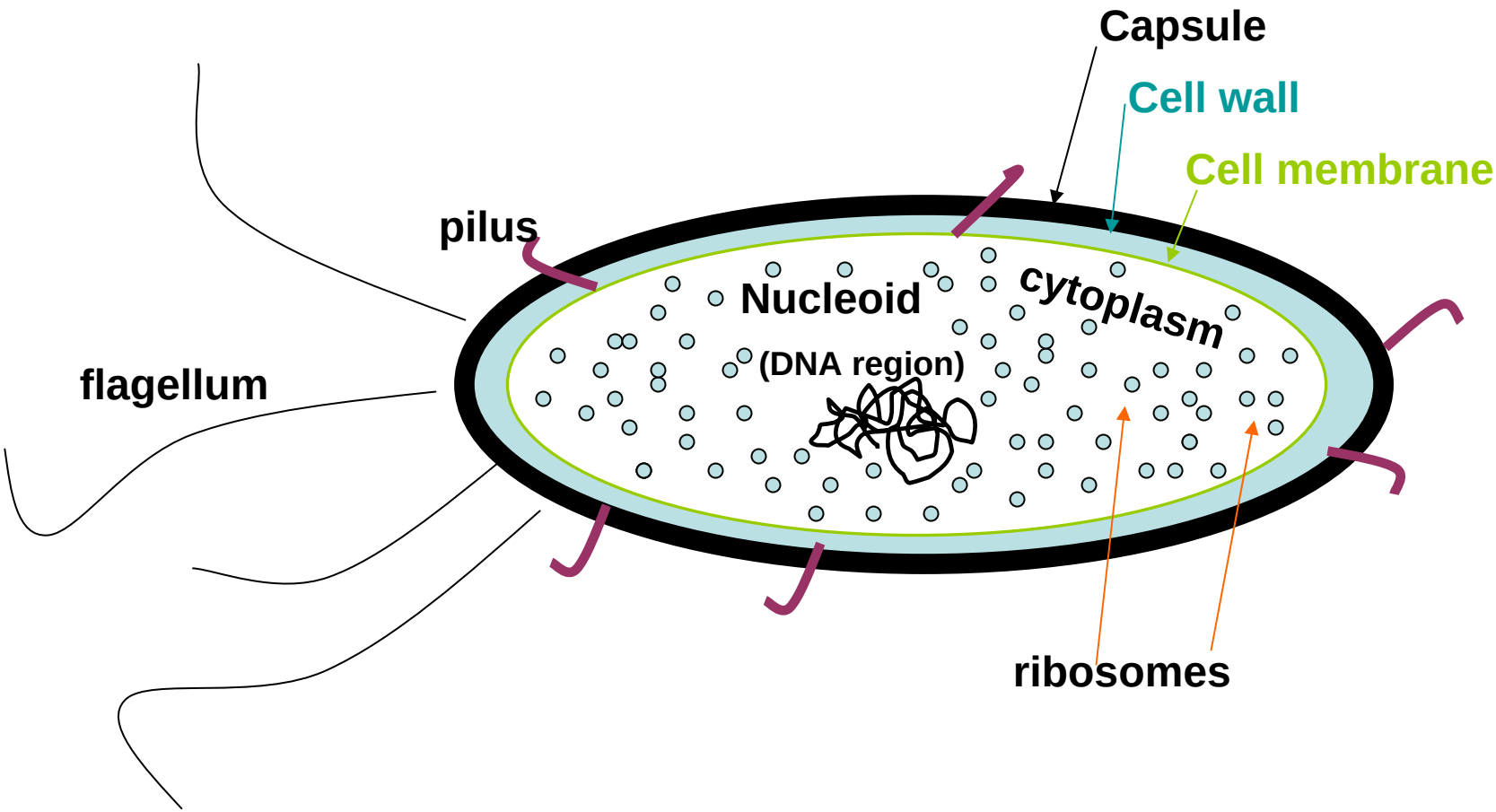
Geometry is important in how they are used.

- Nucleic acids (make up DNA and RNA)
  - are chains of nucleotides
- Carbohydrates example make up starch
  - are chains of sugars
- Proteins example : make up muscle
  - are chains of amino acids
- Lipids example:make up membranes
  - fatty acids (fats and oils)

Organelles are subcellular structures with specific functions

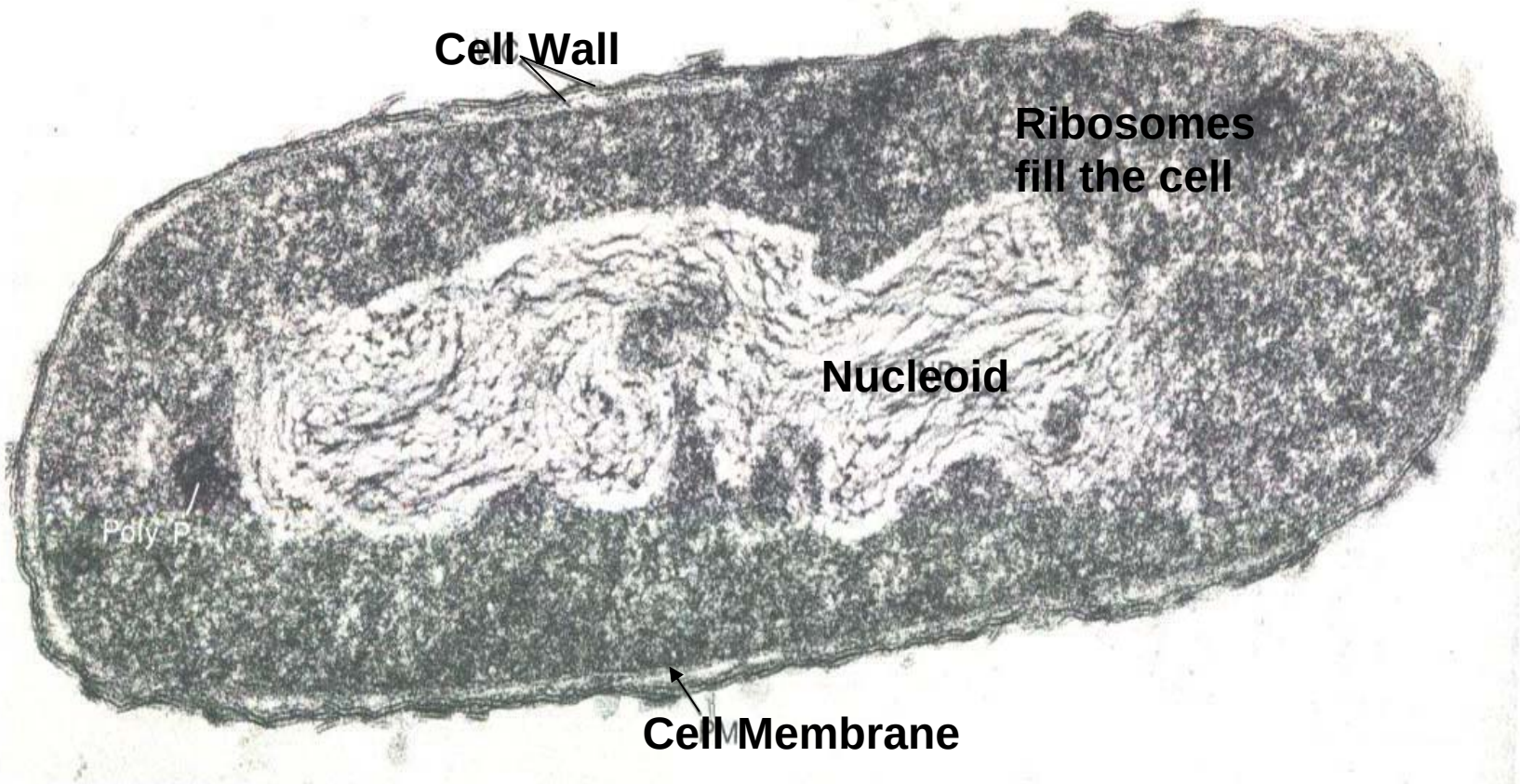
- Nucleus, nuclear membrane
- Cell wall
- Cell membrane
- Mitochondria
- Chloroplasts
- Golgi complex/bodies
- Lysosome
- Ribosomes
- Vacuole
- Flagellum
- Pilus
- Capsule

Bacterial Cell : Procaryotic : no nucleus



Micrograph of *E. coli*

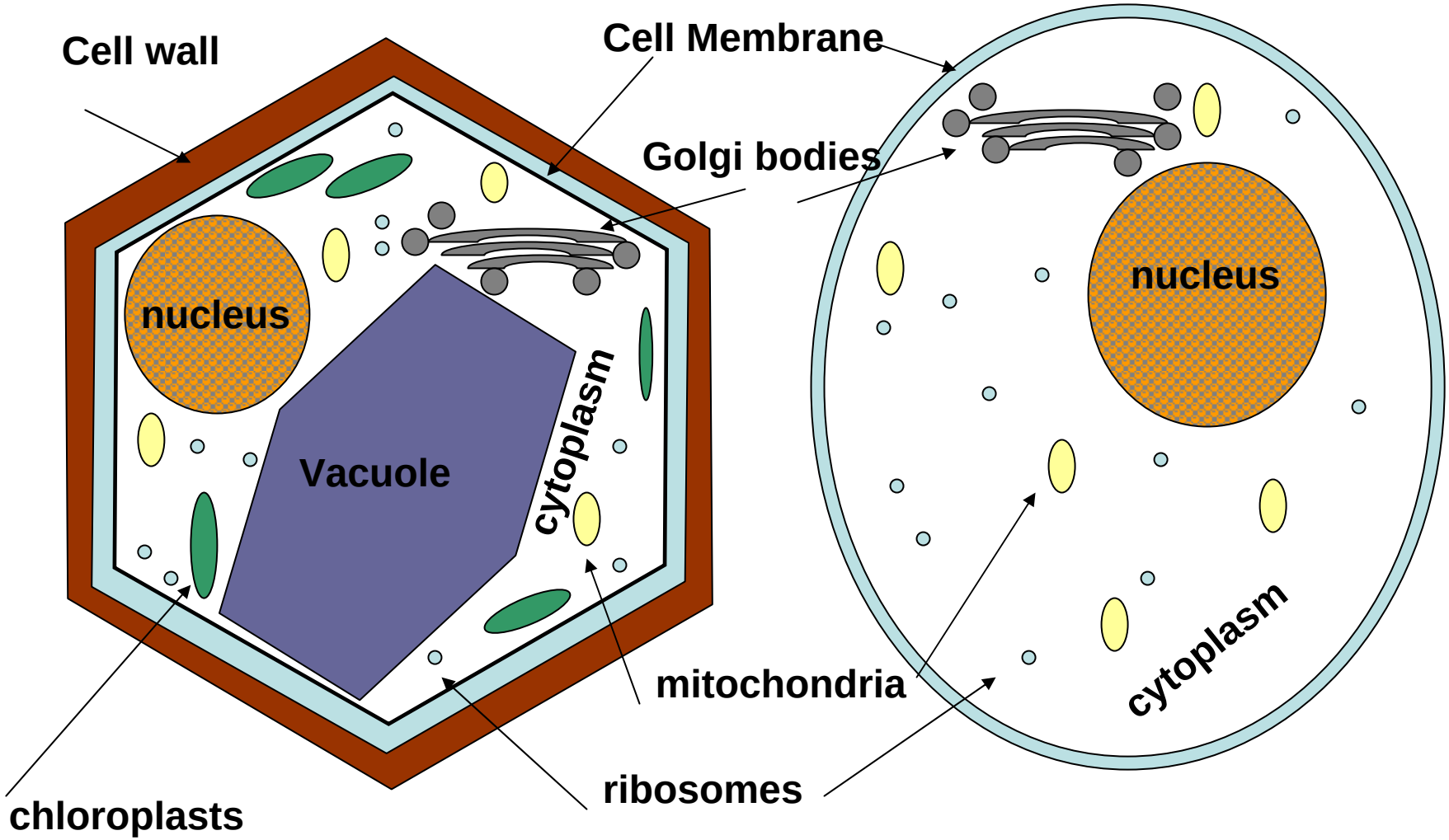
(2.8 x 10^4 times magnified)



Photograph : Mrs. Cohen-Bazire University of California Berkeley

Cell Ultrastructure, Jensen and Park, 1967

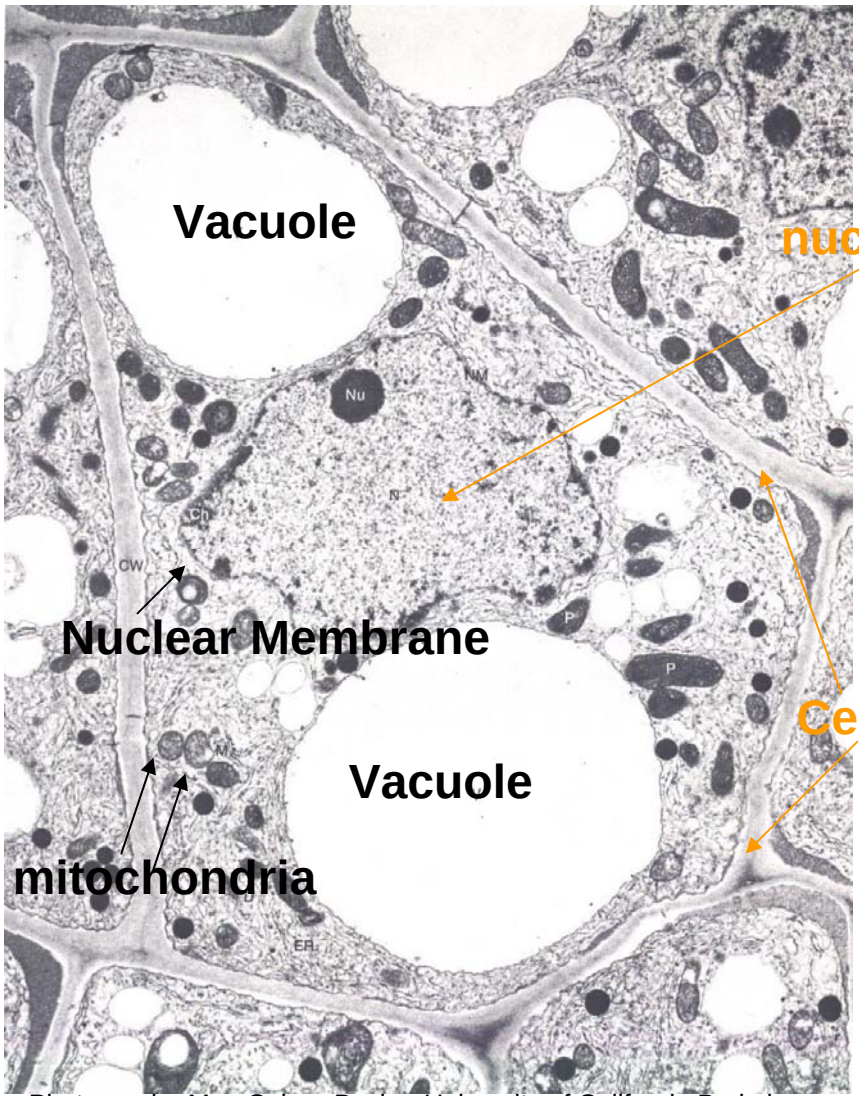
Plant and Animal cells: Eucaryotic cells that have nuclei



Plant cells

Cotton cell 1.28×10^4

Onion cells 1.0×10^2



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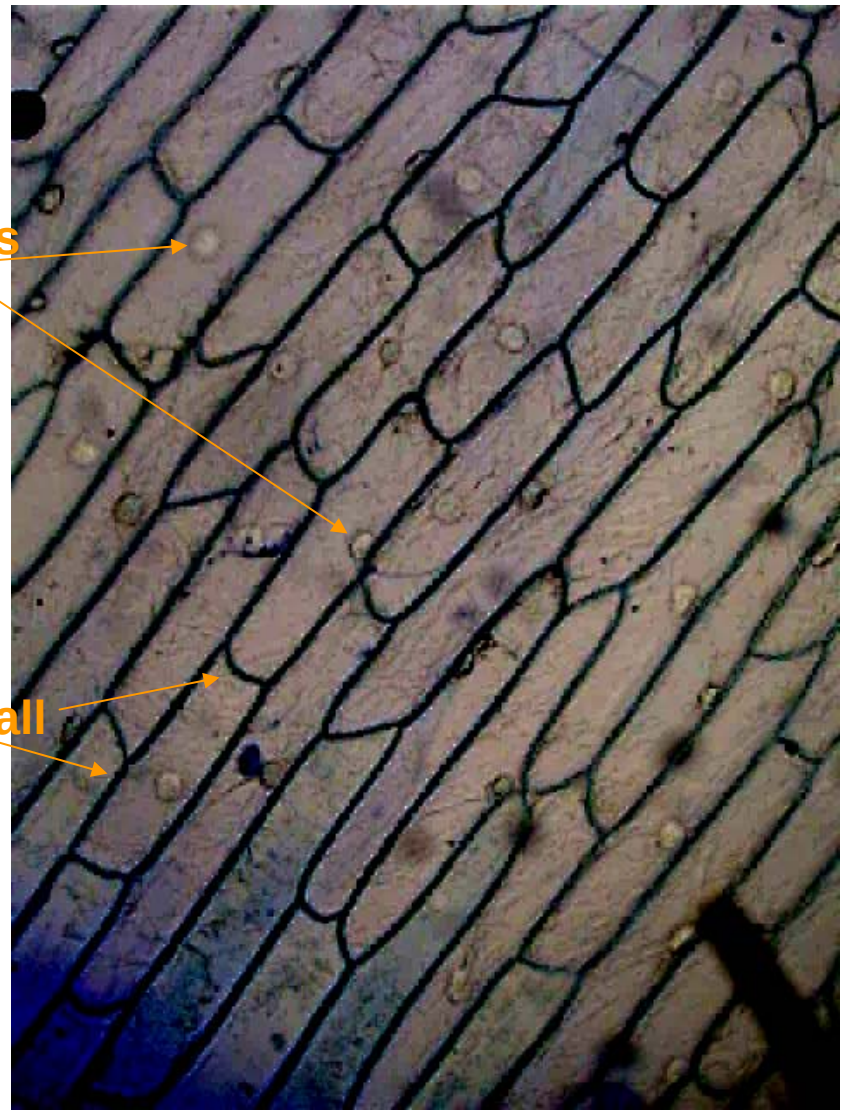
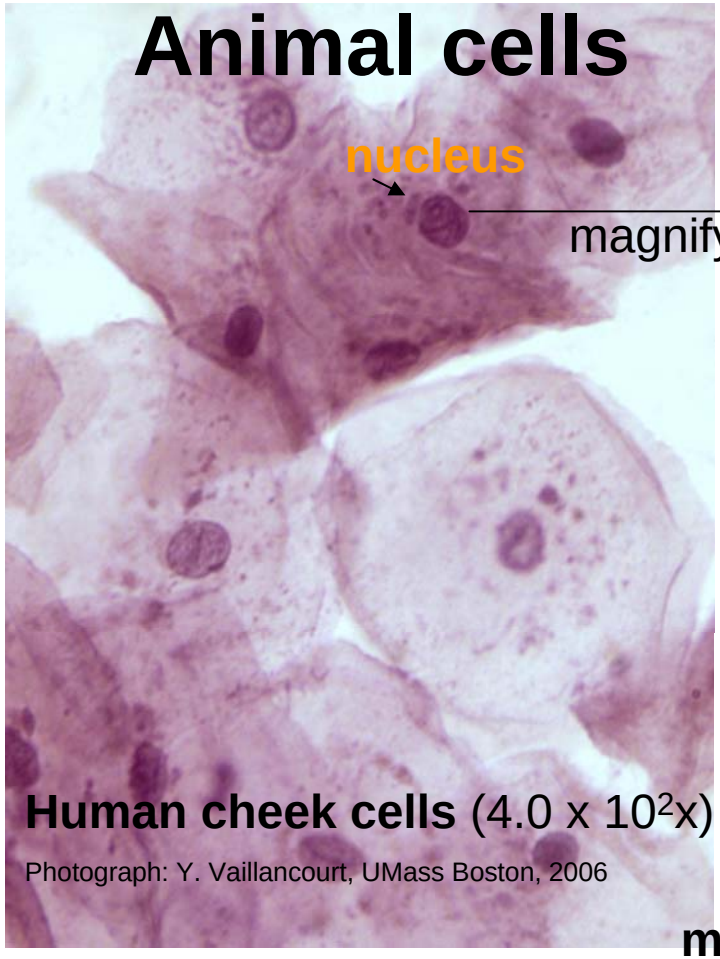


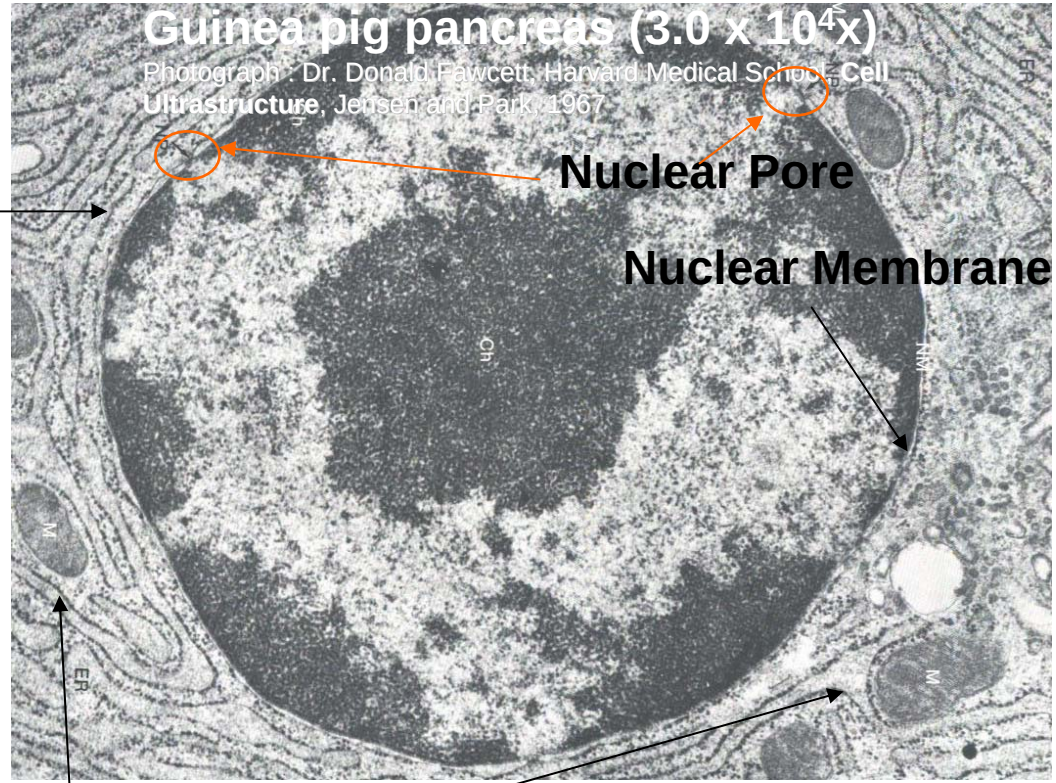
Photograph : Y. Vaillancourt UMass, 2006

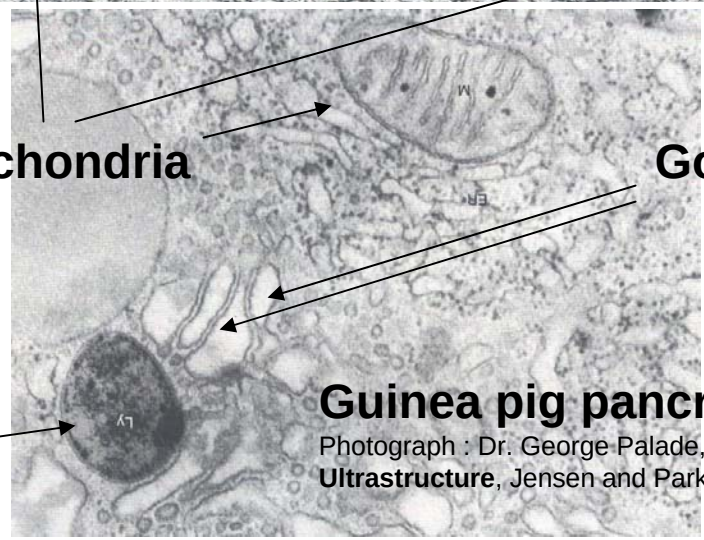
Animal cells



Human cheek cells (4.0 x 10^2x)

Photograph: Y. Vaillancourt, UMass Boston, 2006





There are 2 types of Cell Division

Mitosis : tissue or cell growth

- Asexual reproduction of somatic tissue
  - **Somatic tissue :** vegetative tissue
- Identical daughter cells are created (cloning).
- yields 2 identical cells, this is how things grow, by cells dividing after the chromosomes have duplicated.

Meiosis : formation of gametes (sex cells)

- **Gametes** are cells used in sexual reproduction :egg (Oocytes), sperm (Spermatocytes), pollen
- **Resulting cells have ½ the chromosomal information & it is jumbled.**
- duplicates chromosomes but yields 4 cells, gametes and only ½ of the chromosome number exists in each.
- These cells are used in fertilization, when the chromosome number will double after fertilization, when a **Zygote** (embryo) forms.

BOTH START OFF DOUBLING DNA

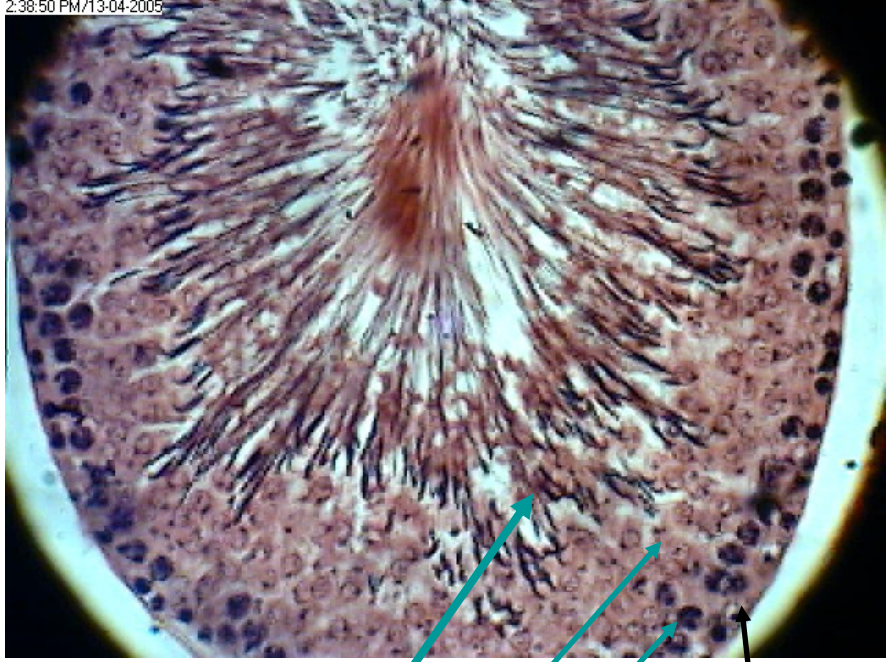
Mitosis

DNA is copied, chromosomes (chromatids) have a copy attached to itself, these get pulled apart and then the cell splits into 2 new cells.

- There are names for each stage involved.
- You can see the stages well as the DNA condenses and moves towards the poles before forming a membrane and 2 new cells.

- For example: Particularly good for viewing stages of cell division as an organism grows are roots of a plant.

Meiotic Stages



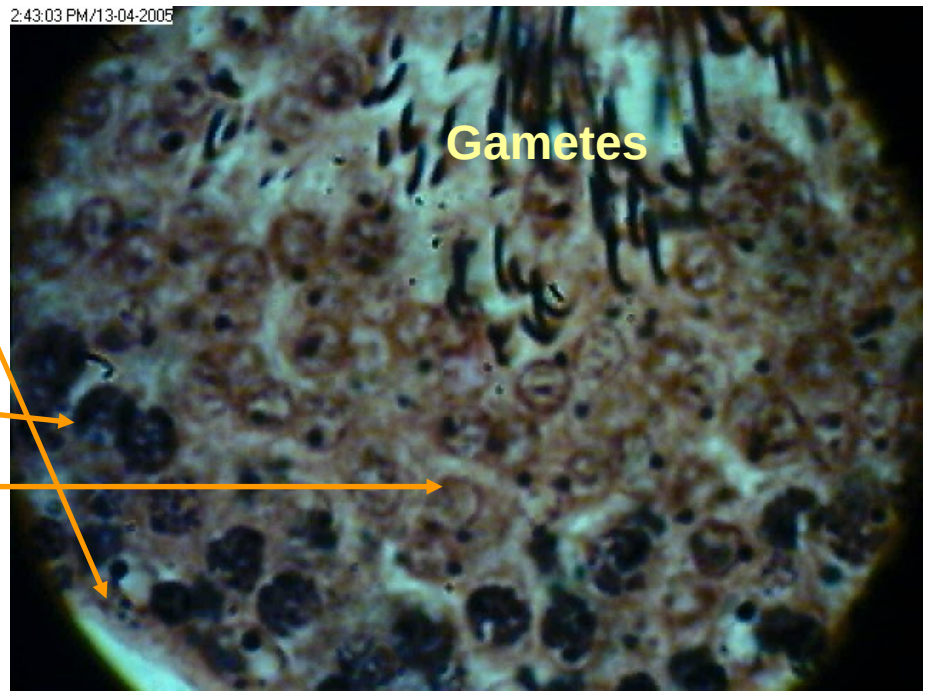
In Rat testis various stages involved in the formation of gametes can be seen.

Stem cells create cells that undergo meiosis.

Cells undergoing meiosis I

Cells undergoing meiosis II

Gametes



Meiosis & Genetics

- Classic Genetics (Mendelian Genetics) based on the work of Gregor Mendel reflects the result of Meiosis.
- Parents pass on information, you might look like a mix of your parents or you might look much more like one than the other.
- It depends on the genetic dynamics.
- Sometimes inheritance is visible sometimes it seems to skip a generation. This we will begin to explain with the basic case of **autosomal** simple dominance.
  - Autosomal refers to the chromosomes that are not related to sex determination. (not an X or Y chromosome)

Simple Dominance

- If you focus on just one trait, for example hair color. Variations of that trait are called **alleles**.
- If one **gene** is involved in determining color, and it is found on an autosomal chromosome, of which you have pairs,then you have 2 alleles for hair color. (one from Mom one from Dad)
- A **dominant allele** will overshadow other alleles, those overshadowed are called **recessive**.
- If you have different alleles (mixed information) for a gene (Loci) it is known as **heterozygous**.
- **Homozygous** refers to alleles being the same.

An Example : brown hair (BB) is dominant over blond (bb)

Blond Mother (bb) x Brunette Father(BB)

Homozygous Homozygous

Each make gametes with only ½ the info

b b B B

Since each will only pass on 1 type of info possible children will have brown hair if brown is dominant, but will carry the blond information. All will be heterozygotes. (Bb)

Heterozygotes carry hidden information

Brunette Mother (Bb) x Brunette Father(Bb)

Heterozygous Heterozygous

Each make gametes with only ½ the info

B b B b

Since each can pass on 2 types of info. each possible child has a chance at 3 outcomes. Chance to have brown hair is 75%, 25% chance of blond.

Use a punnett square to see this.

Punnett Square

Brunette Mother x Brunette Father

Heterozygous (Bb) x Heterozygous (Bb)

	B	b
B	B B	B b
b	b B	b b

Genes

- Genes are segments of DNA that produce specific products.

- They are much more complicated than what we just looked at, series of genes interact. DNA has active and inactive sites.

- To begin to understand some of this lets look at the structure and functioning of DNA.

Replication

- DNA replicates in order for cells to divide.
- It also copies portions of a chromosome in order to express genes.
- Enzymes are involved in opening up the chemical and allowing a copy to be made, like the enzyme **Polymerase**.
- This is manipulated in DNA fingerprinting and is called PCR, Polymerase Chain Reaction.

DNA Structure

- **DNA** is modular, it is made up of repeating units of nucleotides, each nucleotide contains a base, a sugar and a phosphate. A single strand of DNA is a chain of nucleotides.
- In DNA the sugar is Deoxyribose, in RNA it is ribose.

- There are 4 bases in DNA (in RNA thymine is replace with Uracil)
  - A Adanine
  - G Guanine
  - C Cytosine
  - T Thymine U Uracil

- Their assembly is known as the DNA sequence.
- Free single nucleotides float about the nucleus and cytoplasm and are used for replication.

Double Stranded DNA

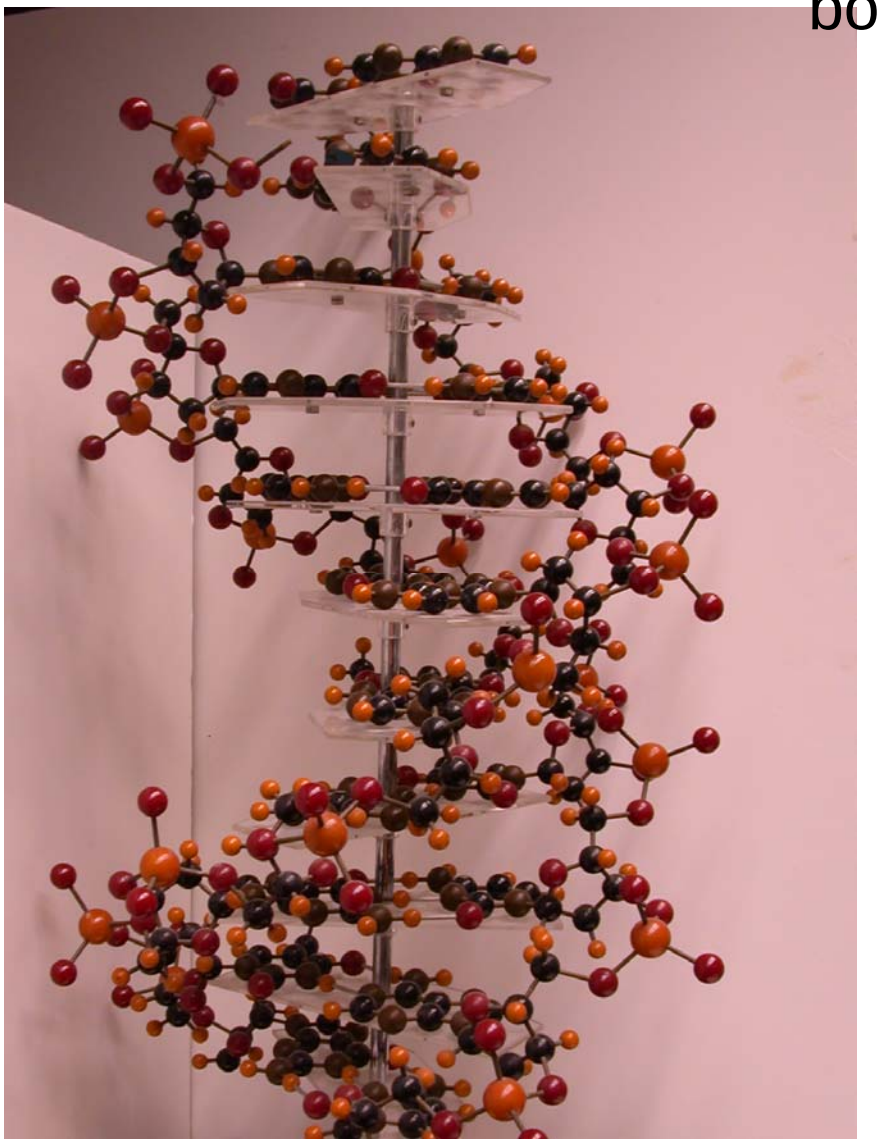
- Two strands can't just be lined up and bonded together unless they are arranged so that every **A** from one strand is matched with a **T** from the other, every **C** with a **G**.

  single strand 1 -A A A C G T A T-

  single strand 2 -T T T G C A T A-

- The cellular machinery carries this out by building the strands.
- If DNA is to be expressed (proteins produced) then RNA is used to make copies of portions of the DNA.
- 3 Bases in a row are known as **Codons**, and will produce 1 specific amino acid.

Double Stranded DNA is a **Helix** : a twisted ladder, each rung a pair of bases bonded together with hydrogen bonds.

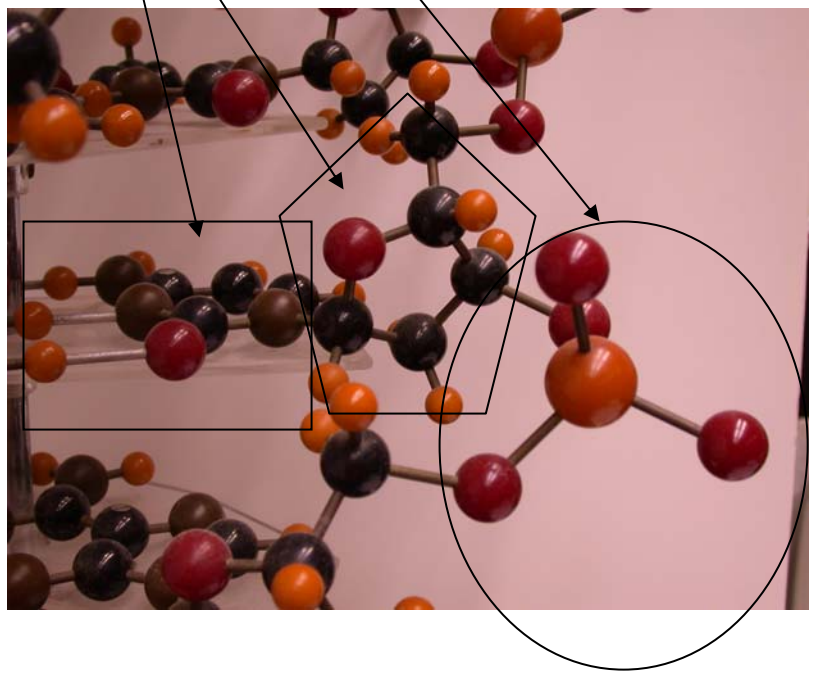


Nucleotide :

1 phosphate

1 sugar

1 base



DNA Expression

- A copy of the segment of DNA is **Transcribed** into a piece of RNA called messenger RNA. (**mRNA**)
- That piece of **mRNA** leaves the nucleus and is Translated into a protein by ribosomes and molecules called transfer RNAs **(tRNAs),** as they ferry amino acids to the site of translation.
- This is where and how a protein is produced. Proteins regulate many biochemical activities we need to function.

Go to
DNAI.org
or
HHMI.org\biointeractive