

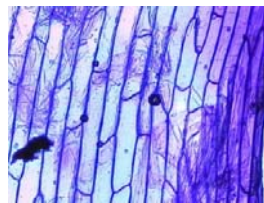
# UNIT 1: Matter and Energy For Life

Chapter 1  
Micro-universe of the Cell

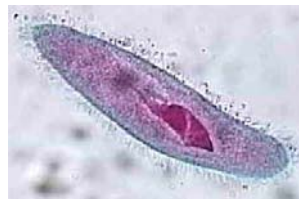
Biology 2201

## Development of the Cell Theory

- People have known about the existence of cells for only the last 300 yrs or so
- Early microscopes allowed scientists to discover what we now take for granted:
  - All living things are made up of cells
  - Cells are fundamental units of life



Onion skin cells



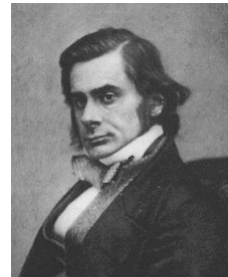
Paramecium

## The cell Theory States That...

- All living organisms are made up of one or more cells
- Cells are the basic unit of structure and function in all organisms
- All cells are derived from pre-existing cells (This means that ALL cells had to come from other cells)
- In a multicellular organism (like a plant or a human) the activity of the entire organism depends on the total activity of individual cells that make up the organism

## Going Back A Few Years

- Cell theory was stated first in 1858, challenging the believe system at the time
- People believed small animals could arise spontaneously from non-living or dead things
  - “Spontaneous Generation”
  - Thomas Huxley renamed it to “**abiogenesis**”
- Live coming from life came to be called “**biogenesis**”



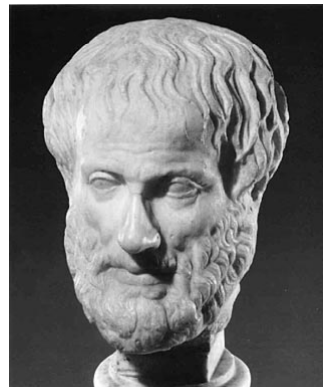
Thomas Huxley

# Evidence for Abiogenesis

<u>Evidence that supported abiogenesis</u>	<u>Fact or Fiction</u>
<ul style="list-style-type: none"> <li>• Maggots suddenly appeared on uncovered meat after several days</li> </ul>	Fiction – Maggots were present, but only after the flies laid their eggs on the meat
<ul style="list-style-type: none"> <li>• Frogs and salamanders suddenly appearing on or in mud</li> </ul>	Fiction – These amphibians hibernate and burrow into the mud and come to the surface to eat
<ul style="list-style-type: none"> <li>• Jan Baptista van Helmont said that mixing a dirty shirt with wheat grains would produce adult mice that would then mate.</li> </ul>	Fiction – The mice that were attracted to the food source (wheat) arrived, and then mated. They possibly hid in the mixture
<ul style="list-style-type: none"> <li>• John Needham's experiment with meat broth teeming with microbes after being boiled.</li> </ul>	Fiction – He did not boil the broth long enough to kill all the bacteria in the broth, and so they divided, making the broth cloudy.

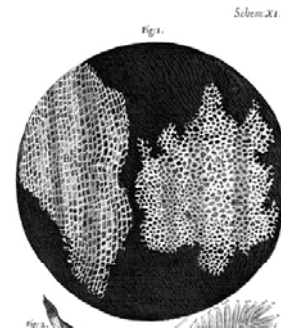
# Key Events in Biological History

- **Aristotle** observes and formulates ideas about nature.
  - He was the first to divide organisms into two groups (kingdoms)
    - **Plants** – those that don't move
    - **Animals** – those that move
  - Aristotle supported *spontaneous generation*.



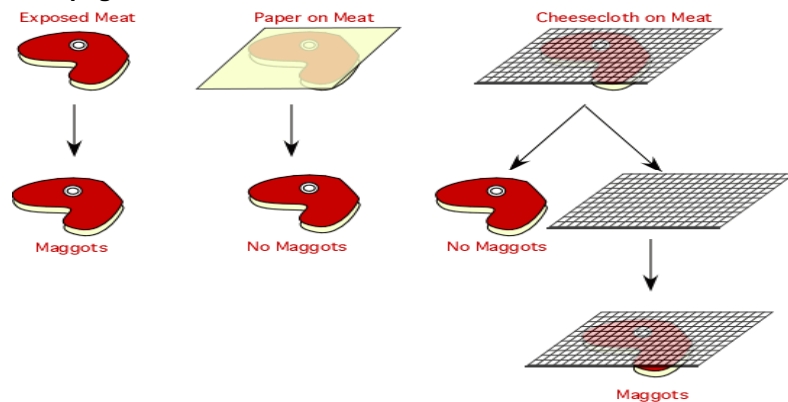
## More History

- After studying the nature of reproduction, **William Harvey** begins to question the idea of abiogenesis, suggesting that maggots on meat come from eggs that are too small to see. This was during the 1600's, and we now know this to be true
- **Robert Hooke** writes a book, in which it shows illustrations of tree bark as seen under the microscope. The drawing showed compartments he called "**cells**"
- **Antony van Leeuwenhoek** designed his own microscope with a tiny simple lens. He reported that he seen tiny "**animalcules**" or tiny organisms that moved. This marked the discovery of **bacteria**, the simplest of all living organisms. Leeuwenhoek developed microscopes that had the clearest quality image at the time.



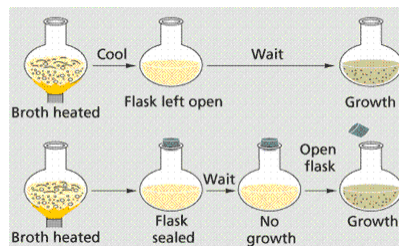
## Francesco Redi

- Conducted one of the first controlled experiments that supported biogenesis. He used meat in jars, half covered with mesh and half open. After several days he found that the mesh-covered meat had no maggots, while the open jar had maggots.
  - See page 8 in textbook



## Needham & Spallanzani

- **John Needham** designed an experiment that incorrectly supported abiogenesis. He boiled a meat broth for a short period of time, and poured it into two flasks, covered and uncovered. Both became cloudy because of bacterial growth after several days. He believed that the organisms came from the water itself. He did not boil the water long enough to kill all the bacteria.
- **Lazzaro Spallanzani** didn't agree with Needham, and so repeated Needham's experiment. This time the broth was boiled for a longer time. No life appeared in the sealed flask, while the open flask had bacterial growth. Boiling the broth "killed the vital principle" that made life arise from non-living matter like water.

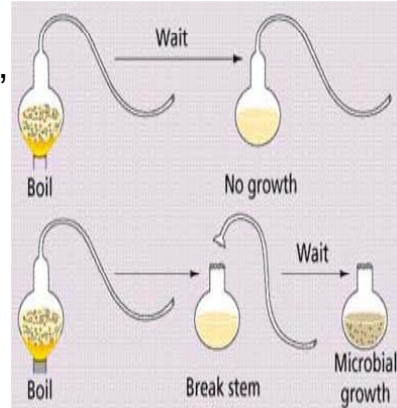


## Other Scientists

- **Robert Brown** observed cells from various organisms and noticed that they all had a dark region in them. This dark region has recently been called the nucleus.
- **Matthias Jacob Schleiden**, a botanist, said that "all plants are made up of cells"
- **Theodor Schwann** wrote that "all animals are made up of cells" and then added that "cells are organisms, and animals and plants are collectives of these organisms"
- **Alexander Carl Henrich Braun** said "cells are the basic unit of life"
- **Jugo von Mohl** said that "protoplasm is the living substance of the cell" then added that "cells are made up of protoplasm enveloped by a flexible membrane"
- **Rudolph Virchow** wrote that "cells are the last link in a great chain [that forms] tissues, organs, systems and individuals... where cells exist there must have been pre-existing cells..."

## Louis Pasteur

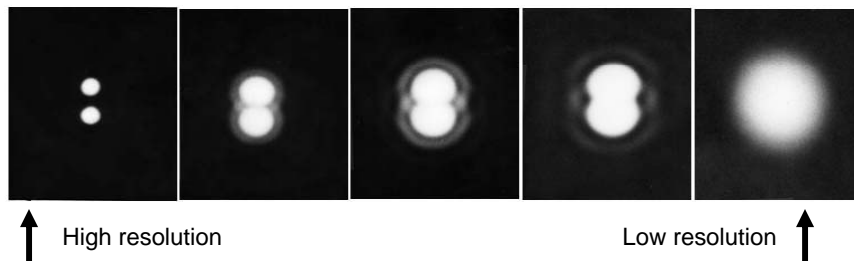
- conducted experiments that disproved abiogenesis, concluding that organisms do NOT arise from non-living matter.
- Goose-neck flask experiment is the guiding principle behind *pasteurization*



Pasteur's Experiments

## Using a Microscope to Explore the Cell

- **Resolution or Resolving power**
  - The ability of the eye, or other instrument, to distinguish between two objects that are close together

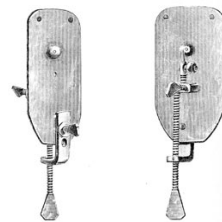


# Early Use of Microscopes

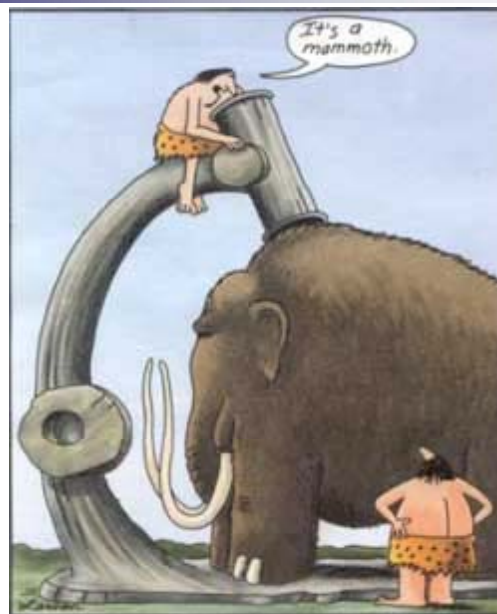
- Tendency to look at the known world
- Magnified up to 50x the actual size
- Most microscopes had 2 lenses doubling the distortion of the poor quality lenses
- Van Leeuwenhoek mastered lens craft in his single-lens scopes achieve magnifications as high as 500x with little distortion



Culpeper  
Screw-Barrel  
Microscope  
(circa 1720)



Van Leeuwenhoek's  
microscope



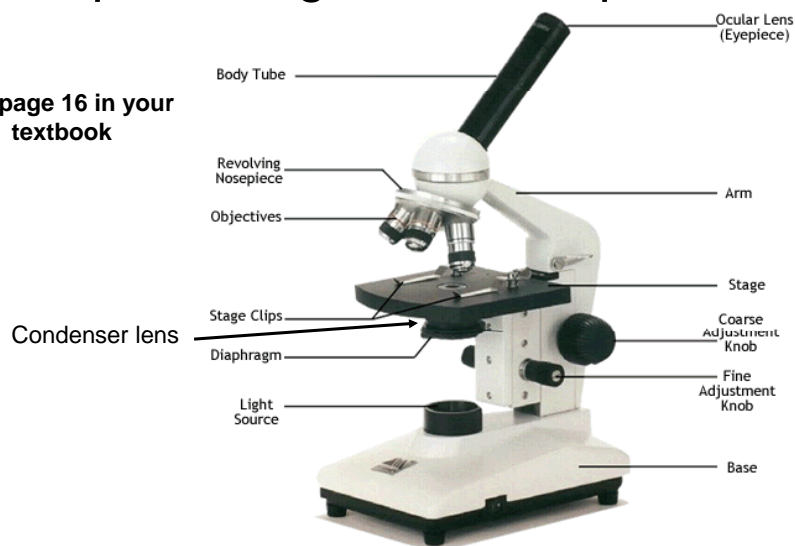
Early microscopes

## Modern Light Microscopes

- Compound light microscopes today have drastically improved how we see the world
- New glassmaking technology has removed the distortions from lenses, allowing scientists to focus more sharply on the images they were observing
- Magnifications up to 5000x  
Resolutions as fine as 0.0002 mm
- The microscopes you will use have similar structure but not the high magnification

## Compound Light Microscope Parts

See page 16 in your textbook





## Caring For and Using a Microscope

- LAB ACTIVITY → PAGE 15 – 19

This must be completed in the class time provided

- Techniques covered in this lab will be on the test / exam

## Microscope Imaging of Today

- **Compound light microscopes**

- Max. magnification of about 2000X
- Can see most but not all cells, and cell structures
- Resolution limited to about 0.2  $\mu\text{m}$
- Resolving power is limiting, so the light source must be changed to accommodate this

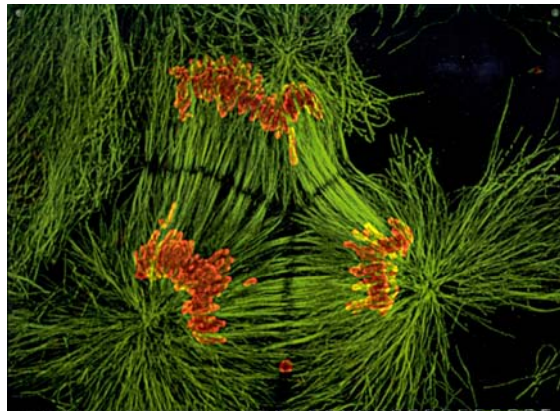
- **Electron microscopes**

- Use a beam of electrons instead of light to magnify objects
- Use electromagnets to focus beams instead of lenses

## Plant parasitic nematode - DIC



## Epithelial cell in anaphase – Confocal Microscope



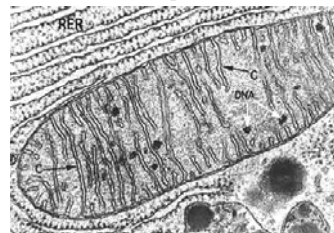
## Polychaete nematode - Darkfield



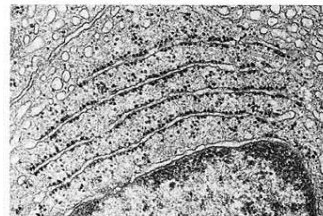
## 2 Types Electron Microscopes

### 1. Transmission electron microscope (TEM)

- Magnifications up 500,000 times
- Resolutions as low as 0.0002  $\mu\text{m}$
- Electrons are “transmitted” through the specimen
- First built in 1938 at U of Toronto – achieving magnifications of 7000X
- First observed cell structures
- See page 20 for figure

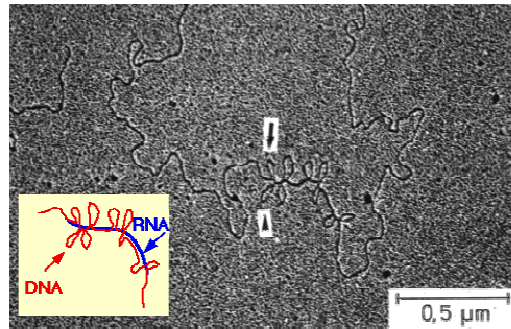


Mitochondrion



Rough ER – notice the ribosomes

# Mitochondrial DNA and RNA

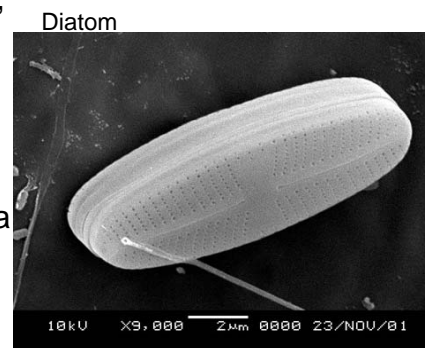


## 2. Scanning Electron Microscope (SEM)

- Magnification's over 300,000 times
- Resolutions 0.005 μm - lower than TEM
- Specimen is sprayed with a gold coating and "scanned" with a narrow beam of electrons
- An electron detector produces a 3-dimensional image of the specimen on a TV screen
- See page 20 for figure



Sea urchin sperm



Diatom

## Mitochondria in human liver cell

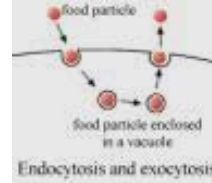


## Structures in Cells

- **ALL** cells start out as fully functional living things
- They must be able to create and maintain substances (compounds, ATP, ADP) and structures (membranes, organelles) that perform all the essential tasks necessary for the cell to function
- My question for you...
  - What are these essential tasks?

## Essential Tasks for Cells

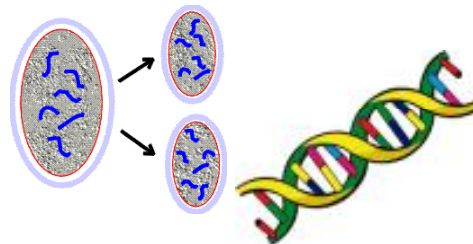
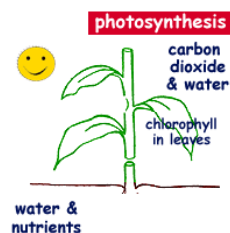
- Obtain food and energy



- Convert energy from an external source (sun or food) into a form that the cell can use (ATP)
- Construct and maintain molecules that make up cell structures (proteins)

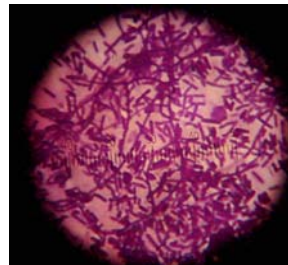
## More Essential Tasks

- Carry out chemical reactions (photosynthesis, respiration)
- Eliminate wastes ( $\text{CO}_2$ , alcohol, urea)
- Reproduce
- Keep records of how to build structures (DNA)



## Prokaryotic Cells

- **Smallest** living cells
- **Simple** internal structure
- Lack membrane-bound organelles
- Pro = Before  
Karyon = nucleus  
They have **NO nucleus**
  - DNA in a Nucleoid



**ALL BACTERIA ARE  
PROKARYOTIC**

## Prokaryotic Cells

- Since they do not have a nucleus, all the genetic information is concentrated in an area called the **nucleoid**. Some prokaryotic cells also have a small ring of DNA called a **plasmid**
- The only living things with prokaryotic cells are Kingdom Bacteria and Kingdom Archaea
- Prokaryotic cells move using **flagella**
  - **Flagella** – long, hair-like projections extending from the cell membrane that propel the cell using a whip-like motion
- prokaryotic cells have cell walls made of a chemical called peptidoglycan
- See Fig. 1.22 on page 33

## Eukaryotic Cells

- Eu = True  
Karyon = Nucleus  
The **DO** have a nucleus
  - Have membrane-bound organelles
    - Nucleus, vesicles, mitochondria, Golgi body
  - Organelles function as a “team” to carry out the essential functions
- ALL PLANTS, ANIMALS, FUNGI**



## The Animal Cell

- **KNOW** Figure 1.11 in your text – you will be expected to label either the animal cell or plant cell (coming up later)
- You will also be expected to know the functions of all the parts of the cell and how they work together to help the cell function



## Cell Organelles

- Organelles (small organs)
  - Specialized structures within cells that each have a specialized function, like nuclei and chloroplasts
- Cytoplasm
  - Fluidic gel made up mostly of water and dissolved nutrients and waste
  - Provides a fluidic environment organelles to carry out chemical reactions
- Cell membrane
  - structure that separates the cell interior from the outside world and controls the movement of materials into and out of the cell

## Organelles

- Nucleus
  - Command centre of the cell that contains the DNA blueprints for making proteins and is surrounded by a double-membrane to protect the DNA from potentially damaging by-products of biochemical reactions
- Nuclear pores
  - Pores in the nuclear membrane large enough to allow macromolecules to enter and ribosomes to leave the nucleus
- Chromatin
  - uncoiled chromosomes (DNA)
- Nucleolus
  - a specialized area of chromatin inside the nucleus responsible for producing ribosome

## ■ Ribosome

- Tiny two-part structure found throughout the cytoplasm that help put together proteins

## ■ Endoplasmic reticulum (ER)

- System of flattened membrane-bound sacs and tubes continuous with the outer membrane of the nuclear envelope that has two types of membrane
  - **Rough ER** – has ribosomes and synthesizes proteins
  - **Smooth ER** – synthesizes phospholipids and packages macromolecules in vesicles for transport to other parts of the cell

## ■ Vesicle

- Small membrane bound transport sac. Some special types of vesicles have different jobs in the cell
  - **lysosome** – contains digestive enzymes that break down old cell parts or material brought into cells
  - **peroxisome** – breaks down lipids and toxic waste products

## ■ Golgi apparatus

- Stack of flattened membrane-bound sacs that receive vesicles from the ER, contain enzymes for modifying proteins and lipids, package finished products into vesicles for transport to the cell membrane (for secretion out of the cell) and within the cell as lysosomes

- Mitochondrion

- Powerhouse of the cell where organic molecules (usually carbohydrates) are broken down inside a double membrane to release and transfer energy

- Centrosome

- Organelle located near the nucleus that organizes the cell's microtubules, containing a pair of centrioles (made of microtubules) and helps organize the even distribution of cell components when cells divide

- Vacuole

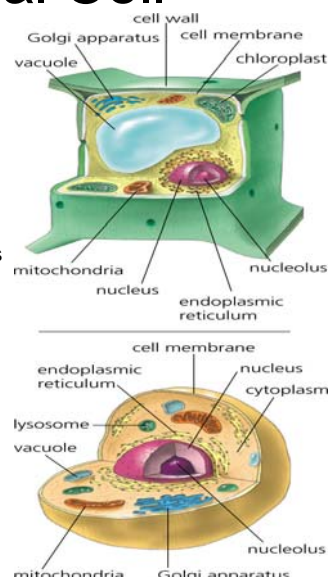
- Large, membrane bound fluid filled sac for the temporary storage of food, water or waste products

- Cytoskeleton

- Network of three kinds of interconnected fibres that maintain cell shape and allow for movement of cell parts

## Plant Cells vs. Animal Cell

- Plant cells contain many of the same structures as animal cells, but there are some differences:
- plant cells have an outer cell wall made of cellulose; animal cells do not
  - Provides rigidity and protection
- Plant cells have one large central vacuole; animal cells have several vacuoles
  - Provides rigidity and stores wastes, nutrients and is filled with water
- Animal cells have a centrosome; plant cells do not
  - Involved in animal cell division
- Plant cells have chloroplasts; animal cells do not
  - chloroplast – plastid that gives green plants their colour and transfers energy in sunlight into stored energy in carbohydrates during photosynthesis





# Chapter 1 Review Questions

- Page 35

- Questions 1, 2, 3, 4, 7, 11, 16

- DUE DATE:

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- TEST DATE:

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