January 29 Lecture Notes. CELLS: The Basics

Cell: A basic unit of living matter separated from its environment by a plasma membrane; the fundamental structural unit of life

1665: The term 'cell' was first coined by Robert Hooke in 1665 as he peered through his microscope at a sample of cork (bark material from the cork oak *Quercus suber* – a specimen of this species is on SBCC campus near the barrel cacti we might have examined during lab in week 1). The individual spaces, or "cells", reminded Hooke of monastic cells (the small cells in which monks dwell and ponder), hence the name.

1674: Antonie van Leeuwenhoek is first human to record observations of live single celled organisms (the alga *Spirogyra* sp.) under a microscope.

Mid 1800's – cell theory developed and formalized (a joint effort building upon the observations of Hooke, van Leeuwenhoek and many others)

Cell Theory (three important premises – I will NOT ask you this on exams!!):

1) Cells are the fundamental unit of structure and function in all organisms
2) All living things are composed of cells
3) All cells are derived from other living cells

Cell sizes: generally 1-10µm (bacteria/archaea); 10-100 µm (plant and animal cells)
(1meter = 1000mm; 1mm = 1000 µm [micrometer or 'micron'])
(by the way, 1 meter = 1 ten millionth of the distance from the equator to the north pole – you don't need to know this….!!!)

(FYI: notably large (and common) single cells are unfertilized eggs of birds such as chickens and ostriches (the latter is one of the largest single cells in known to biology).

PLANT CELL STRUCTURE

Plant cells have the following structures (that you need to know for this class, LOTS of other cell structures exist but are not included here. You're welcome…).

- **Cell wall –** Rigid structure surrounding the entire cell and cell membrane. In plants, the cell wall constructed primarily from cellulose (which we will discuss in depth) and other molecules (that we will touch upon more briefly). We will explore the structure of cell walls after Midterm #1.
- **Plasma membrane (cell membrane)** - lipid bilayer that separates the inside of the cell from the outside environment, thereby allowing the cell to maintain conditions (e.g., solute concentrations) that differ from the environment.
- **Cytoplasm/cytosol (…and protoplasm)**
  Cytoplasm – everything inside the plasma membrane, minus the nucleus (if you're dealing with a eukaryote!) and vacuole(s).
  Cytosol - The liquid portion of the cytoplasm
  Protoplasm – all the contents of a plant cell inside the cell wall (i.e., not including the cell wall). (When referring to a single cell, we often call the protoplasm the "protoplast.") I will NOT ask you the terms "protoplasm/protoplast" on exams…but you might encounter them elsewhere…
- **Nucleus** – membrane-bound structure that contains the cell's DNA
- **Mitochondria** – powerhouse of the cell - produce ATP which provides energy for all cell functions.

- **Plastids** – Sites of manufacture and storage of chemical compounds.
  - **Chloroplasts** – organelles where photosynthesis occurs (also present in some Protista)
  - **Amyloplasts** – storage of sugars (starch). Especially abundant in seeds and storage organs such as tubers. (Light levels can cause conversion from amyloplasts <-> chloroplasts)
  - **Chromoplasts*** – contain fat-soluble pigments called carotenoids (yellow and orange hues).
- **Vacuoles**: Very important! Several roles (FYI – prominent in plants; present in few other cells):
  1) Turgor pressure: the pressure exerted by water on the inside of a cell or vacuole. (Think water balloon…). This maintains the shape of plants cells (the cell wall helps too – a big reason it's there!) and soft tissues such as leaves, stems, flower petals.
  2) Rapid growth of plant cells b/c they (vacuoles) swell with water (think of a flower opening, or a fern fiddlehead unfurling – this is all driven by cell division or cell expansion (which can be accelerated by swelling of vacuoles). Young cells can have many vacuoles, and they typically coalesce into a large central vacuole in mature cells.
  3) Water storage. This is important b/c plants must endure dry/drought periods {VIDEO – Planet Earth, "Deserts" 18:00-19:50}
  4) Waste storage. Plants do not have an excretory system – weird eh? So, many wastes get stored in the vacuole. Many plants have evolved to benefit from this arrangement by making nasty wastes/toxins that serve as chemical defenses.
  5) Pigment storage*. Anthocyanins are water soluble pigments stored in vacuoles.
  6) General storage and recycling location. The vacuole is a logical location to store materials and to chemically break apart and recycle cellular materials, because the vacuole is isolated from the cytoplasm by the single membrane that surrounds it (the tonoplast)
- **Plasmodesmata:** tiny strands of cytoplasm (not protoplasm! Why not? – see the distinction and need for this vocabulary?!!) that extend through small holes in cell walls and connect plant cells.

*Note the difference in pigments found in vacuoles vs. chromoplasts.
Vacuoles contain anthocyanins (red/purple/blue colors), which are water soluble (dissolve in water).
Chromoplasts contain carotenoids (yellow/orange/red colors), which aren't water soluble.
In structures like flowers, there is a wide diversity of colors because plants can have variable concentrations and combinations of different pigments, and in some cases "overlap" anthocyanins and carotenoids to yield 'new' colors (colors not attainable with a single pigment type (anthocyanin or carotenoid). Patterns are formed by allocating pigments in chromoplasts/vacuoles in cells that from the distinct patterns. We discussed this in lecture and in lab – I think it is interesting…which means it will probably be on an exam!
We will discuss many, many (!) other features of plant cells throughout the semester – but let's wait until we encounter the appropriate context. For now, the list above provides us with a solid foundation.

At right is a generalized plant cell. On future exams and quizzes you will be responsible for identifying the structures indicated here and for knowing their general function in the cell (1 sentence descriptions will be adequate…assuming they are accurate!!). We'll discuss the function of most organelles in future lectures. Not labeled here are the plasmodesmata (the little holes that connect the cytoplasm of adjacent cells). Not pictured here are other plastids.