

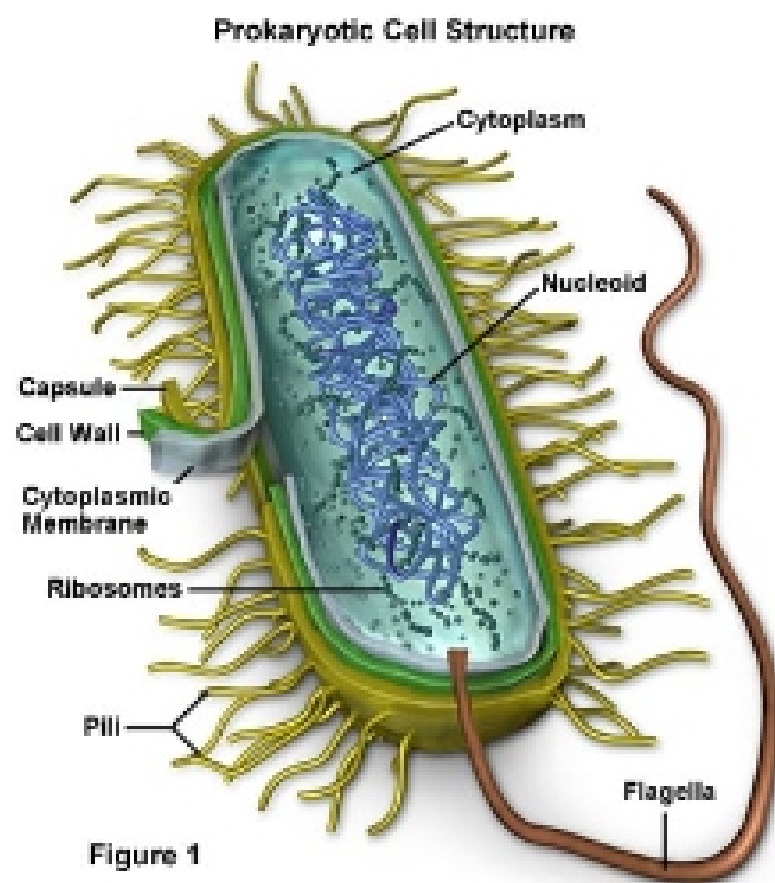
GY 112 Lecture Notes

Proterozoic Life forms

Lecture Goals:

- A) Eukaryote Life forms (Acritarchs)
- B) Metazoans (Ediacaran Fauna)

Textbook reference: Levin 7th edition (2003) Chapter 7; Levin 8th edition (2006), Chapter 9



A) Eukaryotes

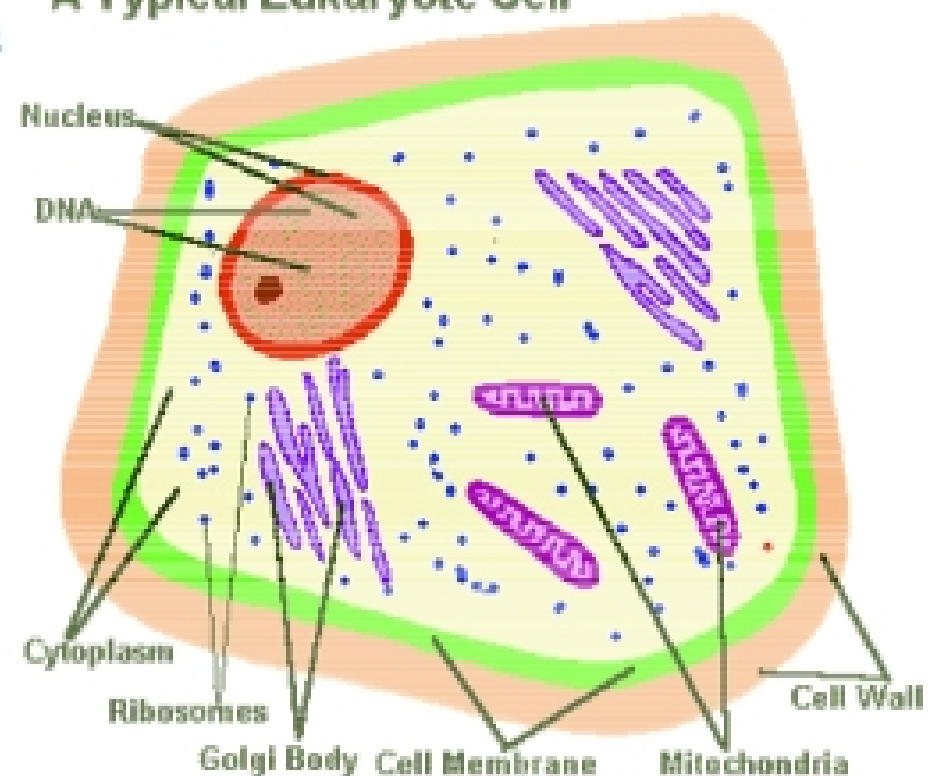
The first life forms on this planet were rather primitive. This is not to say that they were unimportant, rather that they were simple in their makeup. The prokaryotes resembled the bacteria pictured to the left (from <http://micro.magnet.fsu.edu/cells/bacteriacell.html>), were small (less than 0.020 mm), and lacked nuclei and organelles. In other words, **DNA** was spread throughout the cell rather than localized to the nucleus.

Eukaryotes probably first evolved in the Archean. They differed from the prokaryotes in several ways (see image to right from <http://www.earthlife.net>)

1. they had **nuclei**
2. they has **organelles**
3. they were larger (>0.060 mm)
4. they had sex (yahoo!)

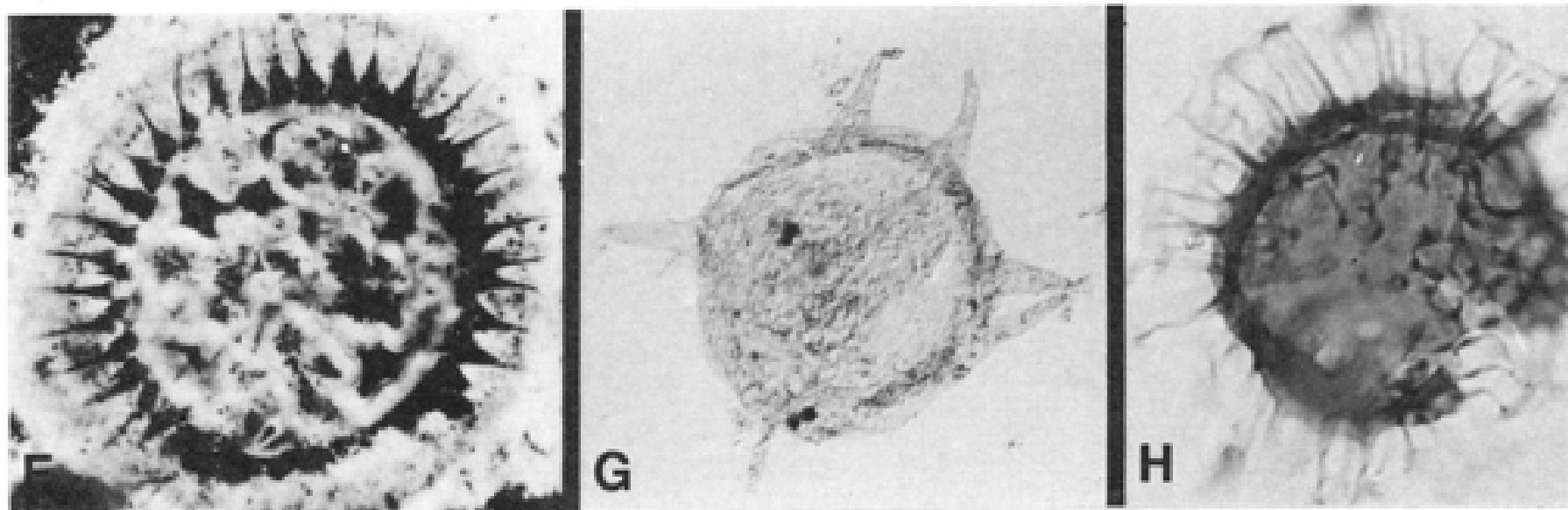
I have told you several times that I am not a biologist, so my understanding of the origin of eukaryotes is a bit weak. However, it seems likely that the earliest eukaryotes formed from the assimilation of 2 prokaryotic cells. It is tempting to envision that one cell simply ate the other, but for reasons unknown, just didn't digest it. My stomach sometimes behaves the same way, but back in the Archean, these two cells developed a unique relationship. The digested cell resided within the other and mutated into what biologists call a **mitochondrion**. This is the structure that helps cells to produce energy by producing ATP through respiration. A similar assimilation may also have occurred between a eukaryote and a cyanobacteria cell to form **chloroplasts** which regulate photosynthesis in plants. Both of these events were

A Typical Eukaryote Cell



critical to all future evolutionary changes on this planet, because they allowed **multicellular** organisms to develop.

Before we get to those beasts, it is first necessary to discuss the **acritarchs**. These were small (perhaps up to 0.1 mm across) unicellular eukaryotic organisms that first appeared some 2 billion years ago and peaked in abundance and diversity at around 750 MA (see image below from <http://www.nap.edu/openbook/0309051916/html/71.html>). They were pretty much gone by the end of the Proterozoic, but some persisted until the Ordovician. They resembled in many ways the cysts of modern planktonic algae called **dinoflagellates**, and it is generally felt that the acritarchs may have been Proterozoic equivalents to them. Maybe the acritarchs didn't die off in the Paleozoic after all. Acritarchs were mostly spherical, but developed highly ornamental cysts over time. Their decline at the end of the Proterozoic may have been caused in part by the onset of the Varangian Glaciation.



B) Metazoans

Metazoans are multicellular organisms that are composed of different types of cells arranged into tissues and organs. Most plants and animals that you are familiar with fall into this grouping. The transition from unicellular to multicellular beasts was a big, big, BIG advance in evolution. When this occurred is a subject of great debate in both geology and biology.



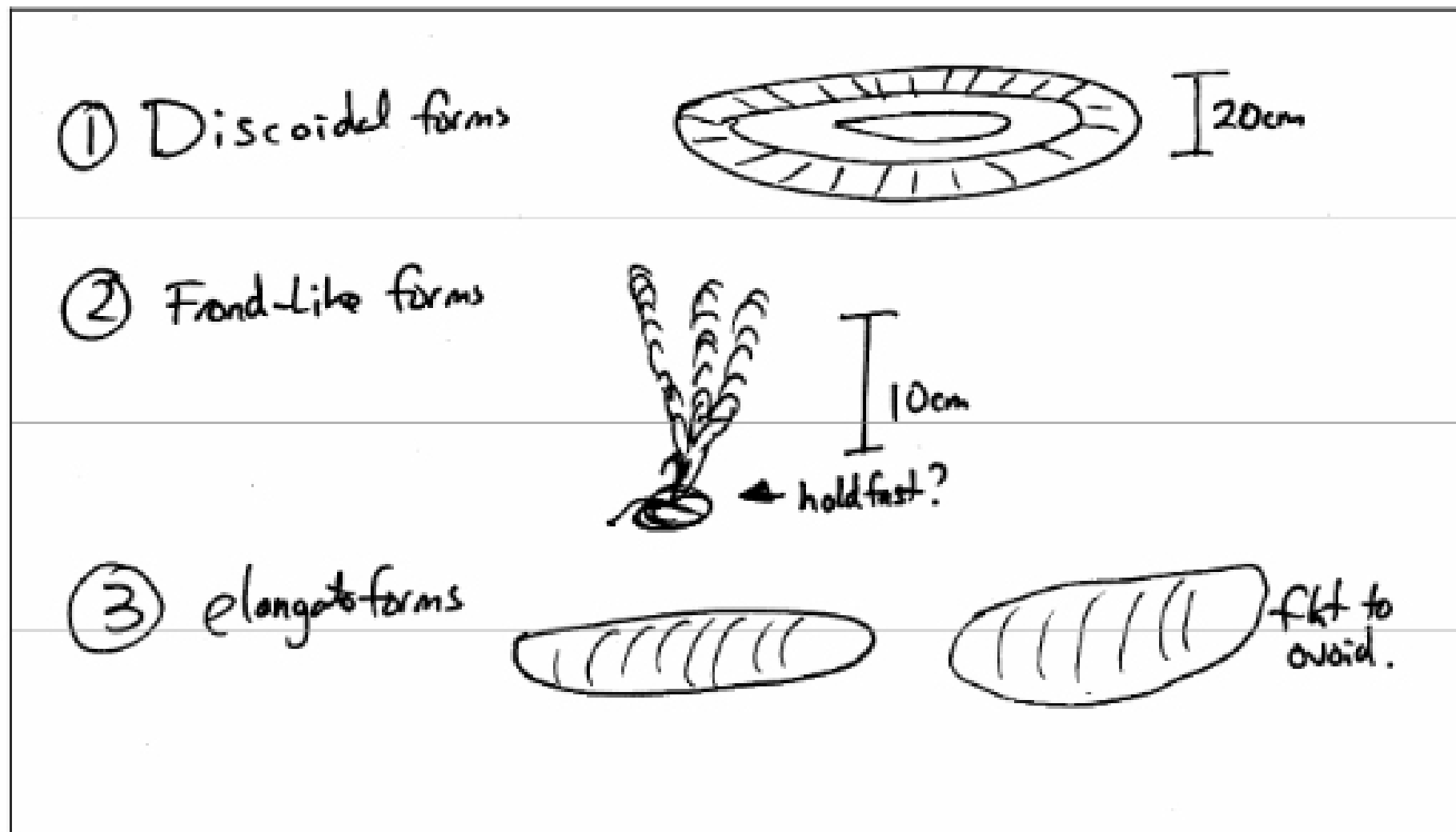
The first fossilized metazoans were called the **Ediacarans** and they were found in Neoproterozoic sedimentary rocks near Adelaide, Australia (in the Ediacara Hills to be exact). Since their original discovery in the middle part of the 1900's, Ediacaran fauna have been found in Newfoundland, China, Ireland, parts of Africa, Russia and England.

The Ediacaran beasts first appeared in rocks about 750 million years old and persisted into the lowest part of the Phanerozoic (to about 533 MA; the Early Cambrian). This is noteworthy for two reasons: 1) Ediacarans seem to have been unaffected by the event that initiated the decline in the acritarch population and 2) the ediacaran time span overlapped the Cambrian explosion

that marks the boundary between the Proterozoic and Phanerozoic Eras.

The dominant mode of preservation of the ediacaran fauna is impressions, but amazingly, those impressions are in sandstones. Fine grained rocks like shales are usually the hosts of fossil impressions because they are much more likely to preserve the fine detail of most deceased beasties. This is particularly true for beasties that lacked hard body parts such as the ediacarans.

The ediacarans are divided up into 3 different groups based upon morphology:



It was once thought that the **discoidal** forms were primitive jelly fish, that the **frond-like** forms were primitive sea fans and that the **elongate** forms were possibly primitive sea cucumbers, but that is now not the case. In the first place, these beasties left impressions in sand. Jelly fish are too gooey to do this. The discoidal ediacarans must have had a pretty competent (or at least firm) membrane to distort soft sand. The second and much more important difference is that the ediacaran fauna display tantalizing features suggesting very advanced features. *Kimberella* sp., an elongate ediacaran, appears to have had a central cavity that was possibly used for digestion (e.g., a stomach) and other internal organs. It may have also had a **mantle** very similar to those used by gastropods.