Biologist's Name: ___________________________________ Class: 8__ Date: _______________

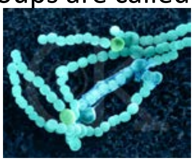
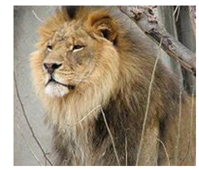
Mrs. Bouchard – 8th Grade Science

The Kingdom Archaea: Up Close

2,000 years ago, scientists thought all life could be divided into plants and animals.

They were wrong! All life on Earth is divided into ___________________________.

Those groups are called ___________________.

2. Organisms are divided into one of the six kingdoms based on three characteristics:

Whether or not their cells have a ___________________________.
(___________________________ or ____________________________)

Whether their bodies are made of __________________ or ______________________.
(___________________________ or ________________________)

If they can ____ (_________________)
or _______________________ food to survive (____________________________).

The Kingdom Archaea contains ____.

Archaea are considered by some scientists to be some of the __________________________

_______________________________.

Archaea's cells are ___________________________ and more basic than other life forms.

Archaebacteria are _______________________ which means they have no ___________________.

Now you will become experts on one aspect of the Kingdom Archaea. Your group is responsible for section number _______. Read the information carefully, then write down the key points in the labeled box. At the end of the exercise, you will share your findings with the rest of the class.

Section 1: Experts' Findings

Kingdom Archaea In-class Activity!

Section 2: Experts' Findings

Section 3: Experts' Findings

Section 4: Experts' Findings

Kingdom Archaea In-class Activity!

Section 5: Experts' Findings

Section 6: Experts' Findings

Section 7: Experts' Findings

Kingdom Archaea In-class Activity!

Section 1: The History

Archae comes from the Greek word for ancient. The archaebacteria are thought to be the first organisms to have evolved on the planet. Scientists did not classify them separately from other bacteria until the 1970s when using powerful electron microscopes they were able to determine that they were structurally different from eubacteria. The primary difference is in the ribosomes, and in the cell wall (it is not made from peptidoglycan, which is different from eubacteria). Otherwise, they are identical to eubacteria but for where they live. They are prokaryotic, having no nucleus in the cell, they are all single celled, some move on their own with hair-like cilia or flagella and some make their own food using photosynthesis (energy from the sun) or chemosynthesis (energy from chemicals).

Section 2: Harsh Conditions

Often called extremophiles these organisms live in very harsh Conditions. Halophiles love salty water where no fish or algae could live. Thermophiles live in extremely hot places such as the boiling hot geysers found in Yellowstone National Park. Others live under layers of snow and ice under glaciers found high in mountain ranges. Methanogens are bacteria that create methane and live in the stomachs or organisms such as cows or in digesters used to create power such as the one at Jordan’s Dairy Farm in Rutland. Others live thousands of feet below the
ocean surface in thermal vents where hot temperatures and chemicals from deep under Earth’s surface allow them to create unique ecosystems.

Kingdom Monera In-class Activity!

Section 3: Hyperthermophiles

Hyperthermophiles are organisms that grow best at temperatures above 80 degrees Celsius. The Archaea *Pyrolobus fumarii* thrives in incredibly deep water at the bottom of the ocean in hydrothermal vent chimneys that can be well over the boiling point of water. *Pyrolobus* can actively grow at 113 degrees Celsius and can survive in an autoclave, a device that uses heat and pressure to sterilize equipment, at 121 degrees Celsius for an hour. These are conditions that even the toughest bacterial endospores can't survive.

Section 4: Extreme Halophiles

Extreme halophiles are organisms that require salt for growth and can survive in high-salt environments. These Archaea grow best between 12 and 23% salt but can survive in a saturated salt solution of 32%. As a comparison, seawater is only 3.5% salt and most bacteria are unable to grow in seawater because it is too salty. The Great Salt Lake, pools of evaporating seawater like the San Francisco Salt Ponds, and the surfaces of salted meats and fish all have very high salt concentrations that extreme halophiles can survive.

In fact, the extreme pink color of some salt ponds, like those in San Francisco, is actually due to the pink pigments produced by the Archaea growing in the water. Extreme halophiles, like *Halobacterium* and *Natronobacterium*, are only able to thrive in these high-salt environments.

One note here: Archaea in this group are able to survive salt-based food preservation methods like used with meats and fish. But no pathogenic Archaea have been discovered yet, so you are not going to get sick from consuming these organisms. As is the case in science, this could change at any time. But it seems that Archaea did not evolve to cause disease in mammals.

Kingdom Archae In-class Activity!

Section 5: Thermoacidophiles

There are also Archaea that are **thermoacidophiles**. These organisms grow best at high temperatures and extremely low pH. For many Archaea, this means a pH less than 2, the same pH as stomach acid. One genus of Archaea, called *Picrophilus*, can even survive pH values below zero. Many geothermal hot springs have very low pH due to the high sulfuric acid content. Even the combination of harsh environmental conditions like heat and acid can't seem to stop the Archaea from growing happily.

Section 6: Chemical Processing (Metabolism)

All Archaea are **chemotrophic**, meaning they use chemicals to obtain energy. Some use organic compounds, like sugars, while others use inorganic compounds, like iron. One of the most common inorganic energy sources used by Archaea is hydrogen gas. An exception to the chemotrophic rule is *Halobacterium*. It can also capture energy from light, kind of like photosynthesis, but not the typical form we associate with bacteria, algae, and plants.

Section 7: Modern Day Biotechnology

Taq* polymerase** is a thermostable DNA polymerase named after the thermophilic bacterium *Thermus aquaticus* from which it was originally isolated by scientists in 1976. It is often abbreviated to "Taq* Pol**" (or simply "***Taq***"), and is frequently used in polymerase chain reaction (PCR), a method for greatly amplifying short segments of DNA.

PCR is now used to isolate small sections of DNA from larger sections in order to determine the exact identity or origin of a known or unknown organism. *Taq* polymerase was identified as an enzyme (a protein which performs tasks) that is able to withstand the protein-denaturing conditions (high temperature) required during PCR. Therefore it replaced the DNA polymerase from *E. coli* originally used in PCR. *Taq* can replicate a 1000 base pair strand of DNA in less than 10 seconds at 72°C.