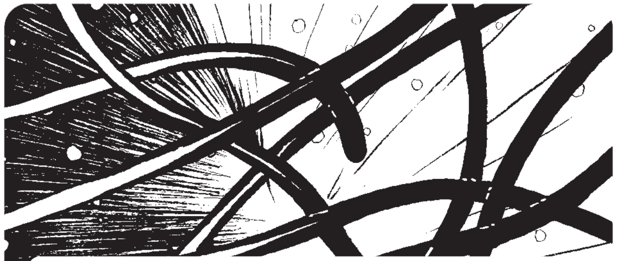


### *Chloroflexus aurantiacus*

"Color-changer, green to orange"

**Domain:** Bacteria

**Habitat:** Hot springs around the world, including Yellowstone National Park.

**Energy Source:** Mixotroph (phototroph and chemotroph). Mainly uses light energy from the sun. In the dark, can use chemical energy from inorganic compounds (sulphur and hydrogen).

**Challenges to Life:** Heat, UV exposure, changing levels of light and oxygen

### *Deinococcus radiodurans*

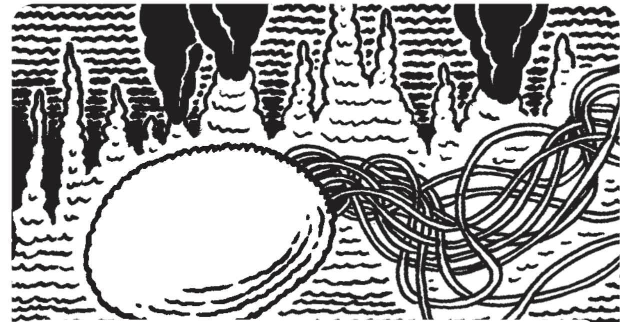
"Terrible berry, survives radiation"

**Domain:** Bacteria

**Habitat:** Widespread, including deserts, hot springs, high mountains, polar regions and animal gut.

**Energy Source:** Chemotroph. Uses chemical energy from organic compounds.

**Challenges to Life:** Dehydration, cold, acidic pH, radiation, oxidative damage



### *Pyrococcus furiosus*

"Raging fireball"

**Domain:** Archaea

**Habitat:** Hydrothermal vents in ocean floor; first discovered near volcanic islands in Italy.

**Energy Source:** Chemotroph. Uses chemical energy from organic compounds.

**Challenges to Life:** Heat, pressure, changes in oxygen levels when vent fluids contact sea water

**Adaptation:** Can do both photosynthesis (like plants) and respiration (like animals), allowing it to survive a range of light and oxygen levels. It is green during photosynthesis and orange during respiration.

**Talent:** Thermophile. Thrives in temperature range of 35–70°C (95–158°F). Among the first organisms on early Earth to do photosynthesis.

**Application:** Studying this organism helps researchers learn about the evolution of photosynthesis.

**Adaptation:** Can rebuild its genome, after radiation breaks it into hundreds of fragments, using a unique DNA-repair mechanism. Produces antioxidants that protect proteins from radiation damage.

**Talent:** Radioresistant. Survives short doses of radiation up to 5,000 Gy. Grows under constant radiation levels of 50 Gy per hour. By comparison, a dose of 5 Gy kills humans.

**Application:** Research may lead to more efficient clean-up of nuclear waste, as well as new vaccines and cancer treatments.

**Adaptation:** A protein called reverse gyrase helps maintain DNA structure in extreme heat. High temperatures tend to unzip double-stranded DNA. Reverse gyrase twists DNA so much it can't unravel.

**Talent:** Hyperthermophile. Thrives in extremely hot temperatures. Grows best at 100°C (212°F), reproducing once every 37 minutes.

**Application:** Helping researchers genetically engineer plants that can grow in hot climates. Adding a gene to another plant made it able to grow in much higher temperatures.

### *Halobacterium salinarum*

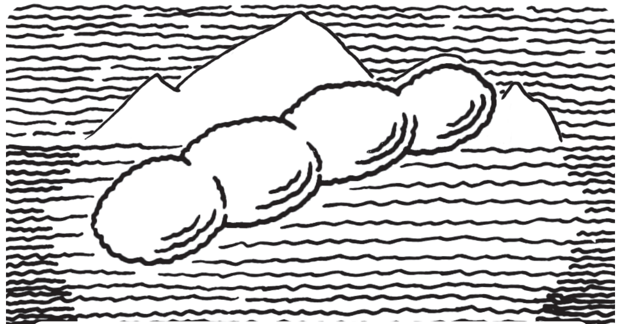
"Breathing bug that disregards salt"

**Domain:** Archaea

**Habitat:** Salty lakes around the world, including Great Salt Lake, Utah.

**Energy Source:** Chemotroph. Uses chemical energy from organic compounds.

**Challenges to Life:** Lack of water, temperature extremes, high salt, radiation, toxic chemicals



### *Psychrobacter arcticus*

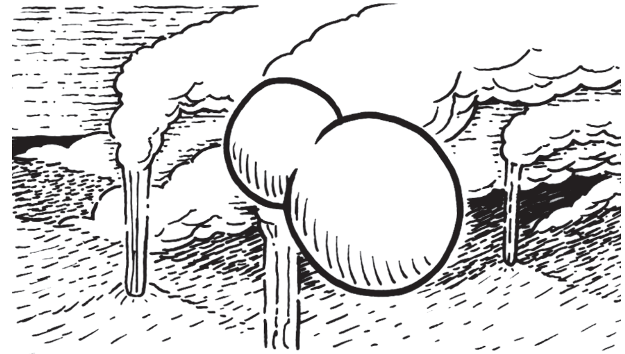
"Cold bug from the poles"

**Domain:** Bacteria

**Habitat:** Very cold places, including permanently frozen soil and pockets of salt water trapped in sea ice.

**Energy Source:** Chemotroph. Uses chemical energy from organic compounds

**Challenges to Life:** Cold, darkness, high salt, starvation, dehydration, limited space.



### *Picrophilus torridus*

"Burning paint"

**Domain:** Archaea

**Habitat:** Acidic environments, including hot springs and volcanic steam vents

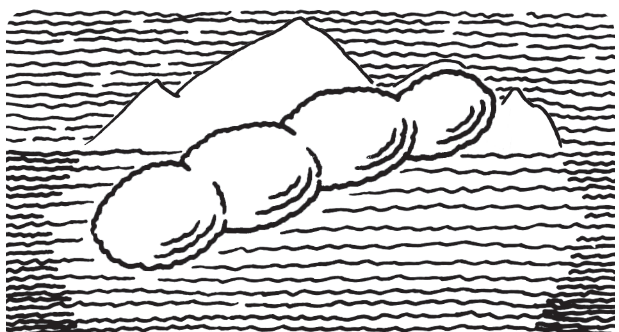
**Energy Source:** Chemotroph. Uses chemical energy from organic compounds.

**Challenges to Life:** Acidic pH, high temperature.

**Adaptation:** Special pumps in the the cell balance salt concentrations. The pumps keep salt levels inside the cell equal to salt levels outside the cell, preventing water loss and dehydration.

**Talent:** Halophile. Can grow in extremely salty water, 10 times saltier than the ocean.

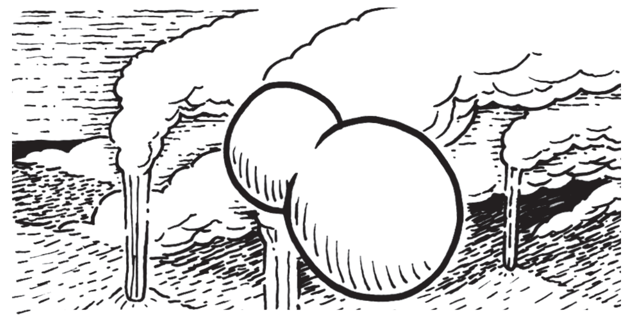
**Application:** Researchers study halophiles to learn more about the important role they play in salt lake ecosystems, which support millions of migrating birds.



**Adaptation:** Special enzymes modify lipids to keep the cell membrane flexible in cold temperatures. Also, since cold temperatures slow down chemical reactions, proteins in the cell tend to be flexible and more active.

**Talent:** Psychrophile. Can grow at extremely cold temperatures, as low as -10°C (14°F).

**Application:** Researchers study cold-tolerant bacteria to learn whether life might exist on icy worlds like Mars and the moons of Jupiter.



**Adaptations:** Acid-resistant cell membrane acts as a barrier to protons, keeping the inside of the cell at a more neutral pH of 4.6. Uses difference in proton concentration between inside and outside the cell to generate energy. Smallest genome of any known organism minimizes the work of DNA repair.

**Talent:** Acidophile. Grows best at pH 0. Most life lives between pH 5 and 8; water has a pH of 7.

**Application:** Acid-resistant enzymes could clean up toxic mine sites, or be used as food supplements since the enzymes remain active in stomach acid.

## *Thellungiella salsuginea*

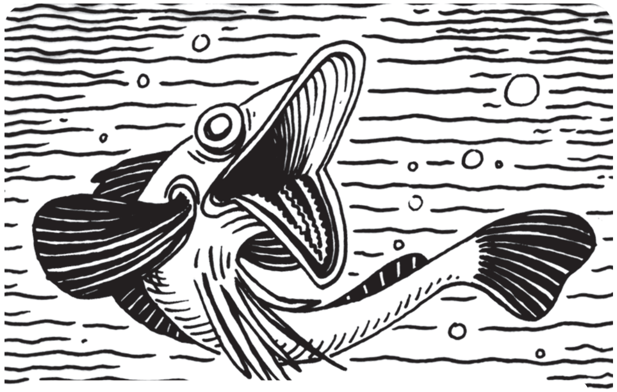
"Saltwater cress"

**Domain:** Eukaryote (Plant – Angiosperm)

**Habitat:** Salty environments, including salt flats in northern Canada and seashores of eastern China.

**Energy Source:** Phototroph. Uses light energy from the sun.

**Challenges to Life:** High salt, cold temperatures, nutrient-poor soils, drought, flooding, toxic metals, short growing season



## *Antarctic Ice Fishes*

(25+ species)

**Domain:** Eukaryote (Animal – Chordate)

**Habitat:** Southern Ocean surrounding Antarctica.

**Energy Source:** Chemotroph. Eats krill, small crustaceans and other fish.

**Challenge to Life:** Cold temperature

## *Tardigrade*

"Little water bear" (1,150+ species)

**Domain:** Eukaryote (Animal)

**Habitat:** Wet environments, including hot springs, deep-ocean sediments, glaciers, fresh-water lakes, tropical forests, even the moss in your own backyard.

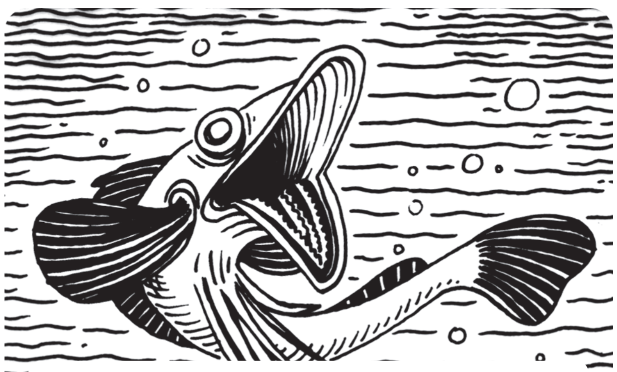
**Energy Source:** Chemotroph. Eats plants and bacteria.

**Challenges to Life:** Dehydration, extremely hot and cold temperatures

**Adaptation:** Roots have specialized ion transporters that keep out salt (sodium and chloride) but let in other nutrients (potassium). Vacuoles hold sodium away from the cytoplasm to prevent cell damage.

**Talent:** Halophile and psychrophile. Can grow and reproduce in extremely salty soil and sub-zero temperatures.

**Application:** Research is helping scientists engineer crop plants that can grow in harsh climates and soil conditions. A gene from this organism made cotton and corn plants more tolerant to salt and drought.



**Adaptation:** Antifreeze proteins keep their blood from freezing. They lack red blood cells, thinning their blood so that it flows better at low temperatures. They absorb oxygen through scaleless skin.

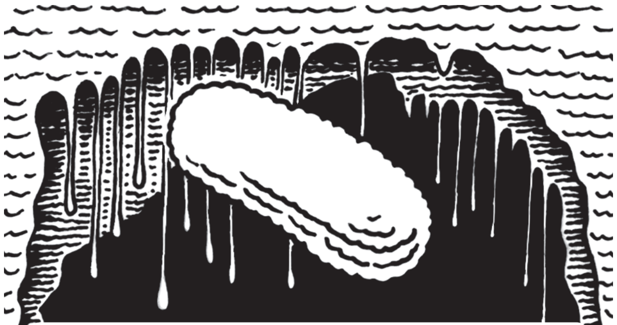
**Talent:** Psychrophile. Can thrive in very cold water, 1.5 to -1.8 °C (28 to 35°F).

**Application:** Antifreeze proteins are used to prevent ice crystal formation in popsicles and ice-cream, as well as to preserve human tissue for transplantation.

**Adaptations:** In a hibernation-like state called cryptobiosis, cells lose almost all water and stop all metabolism. A sugar molecule, trehalose, protects membranes and proteins from breaking.

**Talent:** Can survive more extremes (temperature, pressure, radiation, dehydration) than any other organism. They can even survive outer space.

**Application:** Research is helping us learn how organisms can survive without water. Understanding death-like cryptobiosis could allow us to reversibly stop our metabolism for long-distance space travel.



### *Acidithiobacillus thiooxidans*

“Sulfur-breathing, acid-loving rod”

**Domain:** Bacteria

**Habitat:** Sulfide-rich, underground cave systems in Mexico, Italy and elsewhere.

**Energy Source:** Chemotroph. Uses chemical energy found in inorganic compounds (hydrogen sulfide).

**Challenges to Life:** Extreme pH, darkness, limited food resources, low oxygen, toxic gases

### *Cupriavidus metallidurans*

“Metal enduring”

**Domain:** Bacteria

**Habitat:** Soils rich in natural metals or metal waste from mines and processing plants.

**Energy Source:** Chemotroph. Uses chemical energy from inorganic compounds.

**Challenges to Life:** Toxic chemicals

### *Riftia pachyptila*

“Giant tube worm”

**Domain:** Eukaryote (Animal – Annelid)

**Habitat:** The deep sea, near geyser-like vents on the ocean floor, miles below the surface.

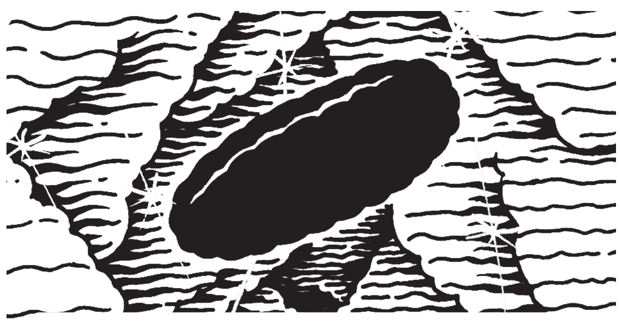
**Energy Source:** Chemotroph. Uses chemical energy from organic compounds.

**Challenges to Life:** Extreme pressure, darkness, low nutrients, toxic chemicals and extreme temperatures (vent water can be over 300°C / 572°F)

**Adaptation:** Builds a “snottite” to concentrate its acidic waste products. Snottites are too acidic for most other organisms, reducing competition for nutrients. Ion pumps raise the pH inside the cell, making it less acidic than its surroundings.

**Talent:** Acidophile. Grows best at pH 0–1. Most life lives between pH 5 and 8; water has a pH of 7.

**Application:** Researchers study snottites to learn more about early Earth environments, cave formation or expansion, and the possibility of life on other planets—underground.



**Adaptation:** Metal-binding proteins convert metal dissolved in liquid into solid metal. Solid metal is pushed out of the cell through channels in the cell membrane, called heavy metal exporters.

**Talent:** Metallophile. Thrives in places contaminated with toxic heavy metals.

**Application:** Researchers hope to use the microbe's genes as biosensors, tools that would help industries more easily locate gold for mining. This organism may also be useful in cleaning up areas contaminated with heavy metals.

**Adaptations:** Through symbiosis with bacteria, converts vent chemicals into food. How this and other organisms survive crushing water pressure is unknown. High pressure changes the activity of some genes, but the functions of these genes are unknown.

**Talent:** Piezophile. Thrives in high pressure miles below the sea surface.

**Application:** Enzymes from this organism could be useful in industry because they function at high temperature and high pressure.