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| Topic | Bacteria | Level | A Level/GCSE |
| Outcomes | <ol style="list-style-type: none"> 1. To consider the importance of bacteria to humans 2. To describe some of the key features of bacteria 3. To appreciate the diversity of bacteria | | |

Bacterial Basics: small yet beautiful

Much of the information below has been adapted from Bill Bryson's book 'A Short History of Nearly Everything'.

Bacteria are microscopic, unicellular organisms that belong to the Kingdom Prokaryotae (remember there are five kingdoms of life: Animals, Plants, Fungi, Protista and Prokaryotes). At present we have little idea of how many bacterial species there are, but it is believed that only 1% of bacterial species can be grown in a laboratory, the rest cannot be cultured (WHY?). Unfortunately, most of what you learn about bacteria is taught from a medical perspective, i.e. bacteria cause disease. Although this is true for some bacterial species, the majority of bacteria on Earth perform functions that are vital to our own existence.

Bacteria and humans

- A healthy individual will have about one trillion bacteria living on his/her body surface. About one hundred thousand of them on every square centimetre of skin.
- There are trillions of bacteria living in your gut, nasal passages, clinging to your hair and eyelashes and drilling through the enamel of your teeth.
- Every human body is home to around 10 quadrillion cells but is host to about a hundred quadrillion bacterial cells – we are more bacteria than human!

Bacteria in the environment

Bacteria perform many useful functions; some of these are commercially useful, others are critical for the existence of complex life.

- Bacteria process our wastes and make them usable again
- Bacteria purify our water and keep our soils productive
- Bacteria synthesis vitamins in our gut, covert the things we eat into useful sugars and polysaccharides and go to war on alien microbes that slip down our gut

- Bacteria pluck nitrogen from the air and convert it into useful ammonium compounds that can be taken up by plants

Bacteria at the extremes

Many bacterial species can live in environments where humans would perish. Scientists in Australia found microbes known as *Thiobacillus concretivorans* which lived in concentrations of sulphuric acid strong enough to dissolve metal.

A species called *Micrococcus radiophilus* was found living in the waste tanks of nuclear reactors. *Deinococcus radiodurans* appears to be almost immune to radioactivity. Other species have been found at the bottom of the sea, in oil wells at depths of 600m, in icy pools and hot springs. A *Streptococcus* bacterium was recovered from the sealed lens of a camera that had stood on the Moon for two years.

Bacterial division

Many bacteria are able to divide and produce new daughter cells in a matter of minutes by binary fission. *Clostridium perfringens*, the organism that causes gangrene, can divide into two every nine minutes and then begin at once to split again. At such a rate, a single bacterium could theoretically produce more offspring in two days than there are protons in the universe. This rapid growth rate explains how food can very quickly go off if contaminated with only a few, disease causing individuals. Compare this to a human cell that can manage only a few divisions in a single day.

Mutants

About once every million divisions a mutant cell will be formed (a cell with an error in its DNA). More often than not the mutant will be at a disadvantage and will be selected out of the population but occasionally such a mutant will be endowed with some accidental advantage. This advantage can be passed to other bacteria of the same or different species through DNA exchange (bacterial sex).

Answer the questions below

- 1) Why is the human body an ideal place for bacteria to live?
- 2) Why can we only culture less than 1% of all bacterial species in the lab?
- 3) Why might a farmer want to sow seeds that have previously been inoculated with bacteria?
- 4) Although some bacteria divide very quickly some do not. What factors do you think may limit the growth rate of a bacterium?

- 5) In the 1960s after the invention of antibiotics, the US surgeon-general, William Stewart declared “The time has come to close the door on [bacterial] infectious diseases. We have basically wiped out infection in the United States”. What had William Stewart failed to foresee?
- 6) Roughly 70% of the antibiotics used in the developing world are given to farm animals in their feed. What are the potential dangers of doing this?
- 7) Bacteria are very small, can you think of any reasons why being small may be advantageous?
- 8) Are bacteria less successful, as successful, or more successful than humans?

Progress: further resources on microorganisms are available here:

<http://thescienceteacher.co.uk/microorganisms/>