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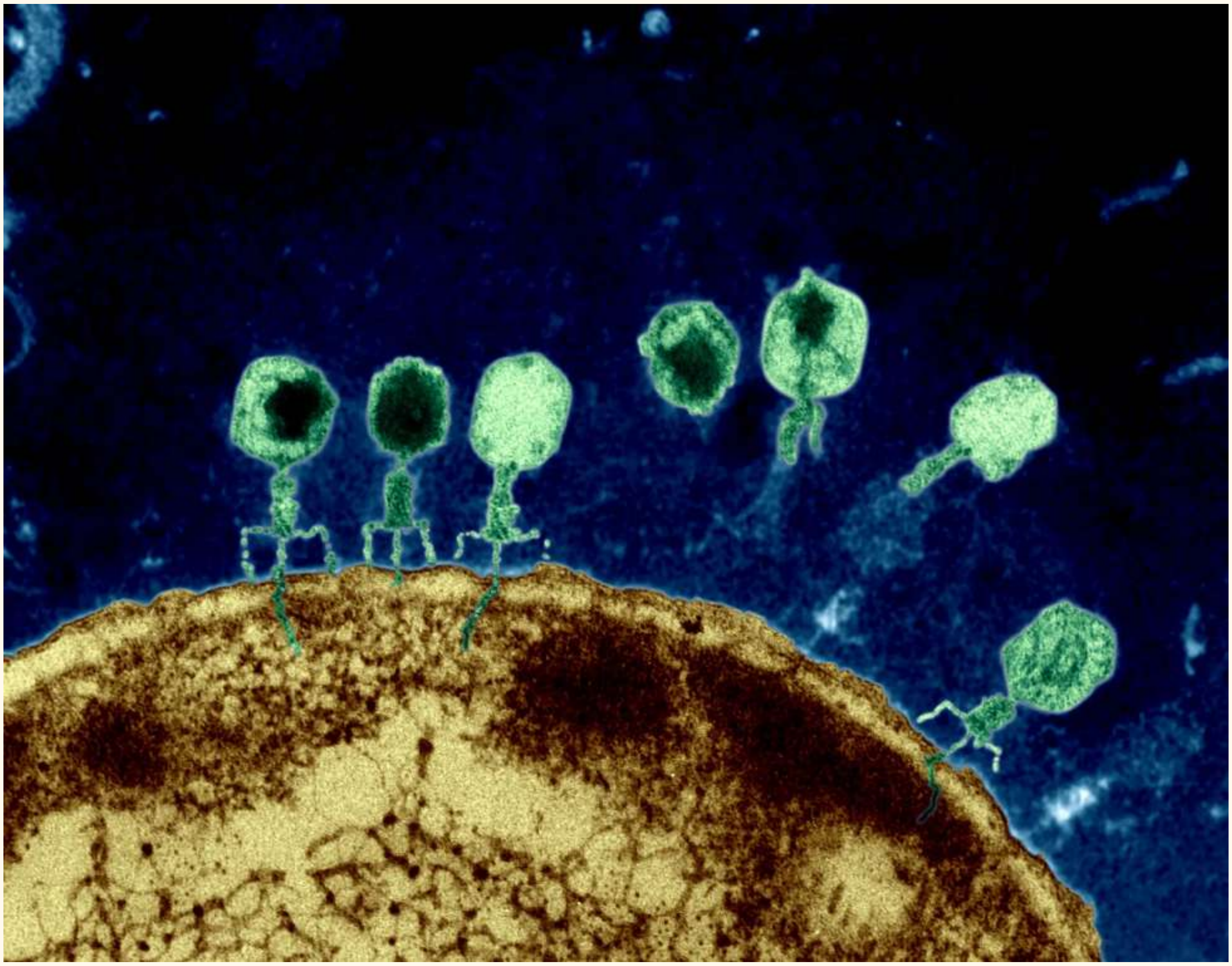
BIOLOGY NEWSLETTER



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Hi guys!

February already! I'm sure the novelty of returning to school has already worn off, so here is the Biology newsletter to spice things up a bit. I hope you enjoy reading it, and if you have any queries, suggestions or even better - articles that you'd like to share, please me email at:

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I'll leave you to dive right on in,

Lucia

Viruses

I know, I know - you must think I'm mad to make a whole issue on these little buggers, but diseases aside, viruses are actually simultaneously both fascinating and incredibly useful in our day-to-day lives. Luckily for us, not all viruses cause global pandemics, and so I thought I'd introduce you to some of my favourites!

Since their discovery in 1892, viruses have been categorized in many ways. Poison, life form or biological chemical? Continuing on with the questions: living or nonliving? While it would be nice to lump them into a single category, they tend to inhabit a sort of gray-region in between the two. If one thinks of the properties of life as a checklist, which includes things like growth capabilities, reproduction, response to stimuli and having metabolism, then viruses are a touch lacking in some of those departments. Their reproduction requires the cellular machinery of a host, leading evolutionary biologists to not count them as part of the conventional tree of life. They are unable to synthesise ATP (a universal energy "currency") nor independently form proteins. These limitations restrict them to reproduction within a host, putting them into the category of **obligate intracellular parasites**.[1] So, according to the stringent definition of life, no, they are not alive.

The origin of viruses is also highly contested among virologists, with a few different theories having emerged. (To save you all a headache, I'll just summarize them here, but have linked the article below in the footnotes if you are interested.) One possible scenario is that viruses are cellular components that escaped from cells to become individual beings. Another hypothesis that gives viruses slightly more credit is that they predate cells completely and just emerged from the primordial soup as self-replicating entities, only later becoming parasitic.[2] Or perhaps, the mechanism of the origin is a combination of several different routes. Either way, viruses have been thought to play a vital role in evolution. Being so numerous, the transfer of genes from viruses into cells is undoubtedly easier than the reverse, suggesting that viruses may have been used to ship the genes of successful cellular experiments to more rudimentary cells, to further their evolution into complex lifeforms.

But enough on the philosophical debates, let's get into the fun stuff!

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[1] https://www.nature.com/scitable/topicpage/the-origins-of-viruses-14398218/
[2] https://www.newscientist.com/definition/viruses/

Food for thought

I'm sure we've all heard about antibiotic resistance, the plague that threatens to overturn the medical world as we know it, reverting modern medicine back to its previous reliance on quackery and magic. Jokes aside, the overuse of antimicrobials, especially in agriculture has led to resistance developing in bacteria strains that are becoming increasingly difficult to combat with the limited number of antibiotic classes that are currently available. If any microorganism is, for example, able to downregulate the expression of a particular protein on its surface that would otherwise allow an antimicrobial to recognise and kill it, well then we might have a problem. And this is where bacteriophages come into play. With a literal meaning of "bacteria eater", and the ability to target, infect and destroy specific bacteria, it shouldn't be too hard to see where scientists are going with this.

With over half of food waste in UK homes being due to spoilage, bacteriophages are increasingly used during food processing to destroy harmful microbes. Although they have been used since the 1920s to treat human infections, the process of finding the correct phage for the specific bacteria infecting the patient is a pain.[3] Bacteria that reside on food however, are much easier to identify, with food poisoning often being attributed to strains of *E.coli* and salmonella. Whilst other methods, such as dousing food in ionising radiation are also effective, the taste and texture of food is often changed. However the phages, whilst killing unwanted bacteria, also have the benefits of leaving no perceptible traces on people, packaging or machinery. As well as this, since there are about 10^{31} bacteriophages on the planet (more than every other organism on Earth combined), you're not actually adding anything new, as the phages would already be present on the food anyway.

But nothing is perfect, and this approach is quite fiddly. As each phage only targets one specific bacterial strain, phage cocktails are needed to kill all strains present. This also means that no one mix will work for everywhere, and that due to the evolution of bacteria, any mixture needs to be tightly regulated and the phages tested for their efficacy.

Sadly, bacteriophages haven't really taken off in Europe, leaving the majority of progress to be made in the US. That being said, quite a few countries, such as Belgium, are already offering phage therapy as an alternative to antibiotics for human infections. And in the dark future of furtively hoarded antibiotics, I think that bacteriophages will become crucial in mediating emerging disease in plants and animals.

[3] https://www.newscientist.com/article/mg25333694-200-how-bacteria-killing-viruses-are-being-used-to-keep-food-safe/

The secret social lives of bacteriophages

It seems that bacteriophages have their own rudimentary messaging service. When they have infected a host cell, they release a small protein, just six amino acids long, called "arbitrium" [4] , as a sort of message to their brethren, saying "I got one!!". The more cells that are infected, the more proteins are produced. This increasingly flamboyant signal indicates that the amount of uninfected hosts is critically low, and causes the phages to stop **lysis**, and hibernate inside the host in a state called **lysogeny**. This allows them to conserve resources when hosts are scarce, and stops them from completely eradicating the bacterial population, which would leave them with no home.

Other examples of co-operation within phage populations include viruses hurling themselves at bacteria with proteins designed to break down the bacterial immune system (which is CRISPR-based). Although this only weakens the bacteria, and results in phage death, their noble sacrifice paves the way for other phages to swoop in and conquer the microbial foe. How heroic.

Glossary:

Obligate intracellular parasites: Microorganisms only capable of reproducing inside a host. Includes all viruses.

Lysis: Breaking open the membrane of a cell to kill it

Lysogeny: A process where a bacteriophage integrates its genome into the chromosome of the host. No progeny (offspring) viruses are produced, and the phage bides its time within the chromosome, until the bacteria is exposed to a stimuli, at which point the phage removes its genome from the host chromosome and begins to multiply.[5] This process may also be beneficial to the host, as the process of removing the genome is very imprecise, and may leave behind sequences that code for a toxin that can increase the bacteria's evolutionary advantage.

[4] https://www.nature.com/articles/d41586-019-01880-6
[5] https://www.britannica.com/science/lysogeny