BACTERIOPHAGES : GENIUS VIRUSES LEADING THE FUTURE OF BIOTECHNOLOGY

AUTHORS: AMARTYA NANDI, KANAV SHARMA, BHAVANA PURI, BHASKAR PURI, MANSI BOSE
DEPARTMENT OF BIOTECHNOLOGY, GGDSD COLLEGE SECTOR 32 C CHANDIGARH

ABSTRACT: *Bacteriophages or phages are the most abundant organisms in the biosphere and are an omnipresent feature of prokaryotic existence. A bacteriophage is a virus which infects a bacterium and can be used for multiple perspectives in biological sciences. With the capability of better bio-film penetration, they are target-specific in nature, lyse bacteria at the site of infection and can be called as targeted antibiotics in the field of medical science. Phages can be used in agricultural industries, petroleum industries and as bio-control agents. With recent advancement of technologies and techniques, phages can be used as vehicles for vaccine delivery to humans and other mammals. In genetic engineering, they can be used as vectors for horizontal gene transfer. Phages possess good therapeutic and clinical values for cancer and HIV therapies. They are revolutionizing CRISPR–Cas9 resistance and extend the frontier for bio-control and bio-processing. Bacteriophages have the ability to reform modern medical science due to its uniqueness and specificity on pathogens. many researchers and institutions have taken a step forward and are analyzing phage human interactions at genomic and proteomic levels. We can conclude that future era of biotechnology can be led by these genius viruses which possess a scientific uniqueness in them and leading biological research to new extents.*

INTRODUCTION

Bacteriophages, informally known as phages, are viruses that parasitize a bacterium by infecting and reproducing inside it. These bacterial viruses have ss and ds DNA or RNA as its genetic material, surrounded by a protein coat known as capsid. Phages infect and propagate in the bacterial cells either by lytic life cycle or lysogenic life cycle. After the discovery of phages, researchers thought about their antimicrobial ability. But after world war II due to the availability of antibiotics, phages got little attention and considered as research tools only.

HISTORY

The earliest reference to bacteriophages was made by Ernest Hankin in 1896. Hankin reported antibacterial action associated with the waters of the Ganges and Yamuna rivers in India. However, Frederick W. Twort of Great Britain and Félix D'Hérelle of France are credited for the discovery of bacteriophages in 1917. D'Hérelle recorded a dramatic account of a patient suffering from Dysentery cured by bacteriophages. He further introduced the concept of phage therapy. More than half a century later, in 1969, Max Delbruck, Alfred Hershey, and Salvador Luria were awarded the Nobel Prize in Medicine for their discoveries of the replication of viruses and their genetic structure.

FUTURE PERSPECTIVES

- **Alternative to today's Antibiotics:** phages can be alternatives to the antibiotics as it targets on the site of infection and it is leading towards targeted and precision Antibiotics
- **CRISPR – Cas systems :** In this CRISPR components are being engineered in to bacteriophages and arming them against the pathogenic bacteria and superbugs.
- **Phage cocktails will be the future of pharmaceuticals :** Phages are target- specific in nature which may pose as a limitation if we treat multiple infections, so to overcome this situation, we can simply mix different strains of phages to make a cocktail which gives wide range capabilities.
- **Future of the therapeutic practices in Cancer and HIV Immunotherapies** as phage have ability to activate both innate and active immunity.
- **Phages can be vehicles targeted gene delivery :** bacteriophages have gained special attention as vehicles for protein/peptide or DNA delivery. In fact, whole phage particles are used as vaccine delivery vehicles to achieve the aim of enhanced immunization.
- **Phage typing:** Sensitive and specific detection of bacteria with the help of bacteriophages using sensitivity patterns to precisely identify the microbial strains
- **Recently in 2017, Phagoburn** was a European Union-financed clinical study that tested the safety, effectiveness and pharmacodynamics of two therapeutic phage cocktails to treat *Escherichia coli* and *Pseudomonas aeruginosa* burn wounds.

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APPLICATIONS

Phage in Vaccines:With the help of Phage display technique bacteriophages are sequenced to a specific antigen and can further be used as Vehicles for delivery of vaccines, for e.g. PYO Bacteriophagum is used in the treatment and prophylaxis of purulent inflammatory and enteric infectious diseases.

Phage in Agriculture: Bio control is a process that uses Bacteriophage that acts directly upon bacterial strains like *Xanthomonas pruni* and *Ralstonia solanacearum* to control infections of peaches and tobacco respectively .

Phage Display: Phage display is a molecular technique used for synthesizing polypeptides with specific characteristics. The DNA that encodes the polypeptide is fused with phage coat protein genes, and the desired protein is expressed on the surface of the phage particle. Filamentous phage M13 of *E.coli* is extensively used in Phage Display.

Phage Typing: Sensitive and specific detection of bacteria with the help of bacteriophages using sensitivity patterns to precisely identify the microbial strains

Phage therapy: Phage therapy is the therapeutic use of bacteriophages to treat pathogenic bacterial infections.

Phage in Food: Phages can be incorporated in drinking water or food to control *Salmonella* and *Campylobacter* in poultry and by spray to target avian pathogens such as *E. coli*. It can also be taken orally or rectally to control *E. coli* in ruminants.