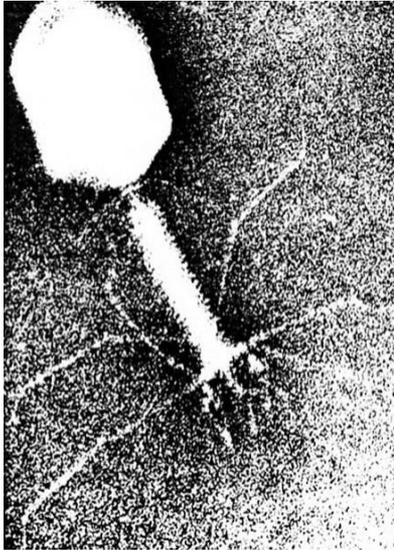


SYMMETRY IN BACTERIOPHAGES

BY MIMI LIU

PRESENTATION OUTLINE



Electron Micrograph of bacteriophage T4

1

What is a **bacteriophage**?

2

What are the **symmetrical components** of bacteriophages?

3

What is the **importance of symmetry** in bacteriophages?

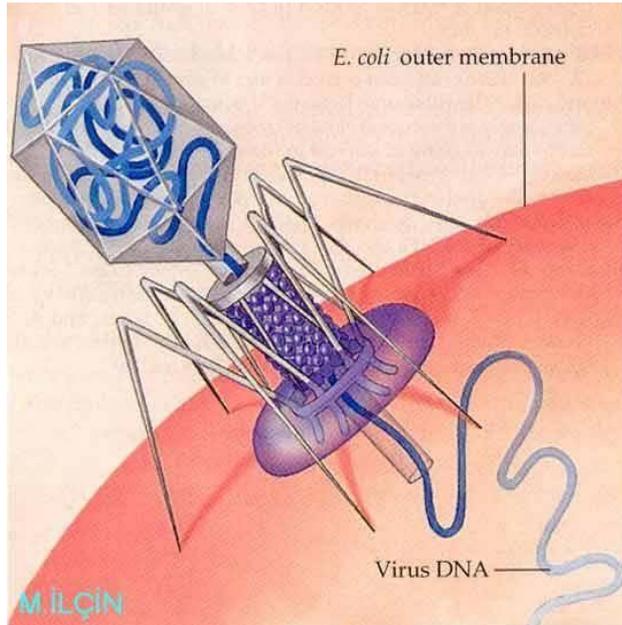


What is a bacteriophage?

BACTERIOPHAGE:

Bacteriophages (or phages)
are **bacterial viruses** that
invade and kill bacterial cells.

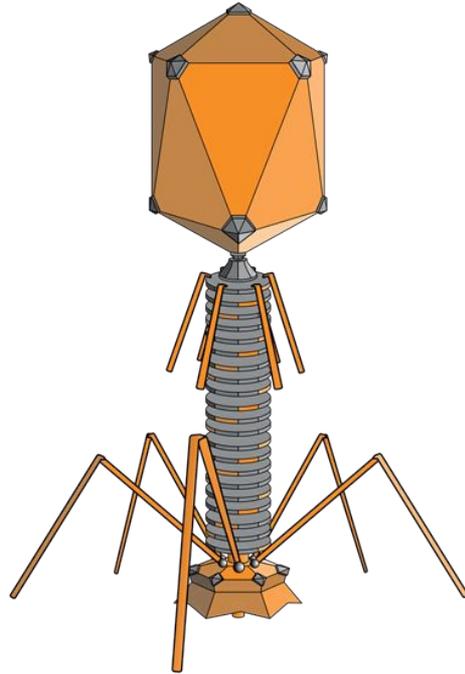
PURPOSE & FUNCTION



Bacteriophage T4 infecting E.coli

- abundant in nature (from soil and water, to the guts of animals)
- infect bacterial host cell by injecting their viral DNA into bacteria
 - lytic cycle (kills bacterial host cell)
 - lysogenic cycle (does not kill bacterial host cell)
- potential to treat bacterial diseases

BASIC COMPOSITION



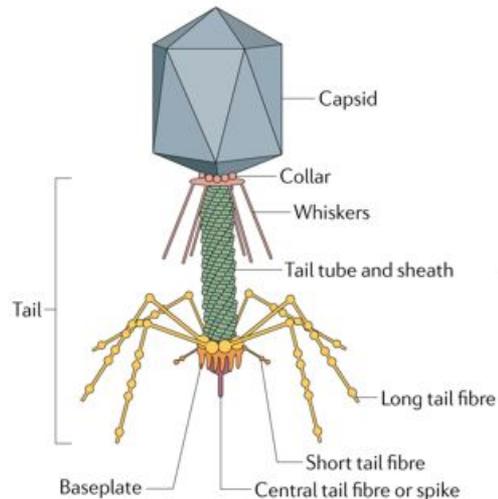
HEAD - protein structure (capsid) containing genetic material

TAIL - collar, sheath, baseplate, tail fibers

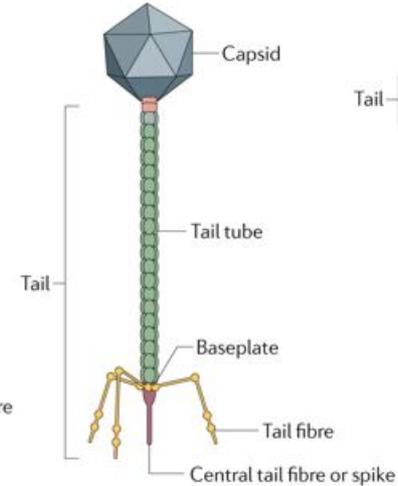
T PHAGE RELATIVES

- variation in structural complexity
- head size, head symmetry, tail length, tail width, absence/presence of sheath, amount of tail fibers, tail fiber length, etc.

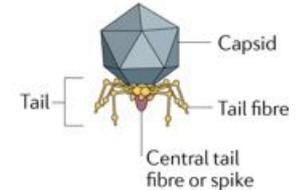
a *Myoviridae*



b *Siphoviridae*



c *Podoviridae*

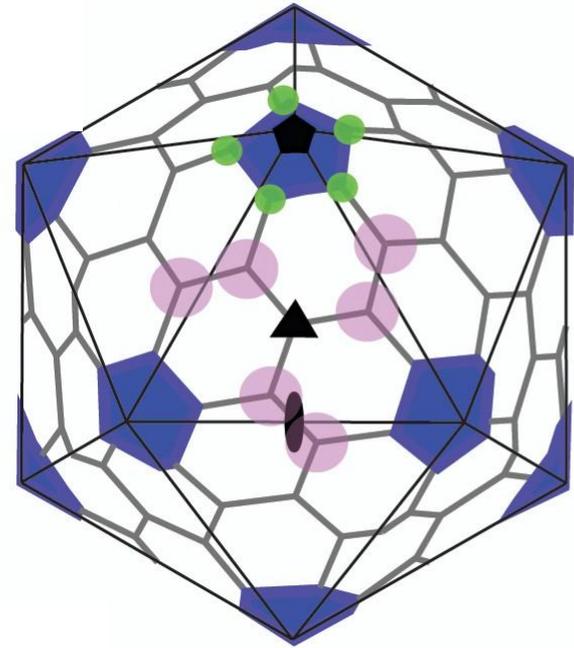


2

What are the symmetrical components of bacteriophages?

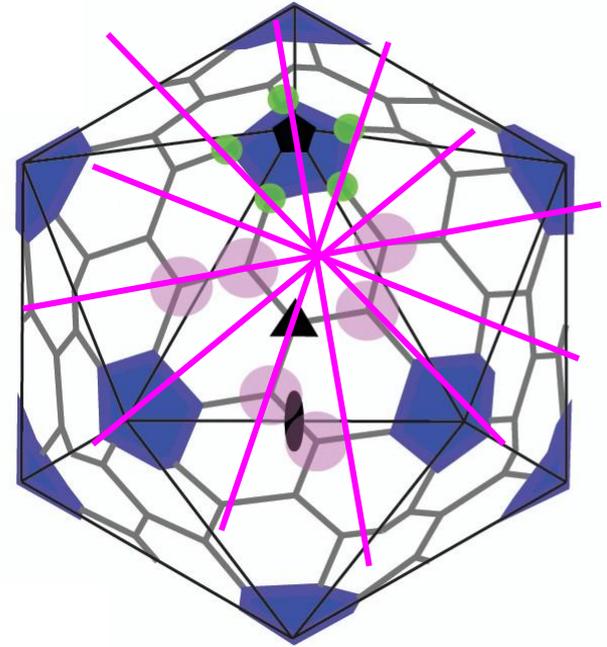
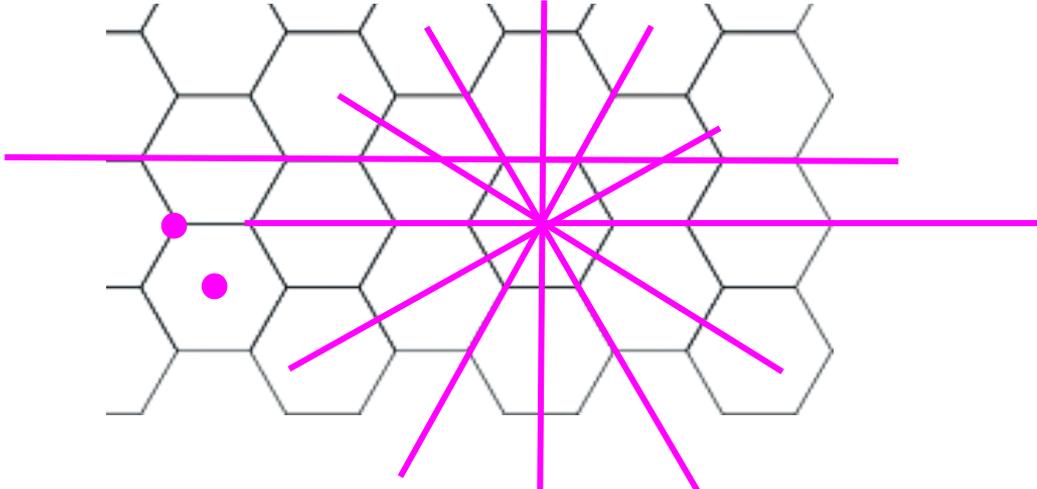
CAPSID HEAD: STRUCTURE

- 55 nm in diameter (on average)
- I_h (or Y_h): Straight Icosahedron
- 20 faces, 30 edges
- 20 equilateral triangular faces, D3 symmetry
- 5-fold symmetry at each vertex
- 2-fold symmetry at each edge



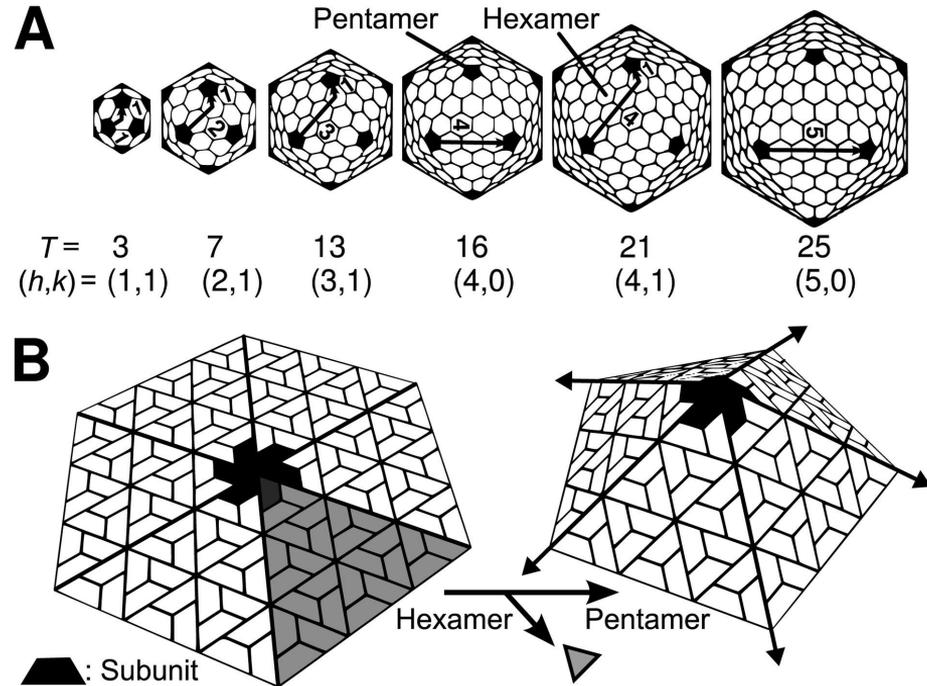
CAPSID HEAD: PROTEIN COAT

- 3D
 - Hexagonal pattern, D5 rotational symmetry
- 2D
 - 8 mirror lines
 - 2 rotation centers

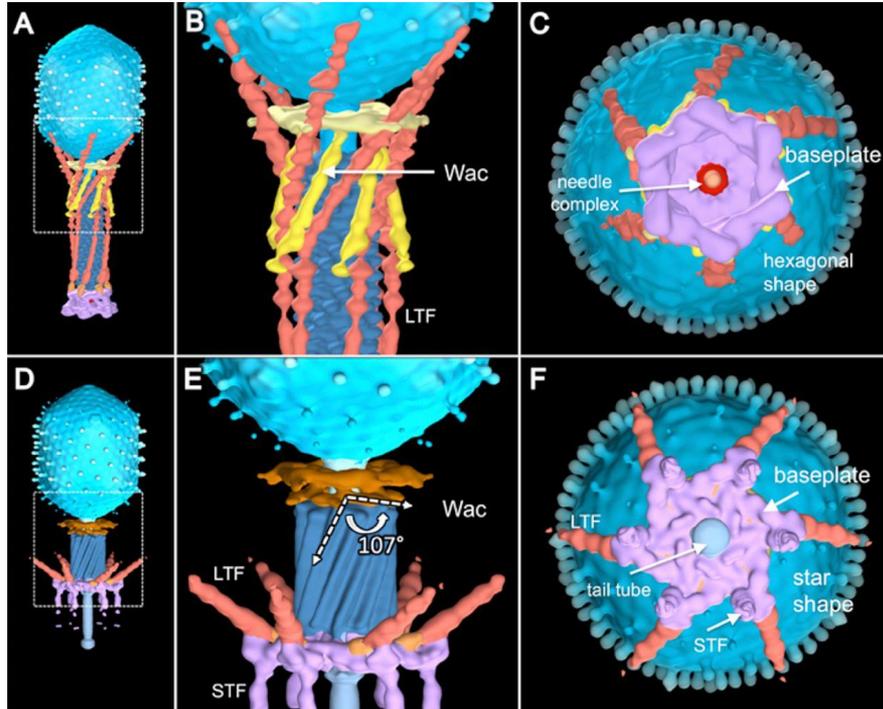


CAPSID HEAD: PROTEIN COAT

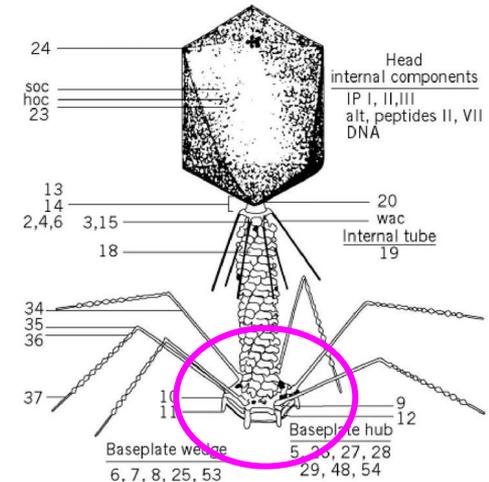
- hexagons and pentagons
- bigger size = more hexagons
- diagram A
 - vertices: D5 symmetry
 - faces: D6 symmetry
- diagram B
 - vertices: C6 symmetry
 - faces: C3 symmetry (ignoring vertex cap)



COLLAR & BASE PLATE (TAIL)



- Both hexagonal shapes
- C₆ symmetry

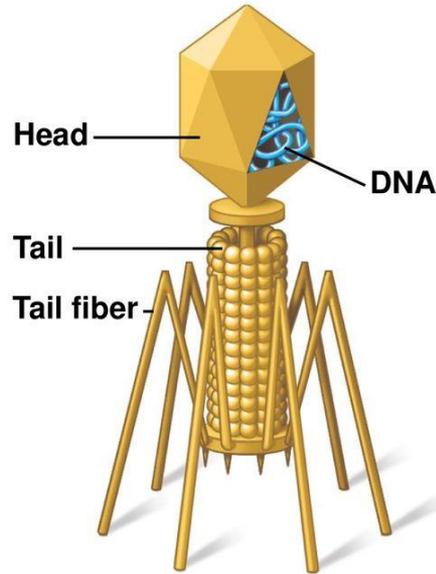




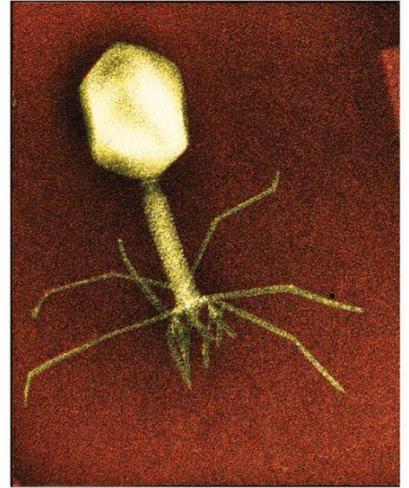
What is the importance
of symmetry in
bacteriophages?

ICOSAHEDRAL HEAD

- extremely stable for infection process
- a lot of DNA; must be able to sustain high internal pressure (10–60 atm) exerted by their tightly packed genomes
- densely packed DNA = high-energy states prime the particles for infection and facilitate delivery of the viral genomes into the hosts

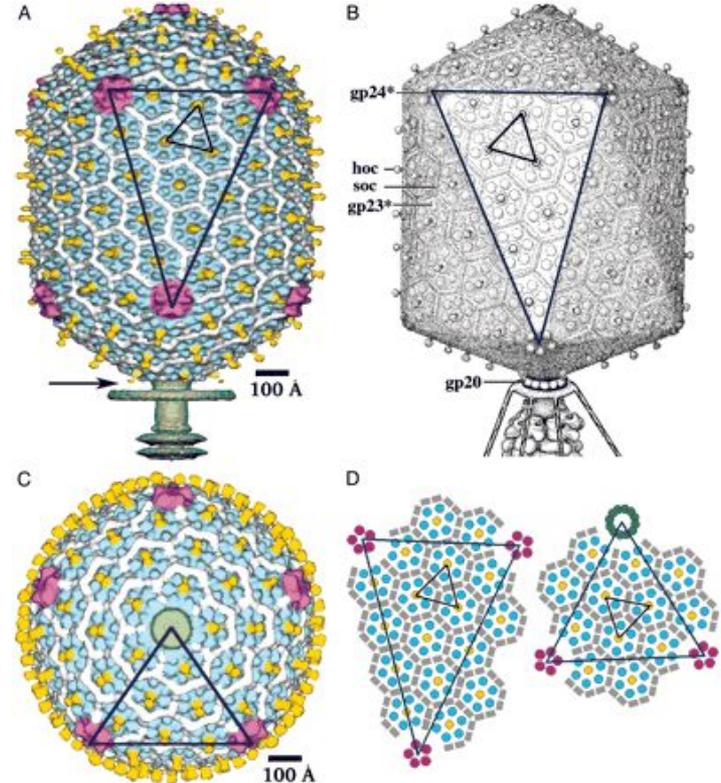


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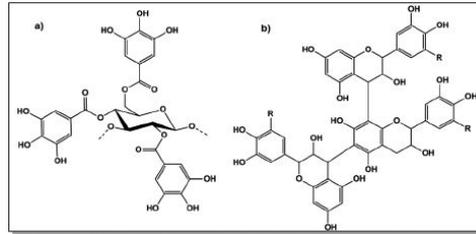
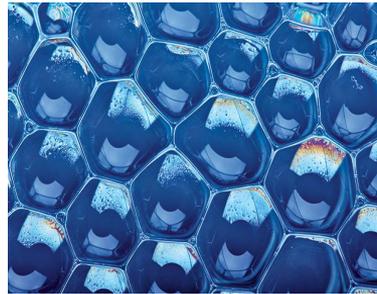
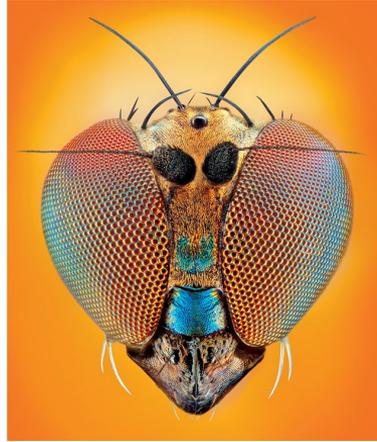


HEAD PROTEIN COAT

- some phages encode additional "decoration" proteins that bind to the exterior of their capsids
- stabilize the bacteriophage
- to withstand environmental stresses and the internal pressure of genome packaging
- it is unknown how various decoration proteins recognize and bind to specific sites on capsids with different icosahedral geometries



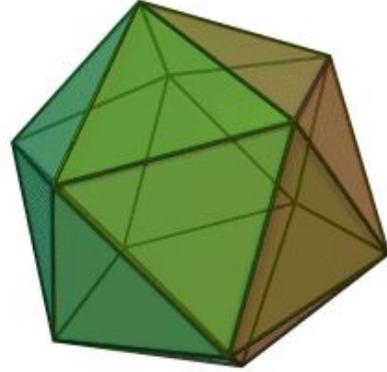
IMPORTANCE OF HEXAGONS



- extremely common in nature
- 2D and 3D
- stability
- balance
- efficiency
- achieve minimum surface area & maximum volume
- closest 3D symmetrical form to a sphere



PHAGE T4 MODEL



THANK YOU

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