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Viruses

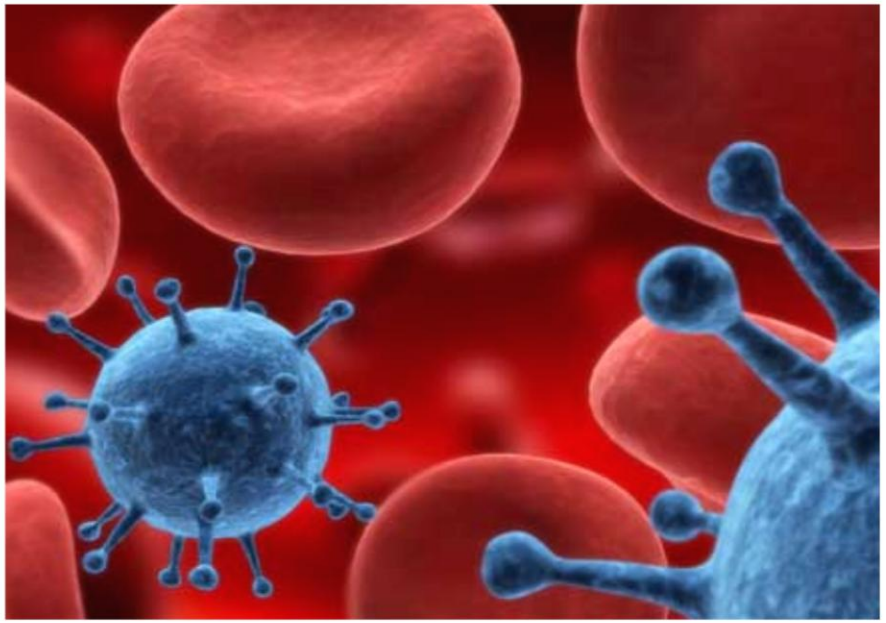
Viruses in History

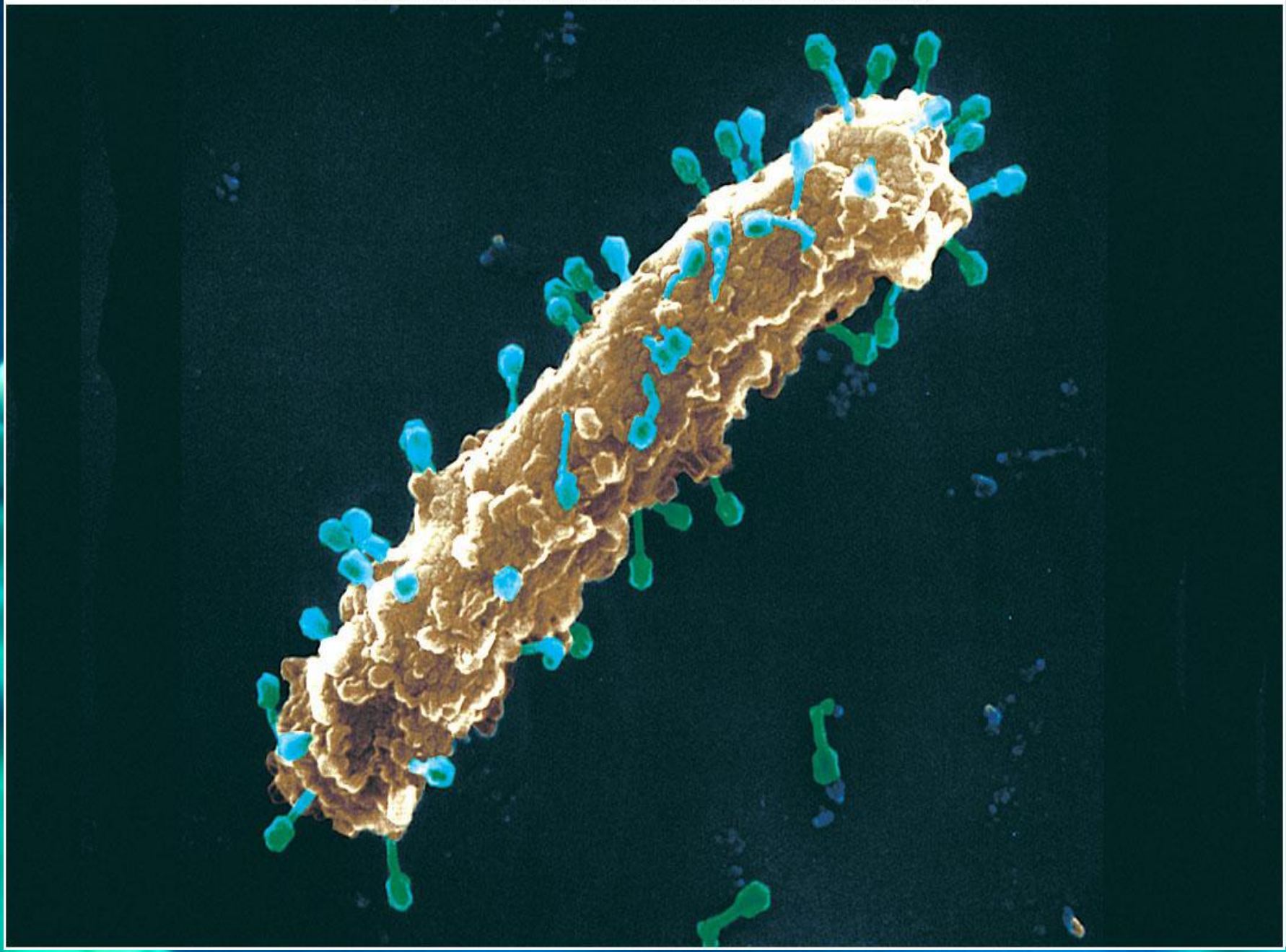
- In 1898, Friedrich Loeffler and Paul Frosch found evidence that the cause of foot-and-mouth disease in livestock was an infectious particle smaller than any bacteria
- This was the first clue to the nature of viruses, genetic entities that lie somewhere in the grey area between living and non-living states

- Viruses depend on the host cells that they infect to reproduce
- When found outside of host cells, viruses exist as a protein coat, sometimes enclosed within a membrane
- When it comes into contact with a host cell, a virus can insert its genetic material into its host, literally taking over the host's functions

Viruses

- Viruses are a means of transmitting genetic information in an effort to continue their survival
- In order to accomplish their end goal, viruses act as agents which reproduce their own DNA/RNA within living cells





Viruses: Modern Day

- Virologists now are well aware of and take precautions to curtail viruses' potency, particular their ability to unrelentingly attack all known cellular life forms
- Virologists have a sense of how viruses work by replicating their genetic materials
- The only other thing viruses have in common with other life forms is that they are what is known as obligate intracellular parasites, meaning they are unable to grow and reproduce outside of a living cell

- This then makes their continued survival contingent upon their hosts
- For this reason, there exists and an intriguing dilemma for pathogens that tend to kill their hosts
- All of the time, new viruses are being discovered
  - Virologists believe that they have only just begun to learn of all the viral varieties that exist
- In order to study a virus, the virologist needs to investigate its intracellular nature

- With plant and bacterial viruses it is possible to extract sufficient amounts of virus from an infected host in order to perform analysis
- Virologists have been able to detect that viruses are mainly comprised of protein and nucleic acid

Are Viruses Living?

- Are they cells?
- Do they use energy to grow?
- Do they use energy to respond to their external environment?
- Are they autotrophs or heterothrophs?
- Do they live off waste?

Are Viruses Alive?

Who's Hosting?

- Viruses need a host to multiply
- A host is an organism that provides energy
  - Examples – people, birds, tomato, potatoes

Counterfeit Parasites

- Parasites – organisms living on or in a host cell that causes harm to the host

- Why are viruses counterfeits?

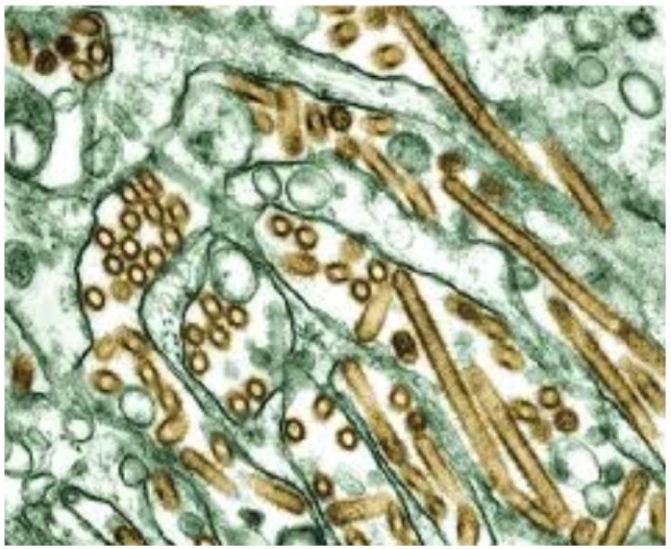
  - Viruses are counterfeits because they destroy host cells, but they are not organisms

How do we name viruses?

They are often named after the disease they cause – such as polio virus

How Flu Viruses Attack

Influenza virus

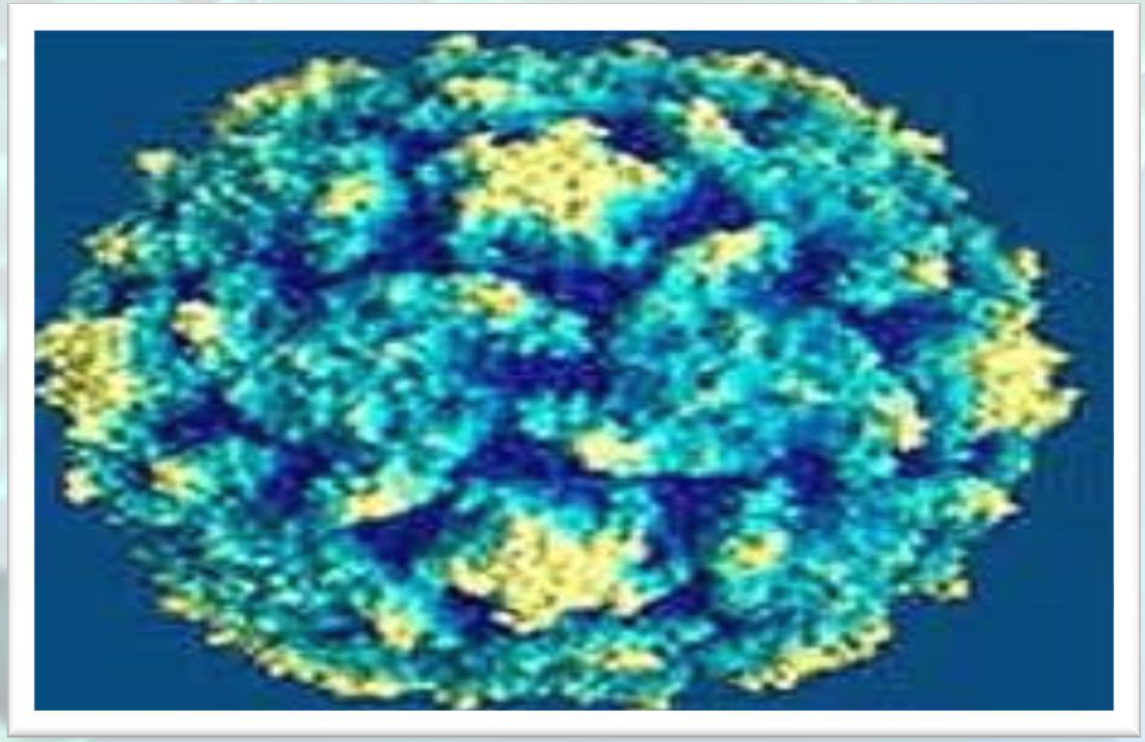


They are often named by the organism they infect

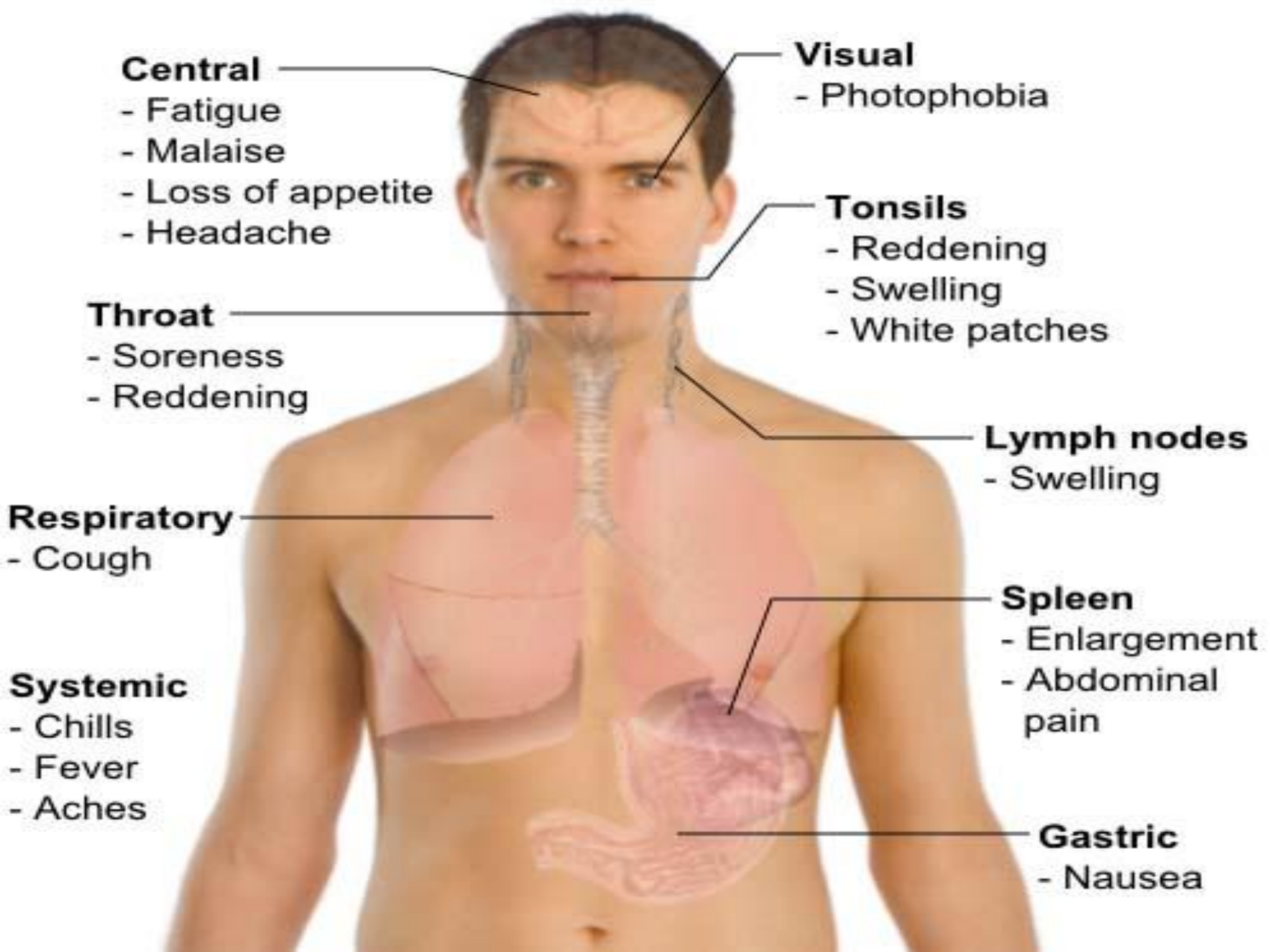
Tomato mosaic

Sometimes they are named by where they are found – Ebola virus

Sometimes they are named by the scientists that identified it – Epstein-Barr virus



Mononucleosis Health Byte


Central
- Fatigue
- Malaise
- Loss of appetite
- Headache
Visual
- Photophobia
Tonsils
- Reddening
- Swelling
- White patches
Throat
- Soreness
- Reddening
Lymph nodes
- Swelling
Respiratory
- Cough
Spleen
- Enlargement
- Abdominal pain
Systemic
- Chills
- Fever
- Aches
Gastric
- Nausea

Viruses: Morphology

- After the creation of the electron microscope, the morphology (shape and form) of viruses was first able to be studied
- Unlike larger organisms, the morphology of microorganisms is relatively poor and is confined to few shapes
- Their poor morphology, however, is compensated by great physiological versatility

- Virologists realized the size and shape of an individual virus to be a distinct, constant characteristic
- A virus can take on many forms including: circles, ovals, long thick or thin rods, flexible or stiff rods, as well as, ones with distinctive heads and tail components
- The smallest viruses known have been measured to be 20 nm in diameter while the largest around 250 nm

Various Sizes

- Cannot be seen on microscopes
- Measured in nanometers
- 1 nm = 1 / 1,000,000,000m
- Yellow fever = 22nm
- Smallpox = 250nm
- Average virus size = 50nm to 60nm

Structure of Viruses

- A unique protein coat – the shape of the protein allows the coat to attach to, or lock onto, specific host cells
- Example: HIV attaches to T4 cells
- The genetic material is inside the viruses

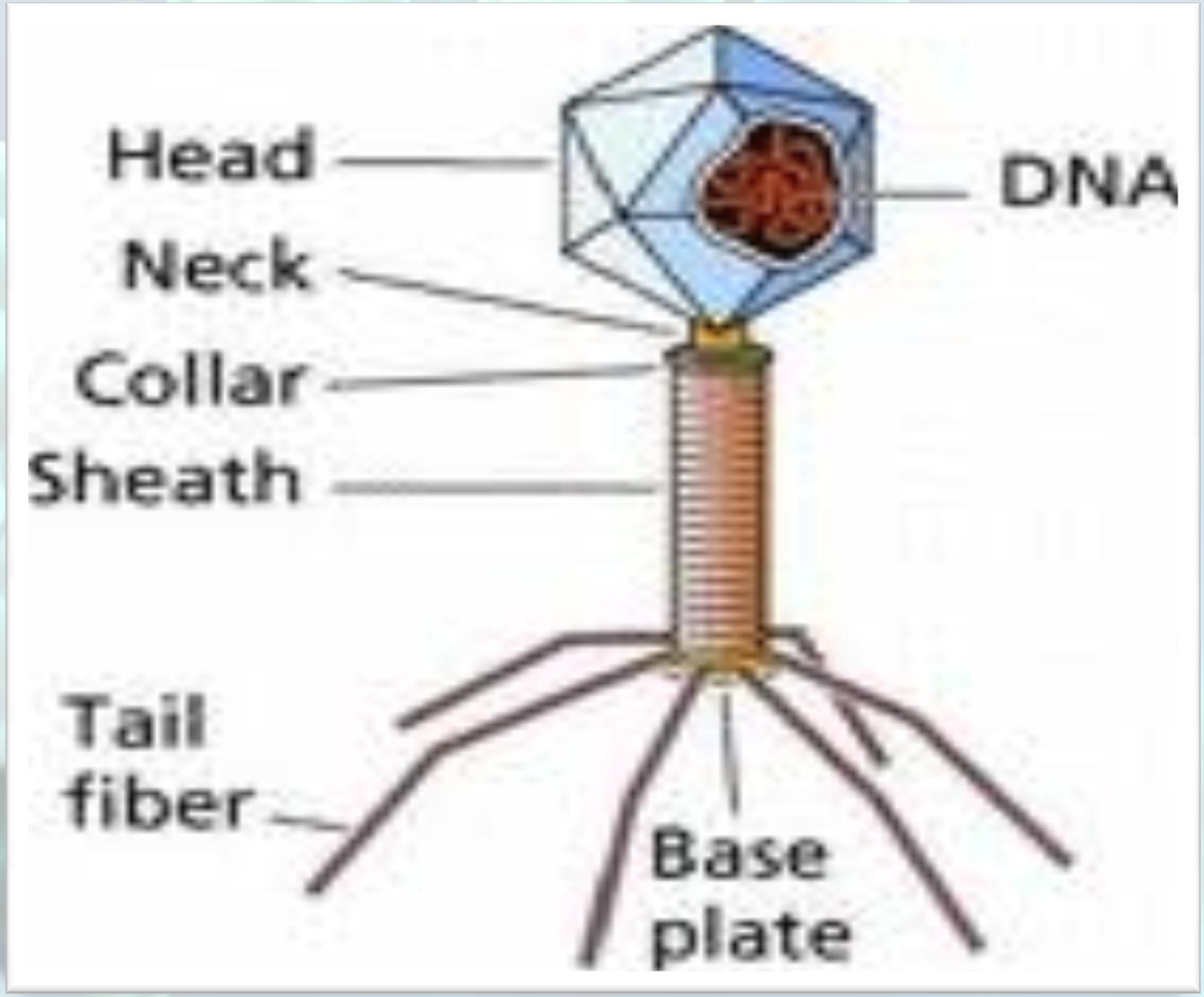
Viruses: Structural Understanding

- Different from all other life forms, viruses have the ability to contain nucleic acid regardless of its form
- While some viruses' genetic material is composed solely of RNA, others consist only of DNA
- Never, though, does a virus contain both

- Within viruses, the nucleic acid polymer is likely to contact between four to seven genes and for very large viruses, between 150 to 200 genes
- While some viruses contain a handful of enzymes and others contain none, no virus contains the scale of enzymes found even in the smallest bacteria
- All viruses are covered with what is known as a protein coat
  - This is comprised of several different types of proteins (capsomers) of which multiple copies exist
  - Defined as identical protein subunits which spontaneously come together (assemble) in a preplanned manner to create the virus coat (capsid)

- A naked virus is a virus which is covered solely by one protein
- There are viruses which obtain a lipid membrane (called and envelope) upon its release from a host cell that surrounds the capsid
- An envelope is the name for the lipid membrane while the viruses in questions are referred to as enveloped viruses
- An additional type of proteins contained by all viruses is known as 'attachment protein or number docking protein‘
- The 'attachment protein' needs to connect with the virus' target cell before entering that cell

- So that the 'the attachment protein' can make communication with the relevant receptor sites located on target host cells, it needs to lie on the outer surface of the virus
- Because of their outreaching tentacle-like structures, these attachment proteins are frequently called ‘spikes’
- This is on account of the fact that they extend outward from the cell so that they make better contact with the host receptor
- Flu Attack! How A Virus Invades Your Body


Head
DNA
Neck
Collar
Sheath
Tail fiber
Base plate

Viruses: Life Cycle

- **Phage--**a virus that is parasitic in bacteria; it uses the bacterium's machinery and energy to produce more phage until the bacterium is destroyed and phage is released to invade surrounding bacteria

- **The general life cycle/replication of all viruses is as follows:**
- **Adsorption (Docking) and Penetration**--Once firmly attached to the cell, a viral enzyme in the tail punches a hole in the host's cell wall so that it can inject DNA into the host's cytoplasm

- **Synthesis of Viral Components**--Once inside the host, the viral genome completely takes-over the host's metabolism, recapitulating it to satisfy its own needs
- Upon entry, viral nucleic acid is transcribed and translated while the viral proteins, either enzymes or structural components, go about their process of manufacturing everything needed to perpetuate the virus strain. Remarkably, in many phages, the entire life cycle--from infection to lysis--requires a mere 20 to 40 minutes

- **Maturation and Release**--Within this phase, the various components accumulate within the cell and begin to spontaneously assemble into new phage
- This is an orderly process whereby each component is added in the proper sequence
- When new enzymes are produced they cause the cell to burst or lyse, thereby releasing a crop of new viruses into the environment

- **The life cycles of a virus include the following stages:**
- Adsorption (docking) with the host receptor protein
- Entry (penetration) of the viral nucleic acid into the host cytoplasm
- Biosynthesis of the viral components
- Assembly (maturation) of the viral components into complete viral units
- Release of the completed virus from the host cell

"We're pretty sure it's the West Nile virus."