# BB101
# Fall 2022

Tutorial 1

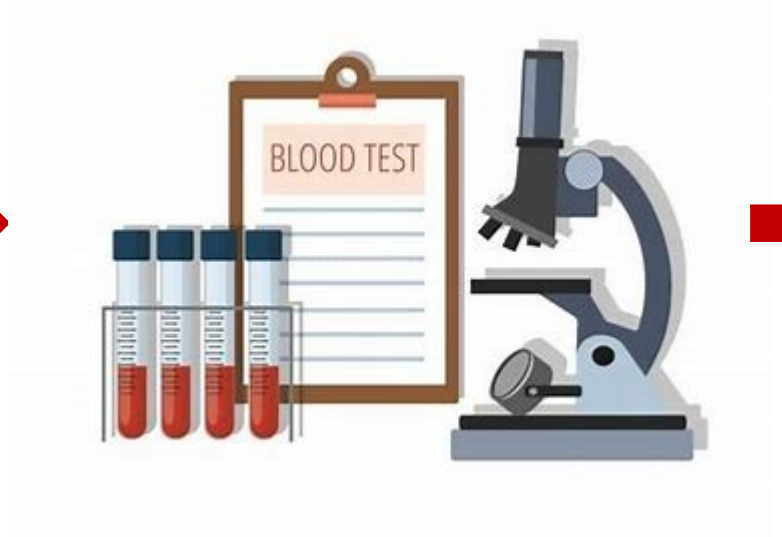
Based on lectures 1 and 2

(Introduction, Cells)

# Imagine the future……..

It is the year 2050. You have set IIT as your goal for your undergraduate degree. You enroll in one of the numerous coaching classes that have an excellent success rate for cracking the JEE.

The first day you show up to the coaching class, you are asked to give a sample of your blood, which is given to a genetic testing lab to test your intelligence and ability to be an engineer. After 2 days, the results of your genetic test shows that you have a 90% probability of being an outstanding engineer. You are admitted into IIT Bombay immediately!




# How can it be that your blood test informs about your aptitude as an engineer?

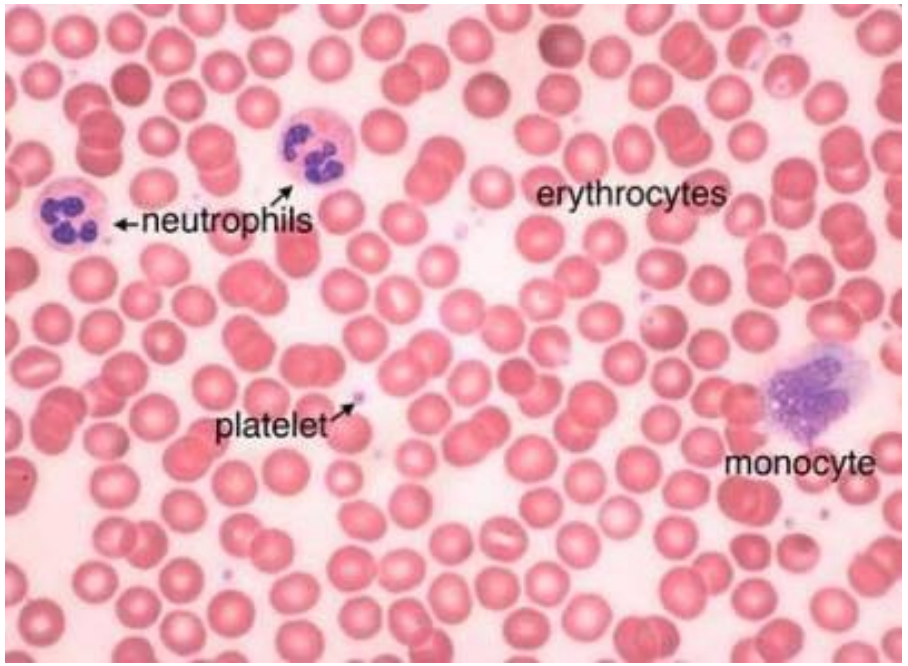

**Let us answer this question by breaking down the steps and what happens at each step**

# Why are we taking your blood to do a genetic test?

Concept to recall from the lectures:

- Blood has cells that contain our genetic material

New information: what are the types of blood cells?

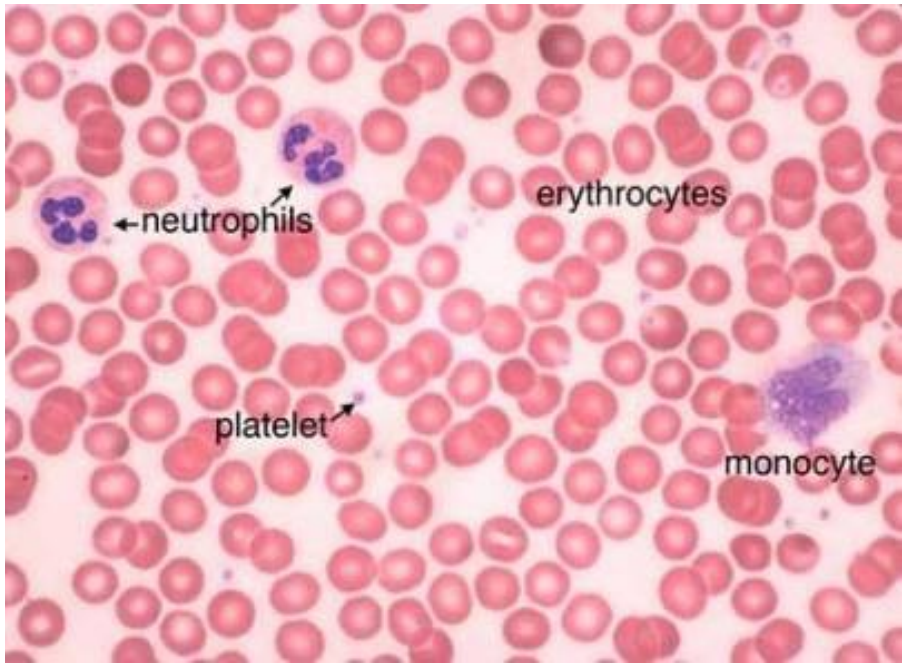



Erythrocytes: carry oxygen
Platelets: help in clotting
Neutrophils, monocytes: immune cells that fight infection

# Which of the blood cells will give the information for the genetic test?

Concept to recall from the lectures:

- The genetic material is DNA and it is found in the nucleus of cells (point to discuss: do all cells contain the same DNA?)




This image shows a blood smear stained with a dye that colors DNA purple.

Answer the question….

All of us are not comfortable giving blood. Which other cells could be used for the genetic test?

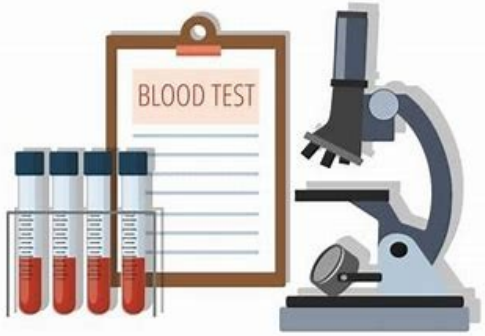
This is called non-invasive diagnostics.

Concepts to recall from the lectures:

- The genetic material is DNA and it is found in the nucleus of cells

Point to consider: which cells are easily accessible and are nucleated?

- Discuss this in class with your TA; you should also Google the answer




# What kind of test will be done to screen for engineering aptitude genes?

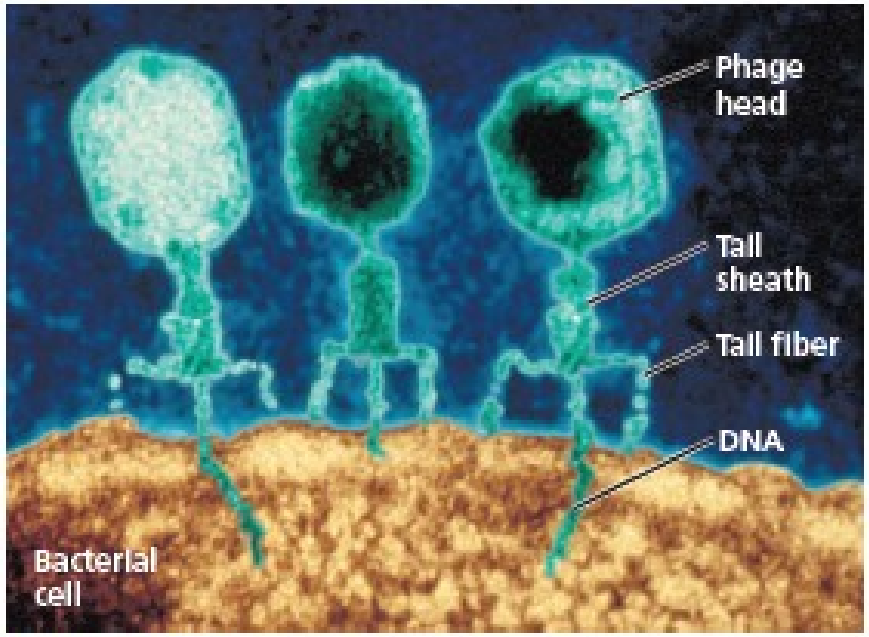
Concepts to recall from the lectures:

- There are variations between individuals that give rise to different phenotypes (SNPs and variable repetitive elements)

New question: how can these variations be used to find genes associated with phenotypes?

We will answer this question after the next lecture on Heredity.

# While we wait for the next lecture to continue figuring out our genetic test to replace JEE… let us explore more about the domains of life




**Viruses infecting a bacterial cell.** Phages called T2 attach to the host bacterial cell and inject their genetic material through the plasma membrane while the head and tail parts remain on the outer bacterial surface (colorized TEM).

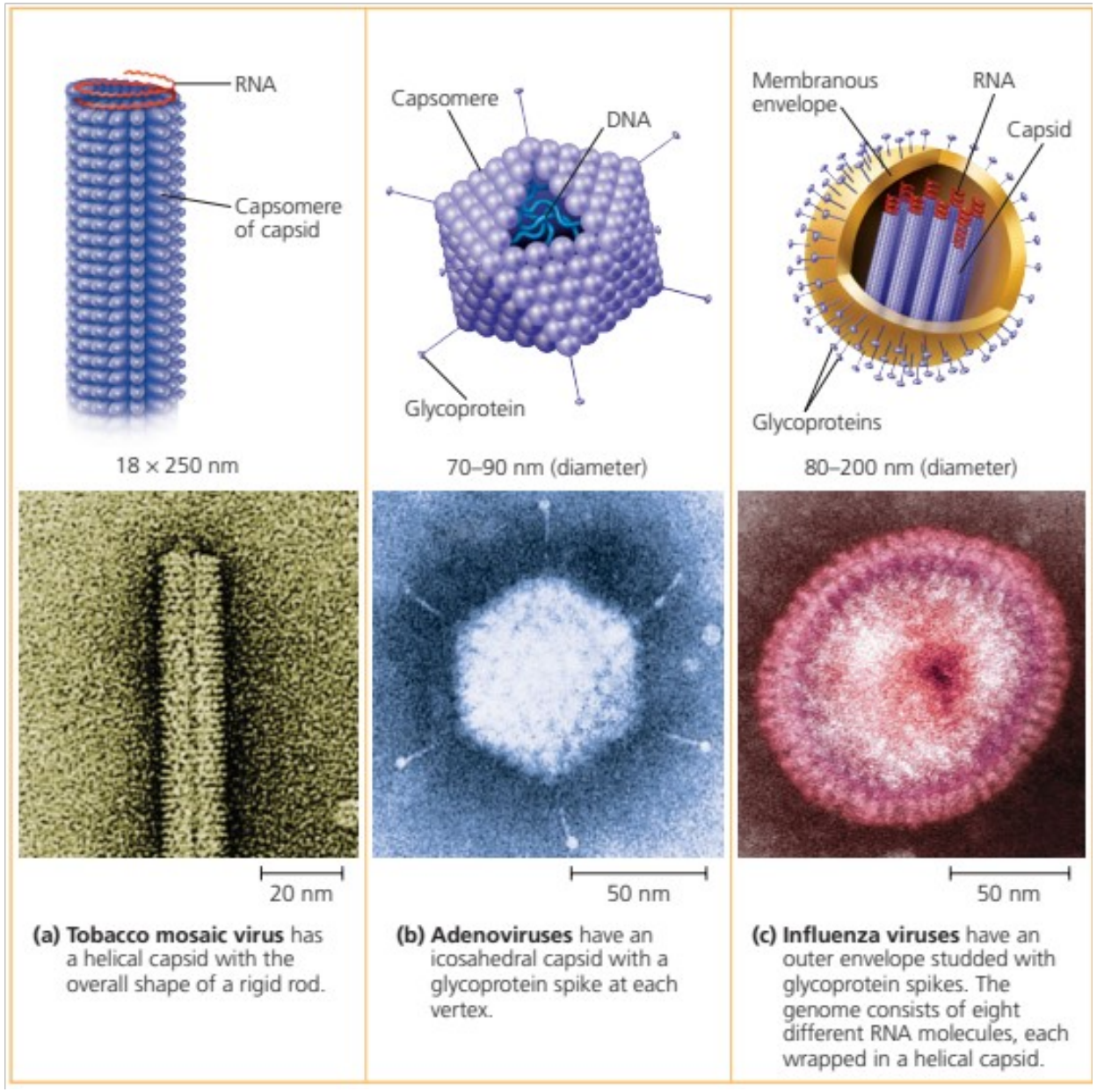
When bacteriophage infect the bacteria, they make new viruses and burst out of the bacterial cell, killing it.

Bacteria can be human pathogens and cause widespread disease (e.g. TB, lung infections, hospital-acquired infections, etc) and are treated by drugs.

Multi-drug resistance is a huge problem (you will learn about the biology behind drug resistance in subsequent lectures).

Bacteriophage that infect pathogenic bacteria are being developed as phage therapy.

# The viral capsid (coat) is highly geometric and organized

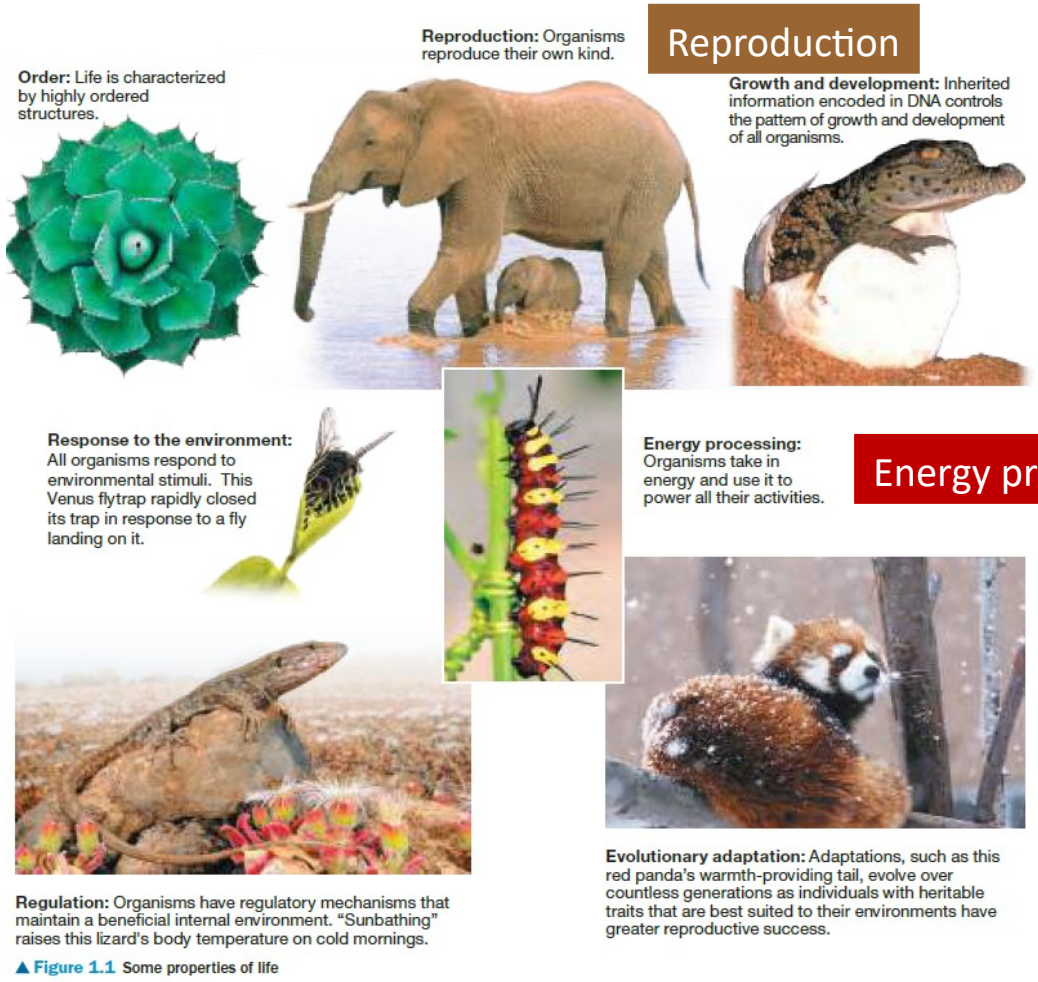



Within this capsid is the viral genome:

- Double stranded DNA
- Single stranded DNA
- Double stranded RNA
- Single stranded RNA

DNA is made up of A, T, G and C nitrogenous bases, while RNA is made up of A, U, G and C.

Double stranded polymers will always follow the rule that A pairs with T/U and C pairs with G.



▲ Figure 1.1 Some properties of life

Based on this figure, give one reason why a bacteriophage virus could not be alive.

Give one reason why a bacteriophage virus could be alive.

Discussion point: If you are using bacteriophage as a therapy, and want to ship them to the patient, is being inanimate a good thing?

# Predict the genome of the virus, based on the percentage of A, T/U, G, C

Genome content of Virus # 1:

A: 30%, T: 30%, G: 20%, C: 20%

Genome content of Virus # 2:

A: 40%, U: 20%, G: 10%, C: 30%

Options:

- Double stranded DNA
- Single stranded DNA
- Double stranded RNA
- Single stranded RNA

Use Google/ChatGPT to find the names of 2 viruses that fall into the category of virus # 1 and 2 that fall into category # 2.

# DNA as an information storage molecule

- You decide to use virus # 1 as your phage therapy, so you sequence the genome of this virus
- Nitrogenous bases (A, T, C, G) are called bases and for double stranded DNA they are called base pairs
- The number of base pairs for virus # 1 is found to be 50,000.This means that the information carrying features are 2x 50,000 (double stranded DNA).
- Imagine that we have to represent this information in binary numbers (like a computer). How many bytes would it take to store this virus' genome?

# DNA as an information storage molecule

A way to represent A, T, G, C in binary is A=00, T=01, G=10, C=11 (for example). 2 bits for one base. 8 bits = 1 byte.

For virus # 1, 1,00,000 bases would take 2,00,000 bits, which is equal to 25,000 bytes (25 Kilobytes)

For the human genome, 3 billion bases would take 6 billion bits. So (6/8) billion bits = 0.75 Gigabytes

Compare the answer with the space needed to store your favorite operating system!

# Paradigm shifts

A paradigm is a set of concepts and ideas (often found in textbooks). Any observation or experimental result that leads to a change in these set of concepts and ideas is said to bring about a paradigm change or a paradigm shift.

| Paradigm | New observation |
|---|---|
| Prokaryotes do not have compartmentalization | Liquid-liquid phase separation gives rise to local areas that resemble compartments in bacteria(nucleoid) |
| Viruses do not have any machinery for reproducing themselves | Giant viruses have machinery for replicating their DNA |
| Mitochondria are the powerhouse of the cell | Yeast can be created lacking mitochondria (petite or small in size) and the anaerobic microbial eukaryote Monocercomonoides sp. reveals a complete lack of mitochondrial organelle. |
| A genome is made of DNA | Do you agree? |
| Humans are eukaryotes so all our cells are nucleated | Do you agree? |