

# MEDICAL LABORATORY SCIENTIST



# WHAT IS A MEDICAL LABORATORY SCIENTIST?

- Medical detective!
- Examine and analyze body fluids, tissues, and cells
- Analyze the chemical constituents of body fluids
- Identify infective microorganisms
- Identify blood clotting abnormalities
- Evaluate test results for accuracy and help interpret them for the physician
- Cross-match blood for transfusions

# EDUCATION

- MLT (Medical Laboratory Technician)
  - Associate's Degree
- MLS (Medical Laboratory Scientist)
  - Bachelor's degree
  - Master's degree
  - Doctorate (first graduate in 2018)
- MLT vs MLS: What's the difference?
  - Some of the work is the same, however, MLS's have a more extensive theoretical knowledge base. This allows them to conduct more advance testing such as: cross-matching for blood transfusion, molecular diagnostics, microbiological testing, etc. MLS's are more likely to advance to management positions.

# AREAS OF THE LABORATORY

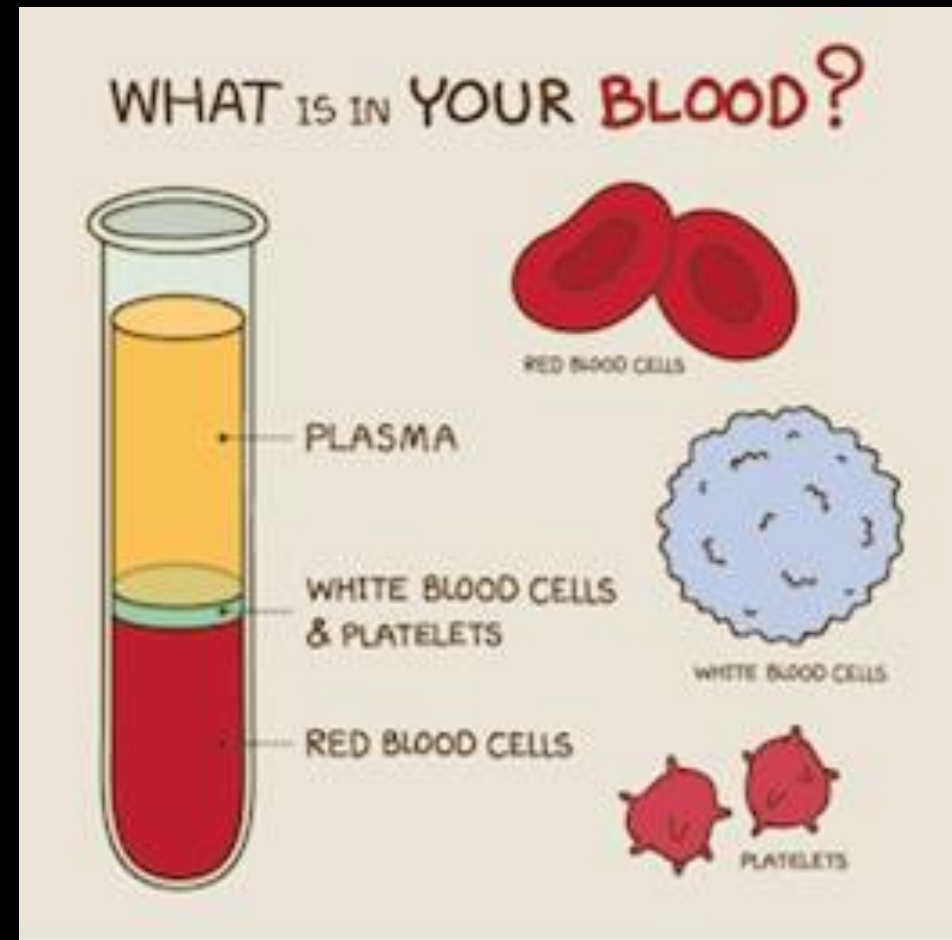
- Blood bank
- Hematology
- Coagulation
- Chemistry
- Microbiology
- Immunology
- Urinalysis/ Body Fluids
- Molecular Diagnostics



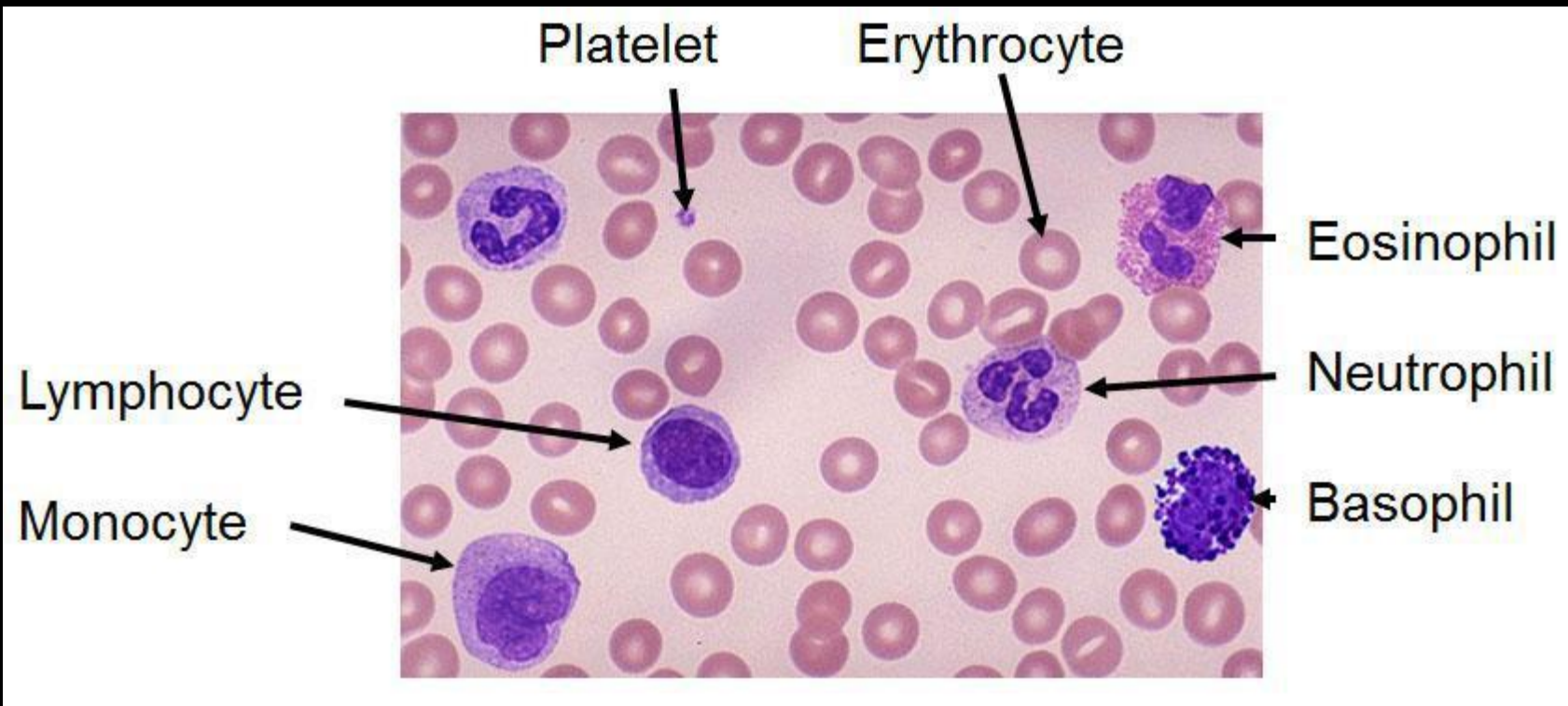
# COMPONENTS OF THE BLOOD

- 55% Plasma
  - Clotting factors, electrolytes, proteins, hormones, etc.
- < 1% Buffy coat
  - White blood cells and platelets
- 45% Red blood cells

These levels vary from person to person!

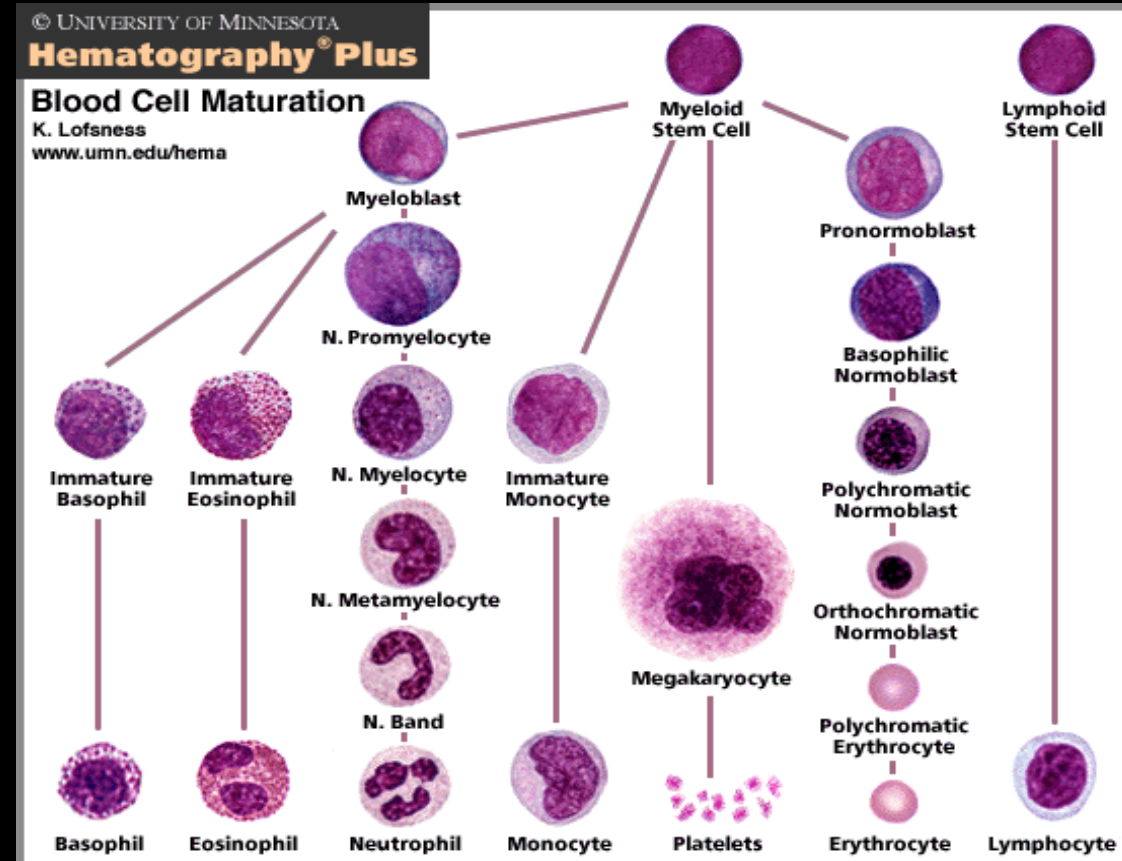


# HEMATOLOGY



# HEMATOLOGY

- Study of blood, blood forming organs, and blood diseases
- Analyze complete blood count results (CBC)
- Perform differential on blood smears
  - White blood cell categorization
  - Red cell morphology
  - Platelet estimate



# WHAT'S INCLUDED IN A CBC?

Abbreviation	Expanded	Definition
WBC	White blood cell count	Number of WBC's present
RBC	Red blood cell count	Number of RBC's present
HGB	Hemoglobin	Protein found in RBC's that carries oxygen to the body's tissues and organs. It also transports CO2 back to the lungs. Low levels mean you are anemic and may require a transfusion.
HCT	Hematocrit	The ratio of the volume of RBCs to the total volume of blood. Measured as a percentage.
MCV	Mean cell volume	The size of a RBC
MCH	Mean cell hemoglobin	Average mass of hemoglobin per RBC
MCHC	Mean cell hemoglobin concentration	Average concentration of hemoglobin in a given volume of blood



# CBC CONT.

Abbreviation	Expanded	Definition
PLT	Platelet	Platelet count
RDW	Red cell distribution width	Variation in RBC sizes
MPV	Mean platelet volume	Average size of platelets
Neut	Neutrophil	Type of WBC. First cells to migrate to the site of infection to begin killing the invading microbes
Lymph	Lymphocyte	Type of WBC. Responsible for immune responses.
Mono	Monocyte	A type of WBC that surrounds and kills microorganisms, ingest foreign material, removes dead cells, boost immune responses
Baso	Basophil	A type of WBC that appears in inflammatory reactions, specifically allergic reactions.
Eo	Eosinophi	A type of WBC that's seen in in allergic reactions, parasitic infections, and cancer.

# An example of Complete Blood Count (CBC)

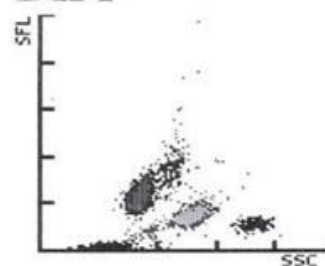
Sample No.:  
Patient ID:  
Name:  
Comments:

Ward: Rack: 2 Tube: 9 2006/04/04 13:56:20  
Dr.:  
Birth: Sex:  
Inst.ID: XT-1800i-1

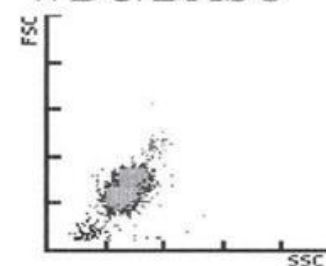
Negative

WBC	7.43	[10 <sup>3</sup> /uL]		
RBC	5.24	[10 <sup>6</sup> /uL]		
HGB	15.4	[g/dL]		
HCT	47.8	[%]		
MCV	91.2	[fL]		
MCH	29.4	[pg]		
MCHC	32.2	[g/dL]		
PLT	294	[10 <sup>3</sup> /uL]		
RDW-SD	43.0	[fL]		
RDW-CV	12.9	[%]		
PDW	11.8	[fL]		
MPV	10.5	[fL]		
P-LCR	28.4	[%]		
PCT	0.31	[%]		
NEUT	3.98	[10 <sup>3</sup> /uL]	53.7	[%]
LYMPH	2.67	[10 <sup>3</sup> /uL]	35.9	[%]
MONO	0.36	[10 <sup>3</sup> /uL]	4.8	[%]
EO	0.38	[10 <sup>3</sup> /uL]	5.1	[%]
BASO	0.04	[10 <sup>3</sup> /uL]	0.5	[%]

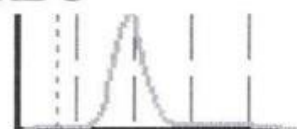
DIFF



WBC/BASO



RBC

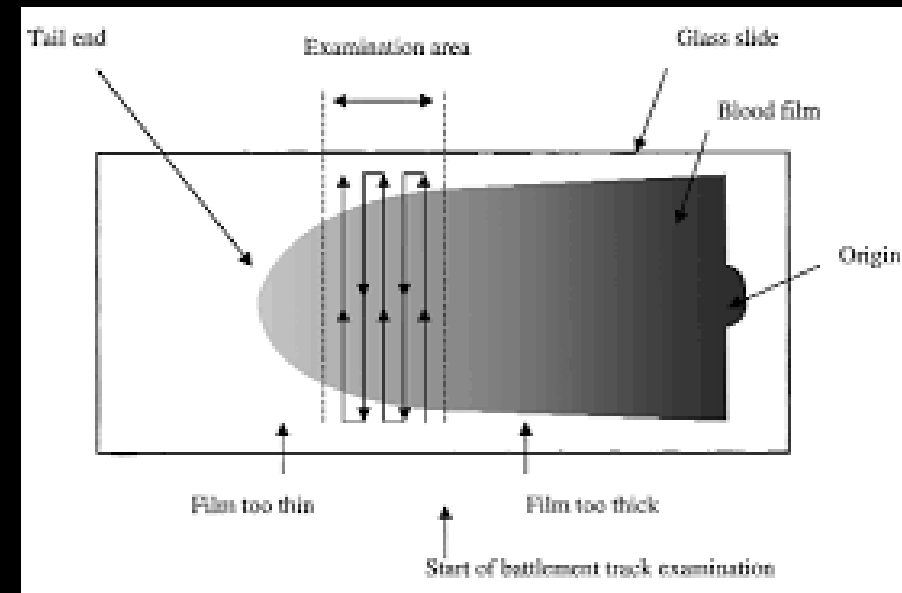


PLT































# HEMATOLOGY

- When the analyzer flags a sample as abnormal, the hematologist will make a smear and perform a manual differential.
- How to perform a manual differential:
  - Make and stain a blood smear
  - Count and classify 100 WBCs
  - Use the results from the CBC to analyze RBC morphology
- Count the number of platelets on each field for an estimate. This is used to make sure the count from the analyzer is accurate.

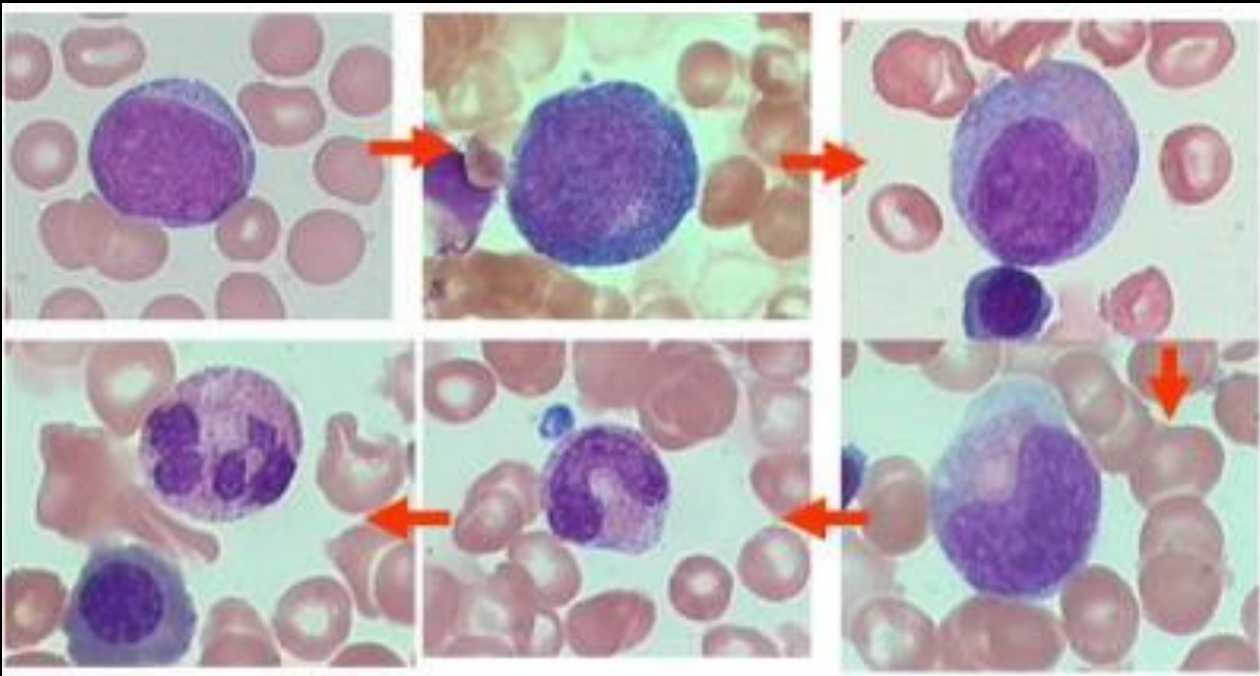


# HEMATOLOGY

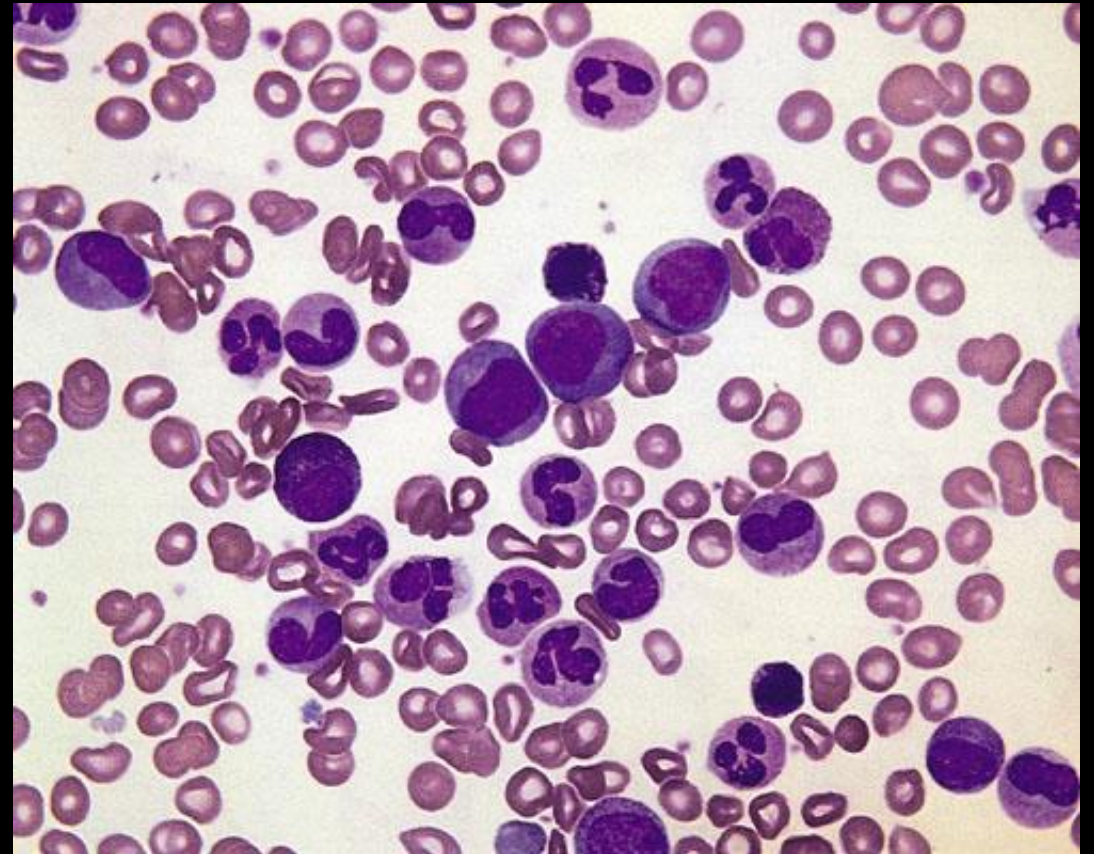
Examples of red cell morphology

Size variation	Hemoglobin distribution	Shape variation		Inclusions	Red cell distribution
Normal 	Hypochromia 1+ 	Target cell 	Acanthocyte 	Pappenheimer bodies (siderotic granules) 	Agglutination 
Microcyte 	2+ 	Spherocyte 	Helmet cell (fragmented cell) 	Cabot's ring 	Rouleaux 
Macrocyte 	3+ 	Ovalocyte 	Schistocyte (fragmented cell) 	Basophilic stippling (coarse) 	
Oval macrocyte 	4+ 	Stomatocyte 	Tear drop 	Howell-Jolly 	
Hypochromic macrocyte 	Polychromasia (Reticulocyte) 	Sickle cell 	Burr cell 	Crystal formation HbSC  HbC 	


# HEMATOLOGY



An example of the cell line maturation of neutrophils.



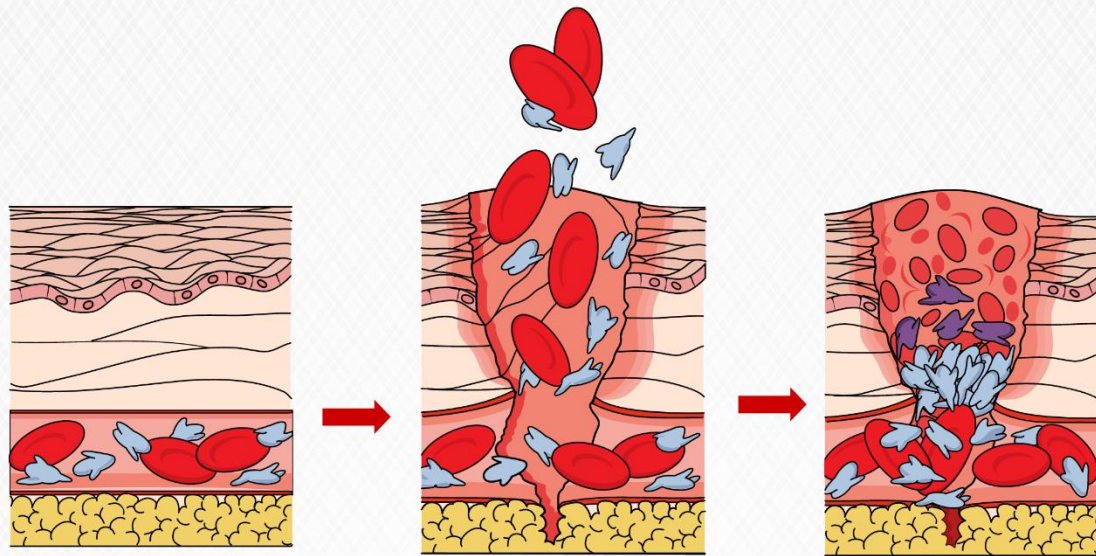
An example of Acute Myeloid Leukemia



If you start bleeding, your body will form a clot to stop. Let's take a look at the coagulation process.

# COAGULATION

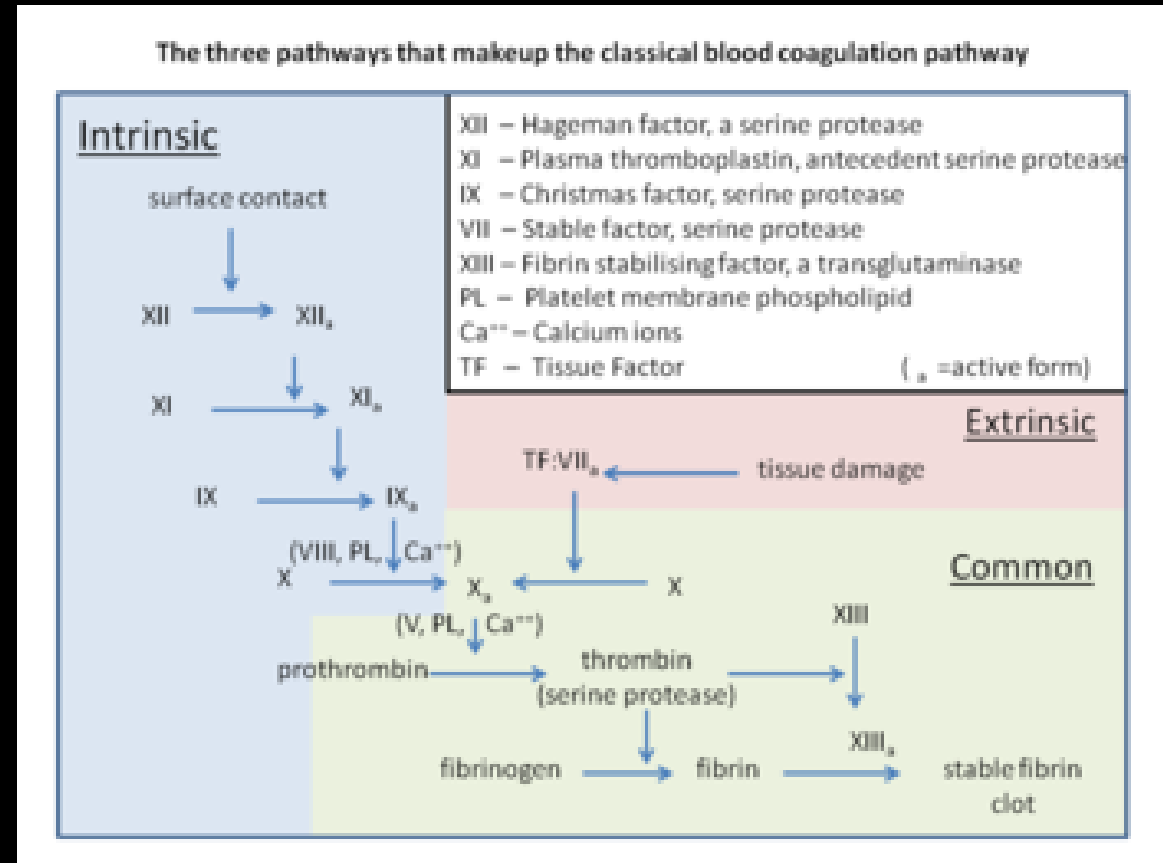
## The Coagulation Process



Coagulation (also known as clotting) is the process by which blood changes from a liquid to a gel, forming a clot

# COAGULATION

- Process to form a blood clot
- Disorders that disrupt the process
  - Hemophilia A, B, C
  - Von Willebrand Disease
  - Factor deficiencies
- Medications that disrupt the process
  - Heparin
  - Warfarin (Coumadin)
  - Aspirin

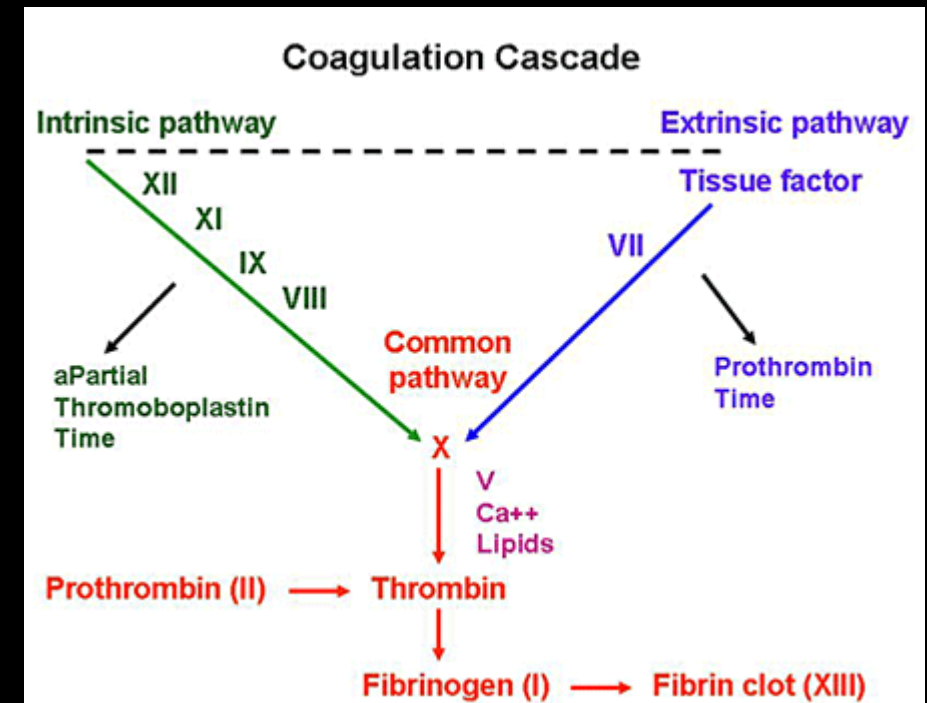




# COAGULATION

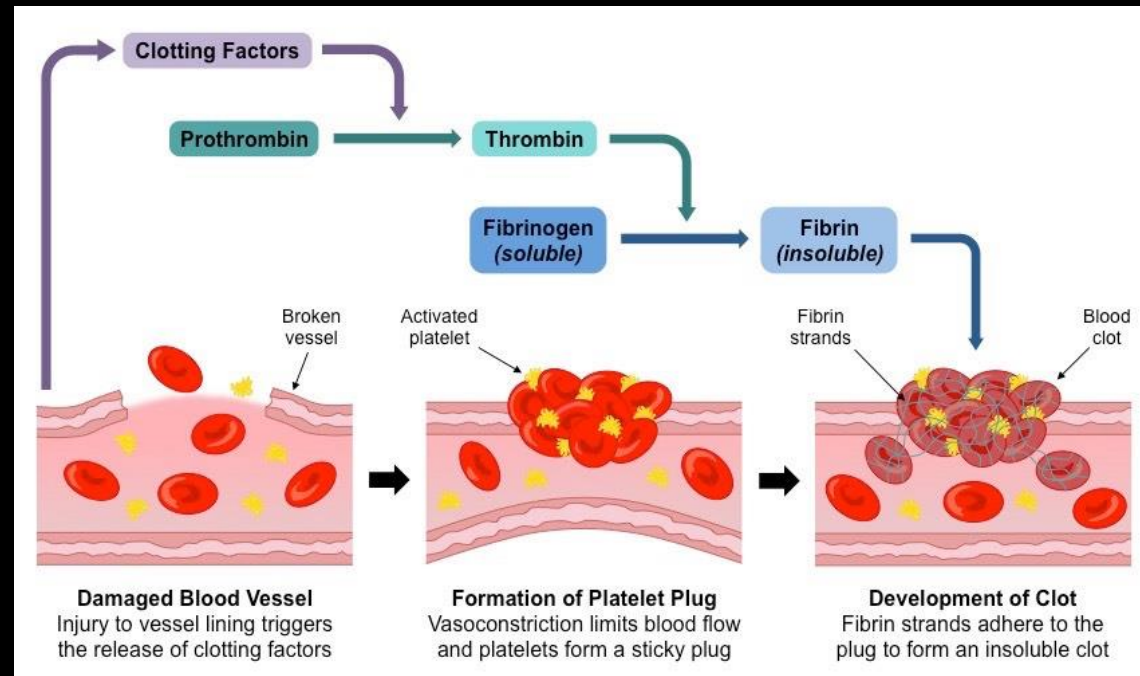
## Coagulation Tests (most common)

- Prothrombin test (PT)
  - Measures Extrinsic pathway (blue) clotting time in seconds
- Partial Thromboplastin Time (PTT)
  - Measures Intrinsic pathway (green) clotting time in seconds
- D-Dimer
  - Fibrin degradation product
  - Small protein fragment in the blood after a blood clot is broken down.
- Fibrinogen
  - Protein that's converted from thrombin to fibrin to help form a clot



# COAGULATION

- There are more coagulation tests that can be run on patients to diagnose bleeding disorders.
- This is a VERY brief overview of the coagulation process.





Now that you know what blood is composed of and how it clots, let's take a look at what happens when someone needs a transfusion.

# BLOOD BANK



# BLOOD BANK

## Blood product storage

- Red blood cells
- Platelets
- Plasma
- Cryoprecipitate

## Patient testing

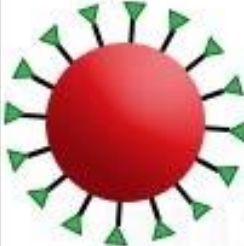
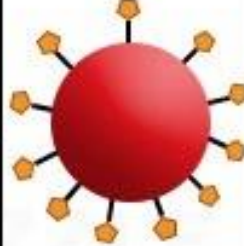
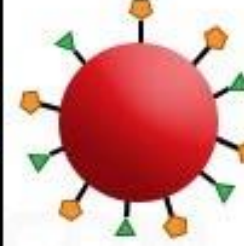
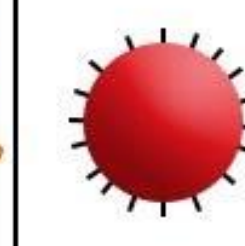






- Antibody screen and identification
- Crossmatch for transfusion
- Rhogam workup
- Cord blood
- Elutions
- Type
- DAT



# BLOOD BANK

## Blood Type

- Antigens on the RBCs
- Antibodies in the plasma

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-B and Anti-A
Antigens in Red Blood Cell	 A antigen	 B antigen	 A and B antigens	None



# BLOOD BANK

## Antibodies

- Patients can develop antibodies other than A and B
- Antibody development is due to a foreign antigen
  - Most commonly developed through a transfusion
- Pre transfusion testing to identify any present antibodies
  - Antibody screen
  - Most screens are negative
  - Positive screens require further workup. Additional panels will be used to perform a rule out.

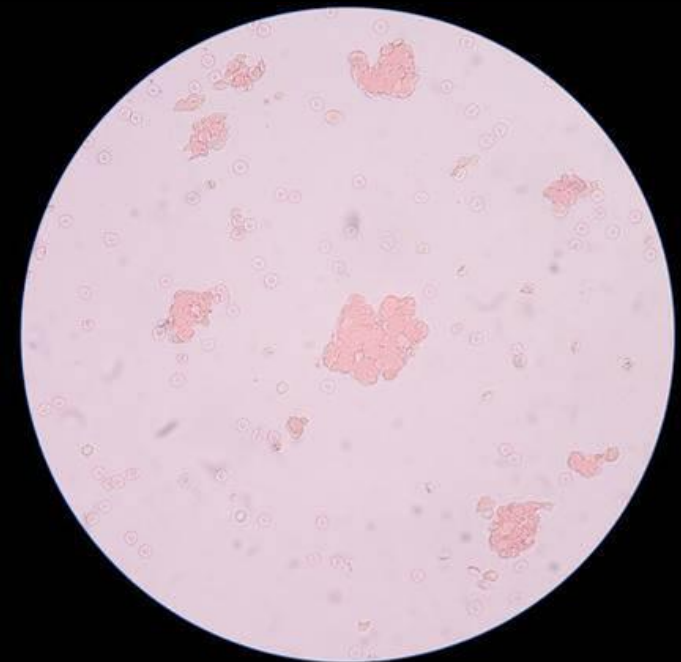
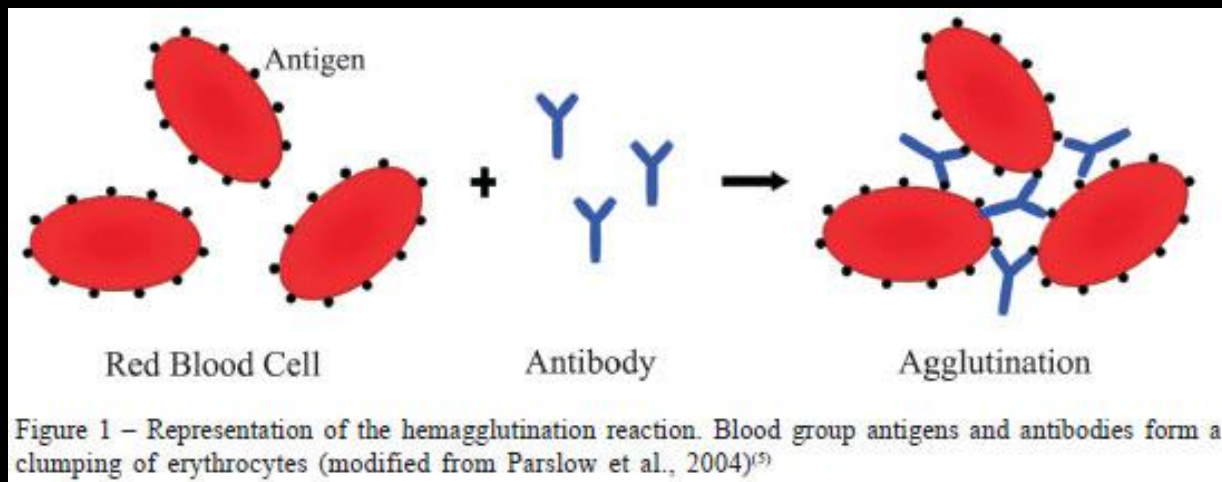
Cell #	Rh-Hr						Kell				Duffy		Kidd		Lewis		Lutheran		P	MNS				Xg
	D	C	c	E	e	C <sup>w</sup>	K	k	Kp <sup>a</sup>	Js <sup>a</sup>	Fy <sup>a</sup>	Fy <sup>b</sup>	Jk <sup>a</sup>	Jk <sup>b</sup>	Le <sup>a</sup>	Le <sup>b</sup>	Lu <sup>a</sup>	Lu <sup>b</sup>	P <sub>1</sub>	M	N	S	s	Xg <sup>a</sup>
1	+	+	0	0	+	0	0	+	0	0	0	+	0	+	0	0	0	+	+	+	0	+	+	0
2	+	0	+	+	0	0	0	+	0	0	+	0	+	0	+	0	0	+	+	+	+	+	+	+
3	0	0	+	0	+	0	+	+	0	0	+	0	+	0	0	+	+	+	0	0	+	0	+	0

An example of a antibody screen. This panel includes clinically significant antibodies. It's like solving a puzzle!



# BLOOD BANK

- If an antibody is identified, extra testing has to be done to ensure the unit of blood transfused doesn't contain the matching antigen.
- If the unit of blood has the antigen that corresponds to the antibody circulating in the patient's blood, a transfusion reaction may occur due to the antigen and antibody agglutinating.



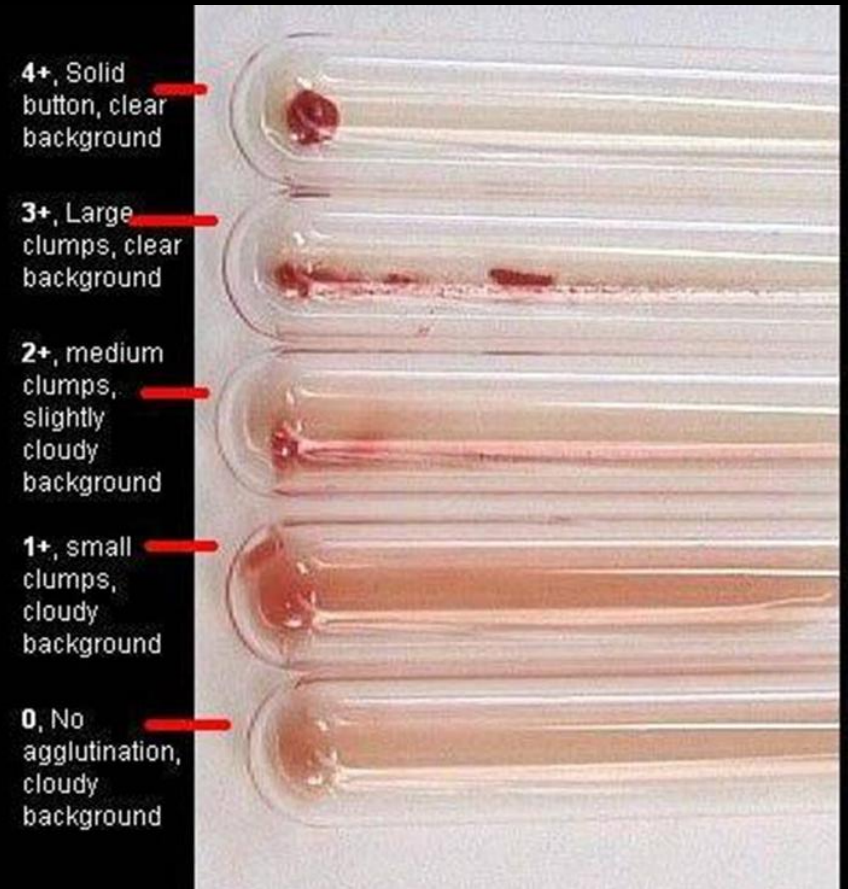
# BLOOD BANK

## Crossmatch

- Patient plasma is tested with donor RBCs
- No agglutination = compatible unit
- Agglutination = not compatible

## Traumas

- Universal blood products are given in emergent situations without a crossmatch



# GO DONATE BLOOD!

If you are healthy and able, please go donate! You can save many lives by doing so.

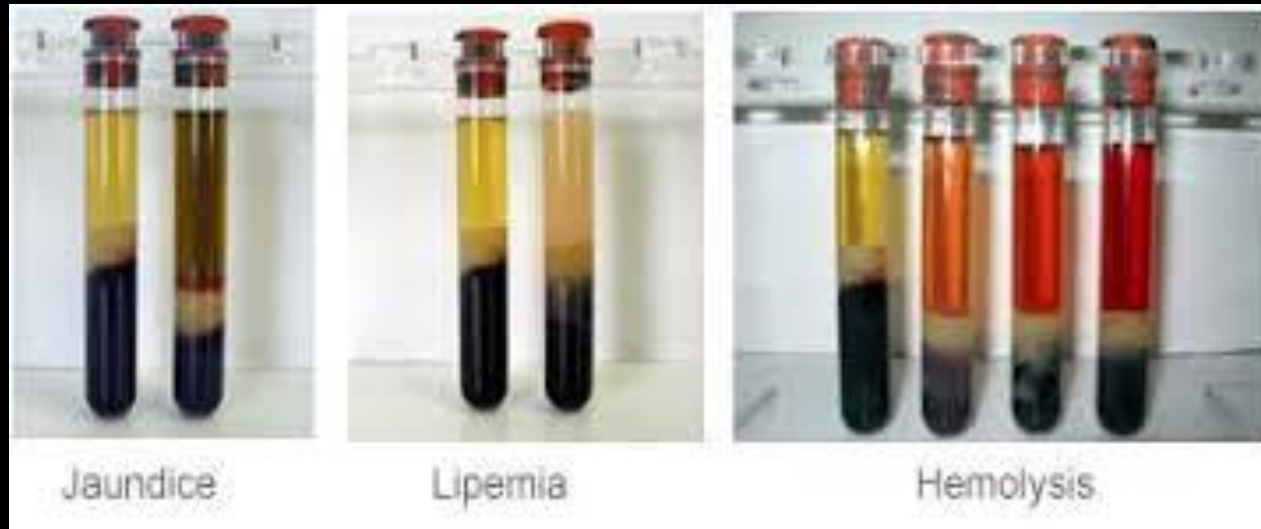
**GIVE BLOOD**

*You can make a difference.*



**American  
Red Cross**

Remember the components of blood we talked about? You can tell a lot by looking at a spun down sample.



# CLINICAL CHEMISTRY



# CLINICAL CHEMISTRY

Plasma and/ or serum is used to test the following:

- Electrolytes:
  - Na, K, Cl, Ca, Mg, CO<sub>2</sub>
- Proteins
  - Albumin
  - Total Protein
  - C-Reactive Protein
- Kidney
  - Blood Urea Nitrogen
  - Creatinine

# CLINICAL CHEMISTRY

- Liver
  - Alkaline Phosphatase (ALKP)
  - Aspartate amino transferase (AST)
  - Alanine amino transferase (ALT)
  - Bilirubin
- Other
  - Glucose
  - Beta Hydroxybutyrate
- Thyroid
  - TSH
  - Free T3 and T4

# CLINICAL CHEMISTRY

- Therapeutic drug monitoring
  - Digoxin
  - Vancomycin
  - Gentamicin
  - Phenytoin
  - Carbamazepine
- Blood Gas
  - pH
  - O<sub>2</sub>
  - CO<sub>2</sub>







Now that we're done talking about the blood,  
let's talk about other body fluids.

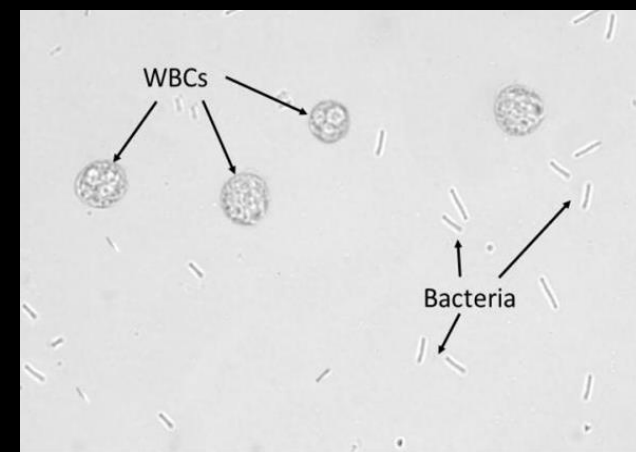
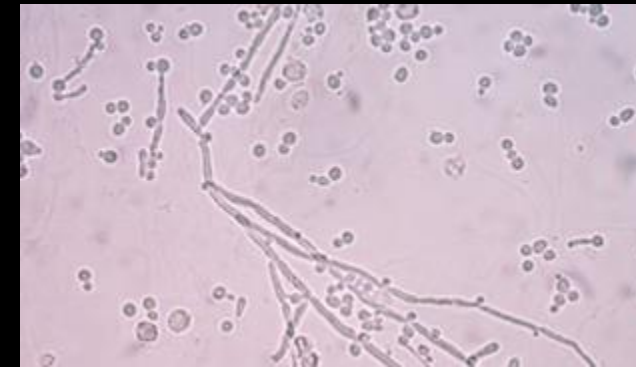
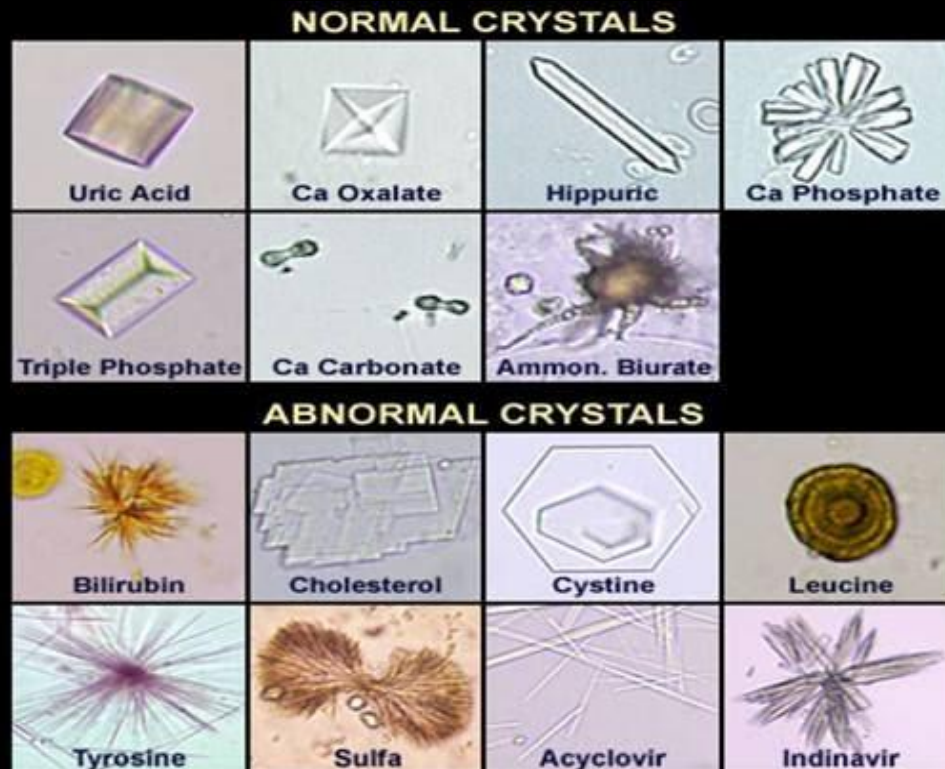
# URINALYSIS AND BODY FLUIDS



# URINALYSIS

Analyze and interpret urine components such as:

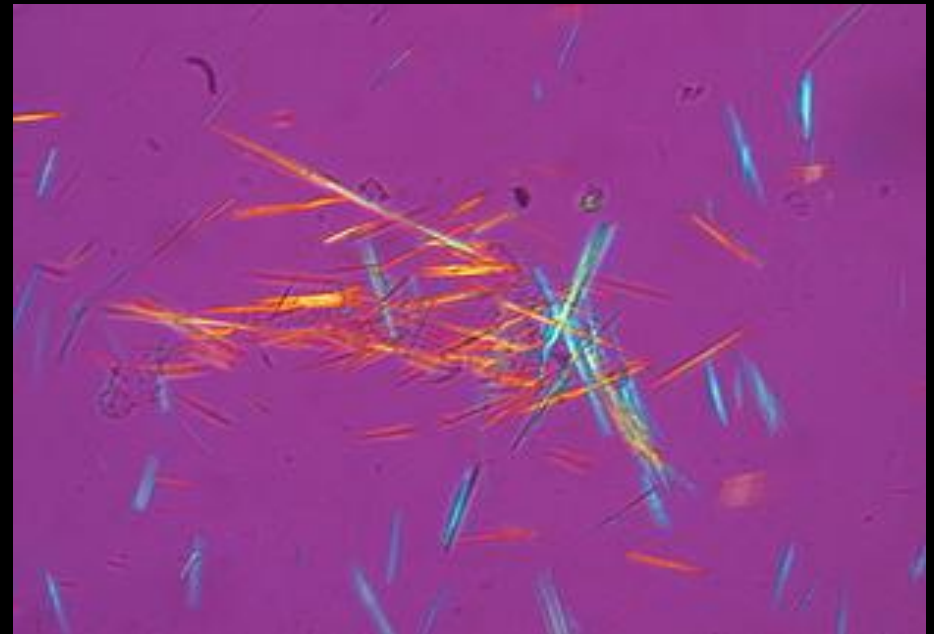
- pH
- Specific gravity
- Color and clarity
- Nitrates (bacteria)
- Leukocytes (WBCs)
- Glucose
- Ketones
- Bilirubin
- Urobilinogen
- Crystals
- Casts



White blood cells (WBC) and bacteria in urine as seen under a microscope.

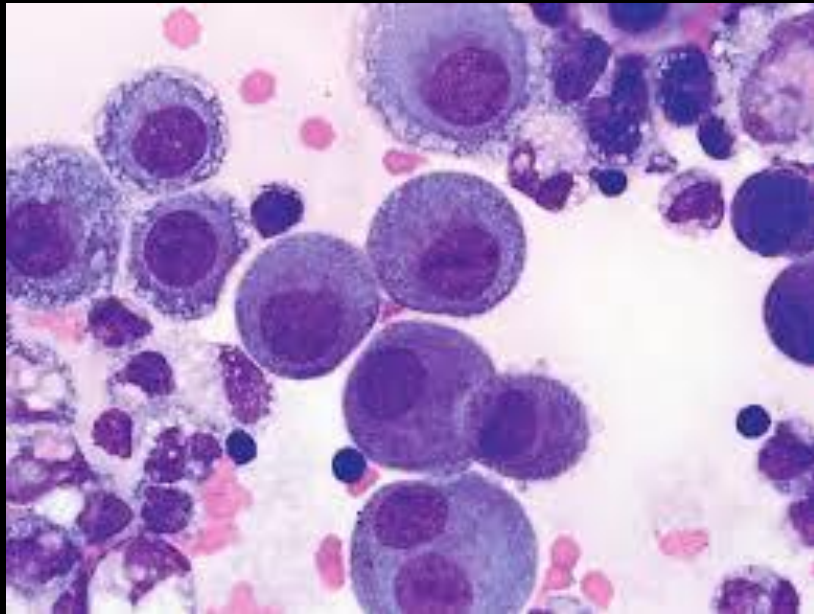
# BODY FLUIDS

- Types
  - Pleural (lung)
  - Synovial (joint)
  - Pericardial (heart)
  - Peritoneal (abdominal cavity)
- Tests
  - Cell count
  - WBC Differential
  - Crystal analysis on synovial fluid
    - Monosodium urate (gout)
    - Calcium pyrophosphate

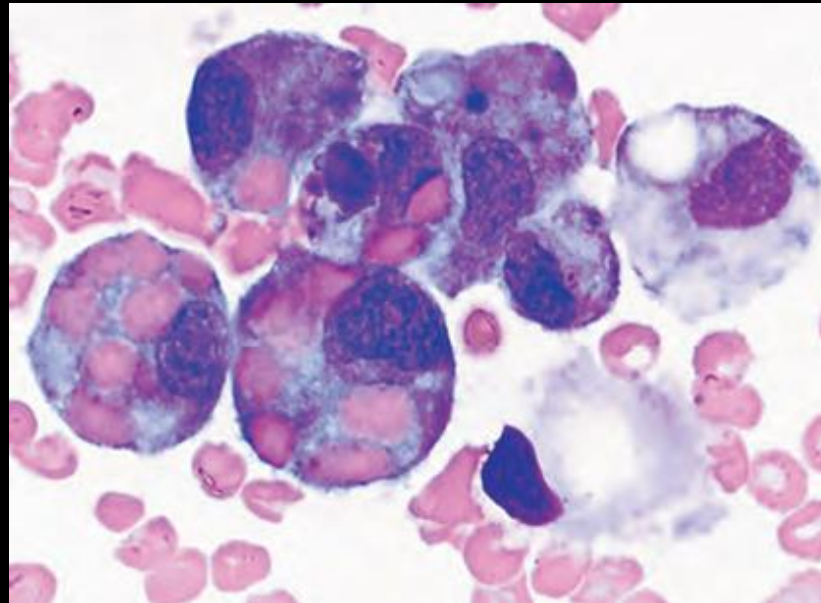


An example of MSU crystals (gout)

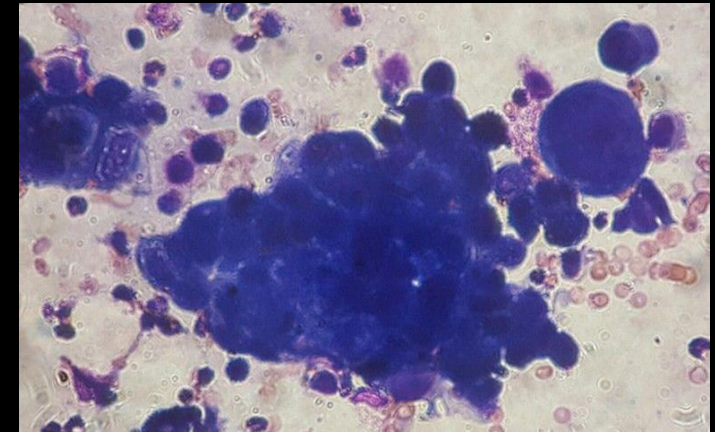
# Body Fluids




Mesothelial Cells (lining cells)



Macrophages having  
phagocytosed multiple  
RBCs

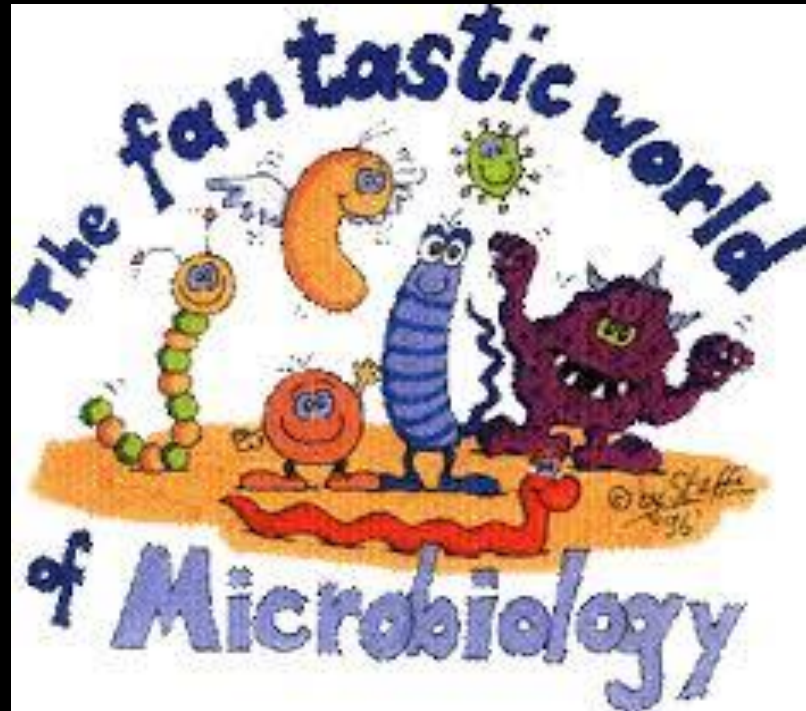


Malignant cells



Now let's switch gears and look at another area of the lab. Hint: you'll need a microscope

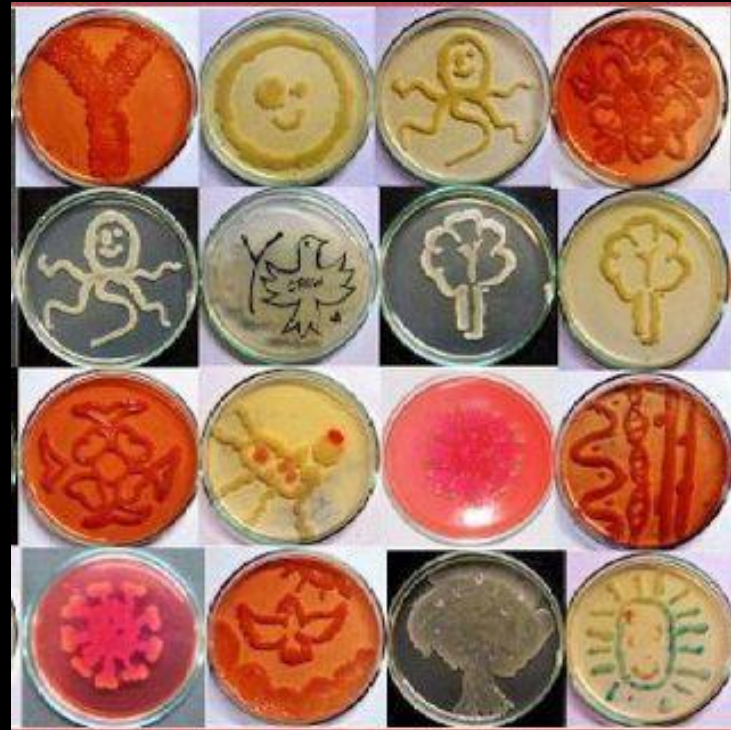
# MICROBIOLOGY



# MICROBIOLOGY

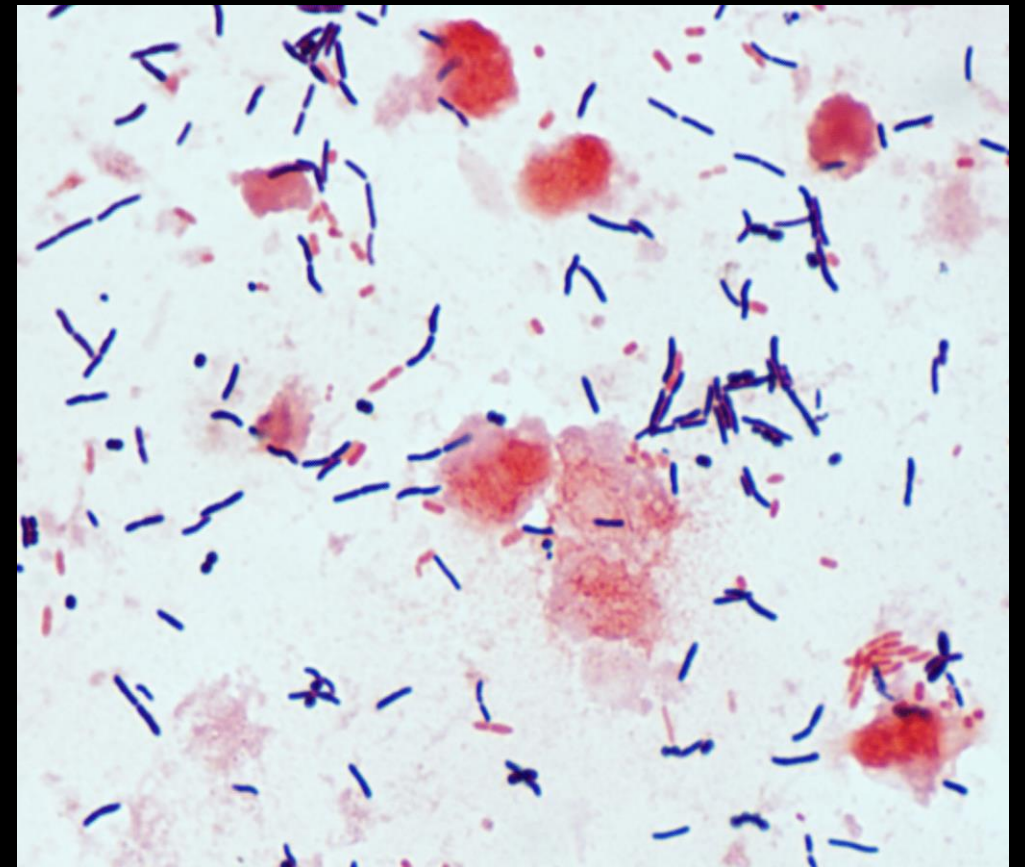
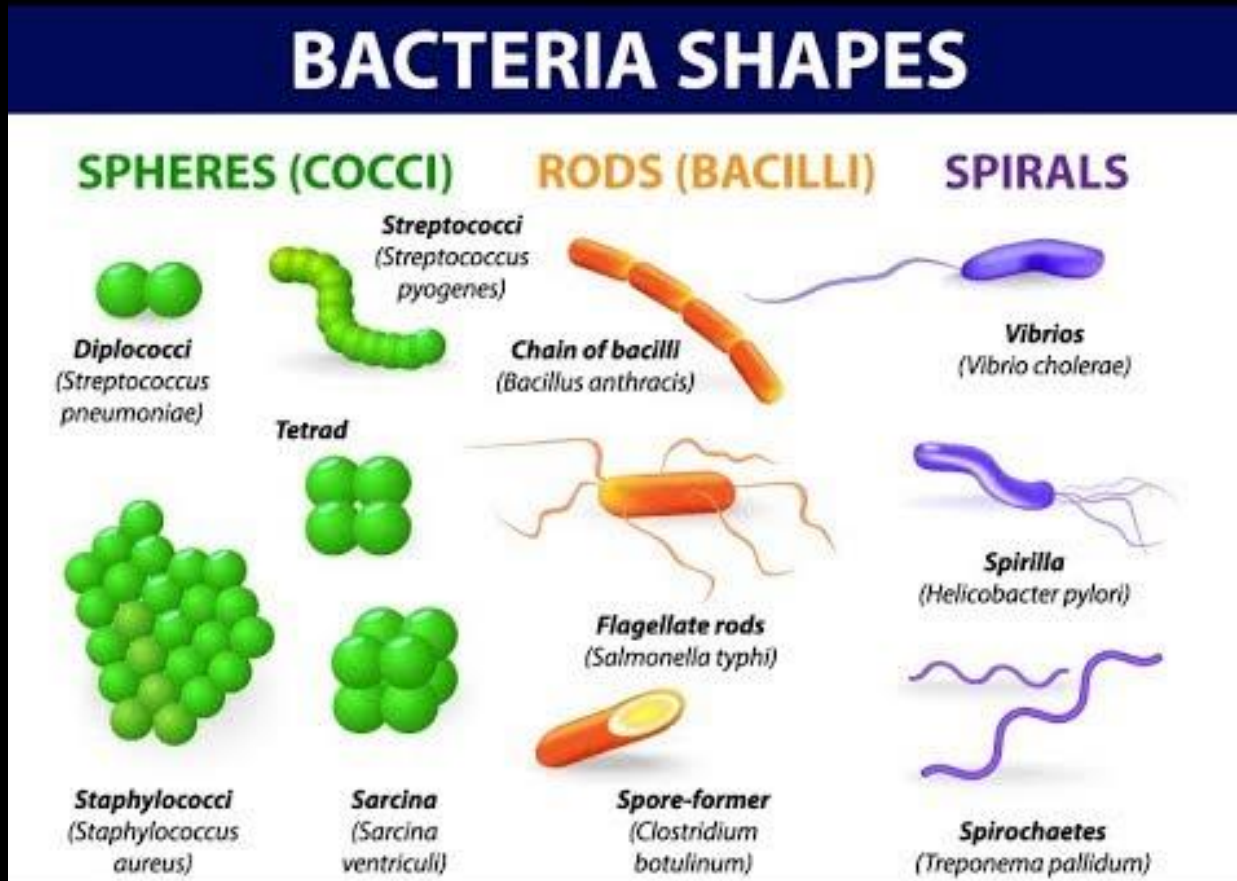
Different areas of study

- Bacteriology
- Parasitology
- Mycology (fungal organisms)
- Virology





# BACTERIA

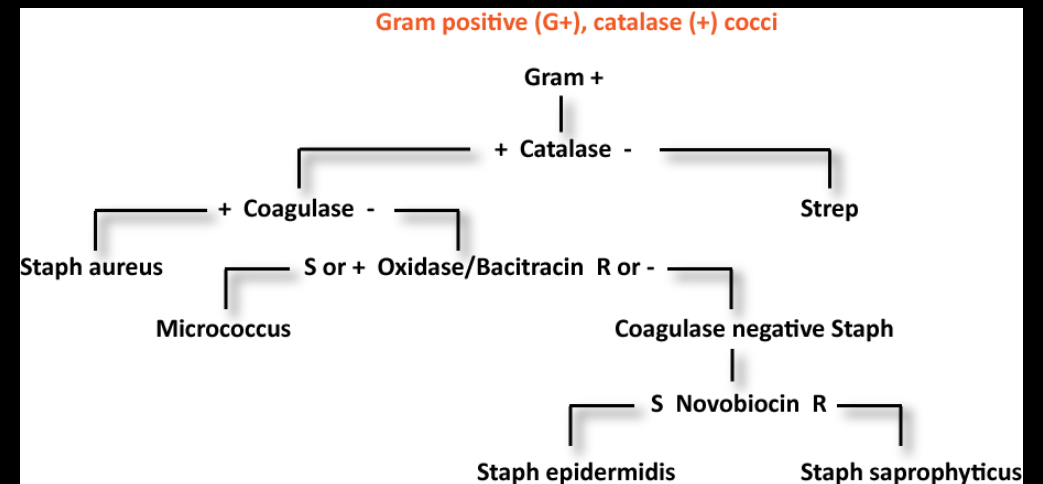


An example of a gram stain.

# BACTERIA

Bacteria identification – Time to put on your detective hat!

- Culture growth
  - Different types of media used to grow organisms
- Tests
  - Organisms can be identified by using a flow chart
  - Tests like catalase and coagulase help identify gram positive cocci



# PARASITES



Giardia lamblia



Tapeworm

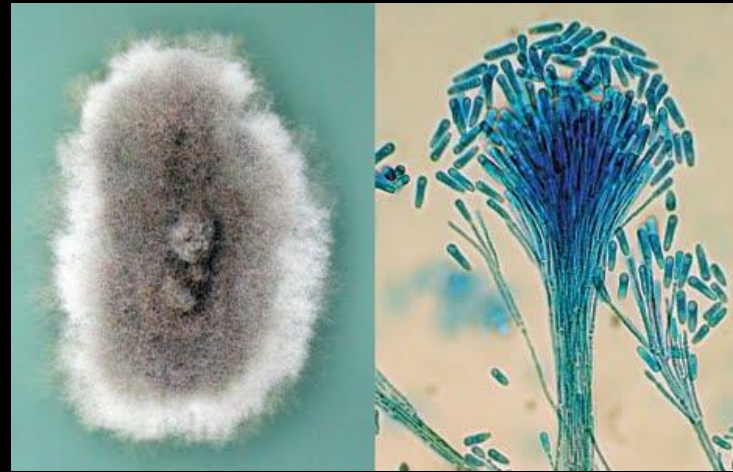


Hookworm under the skin

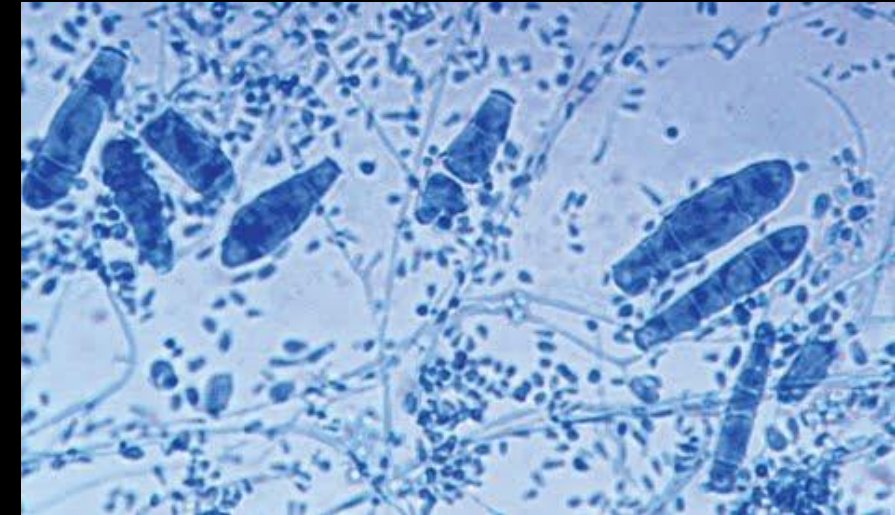
# MYCOLOGY



*Aspergillus flavus*

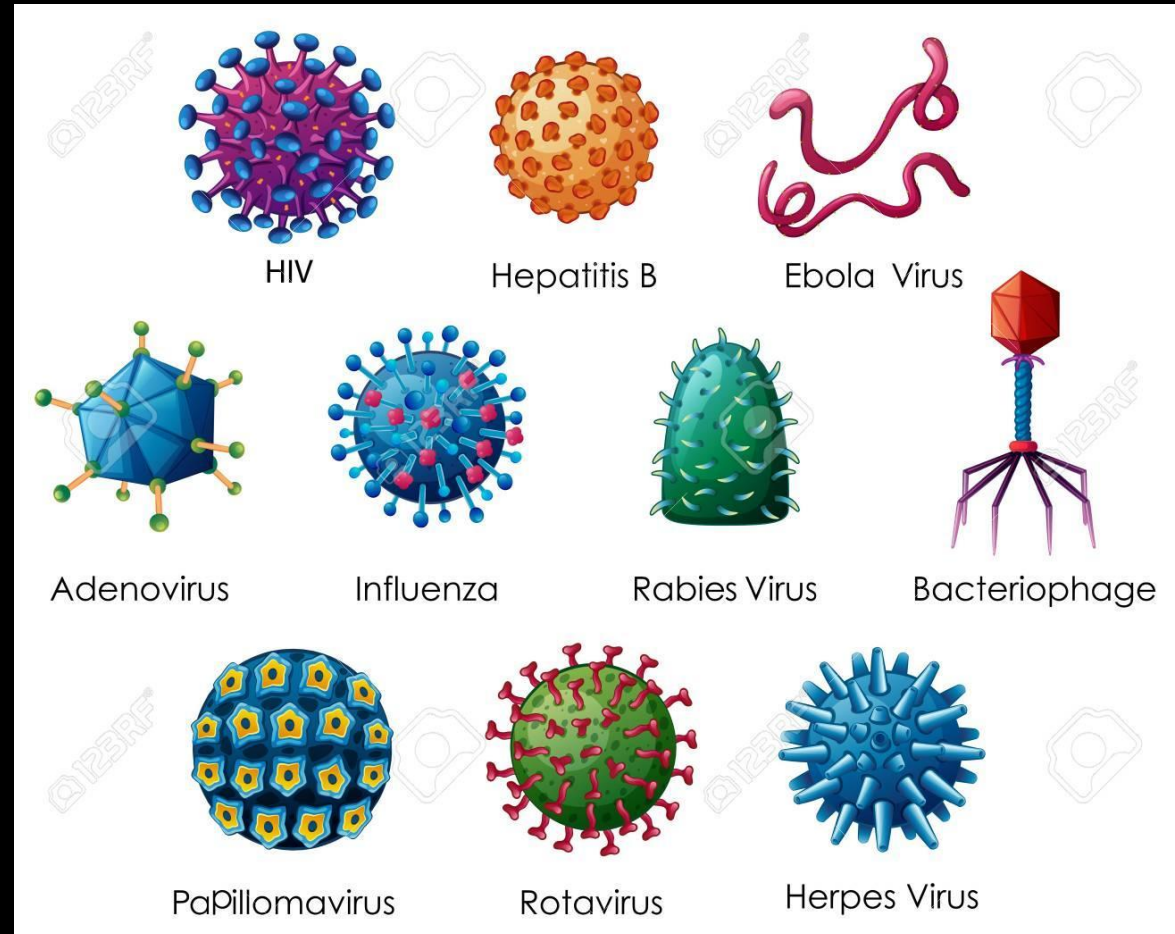


*Scedosporium apiospermum*



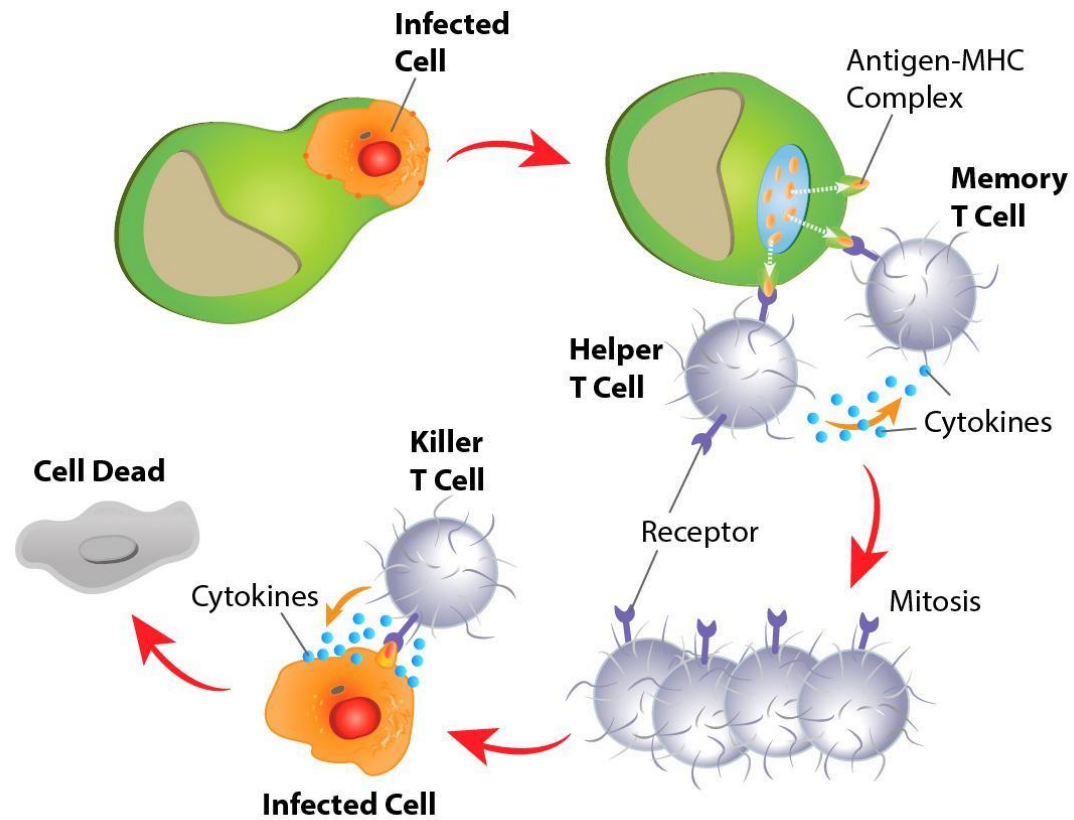
*Trichophyton*

# VIROLOGY



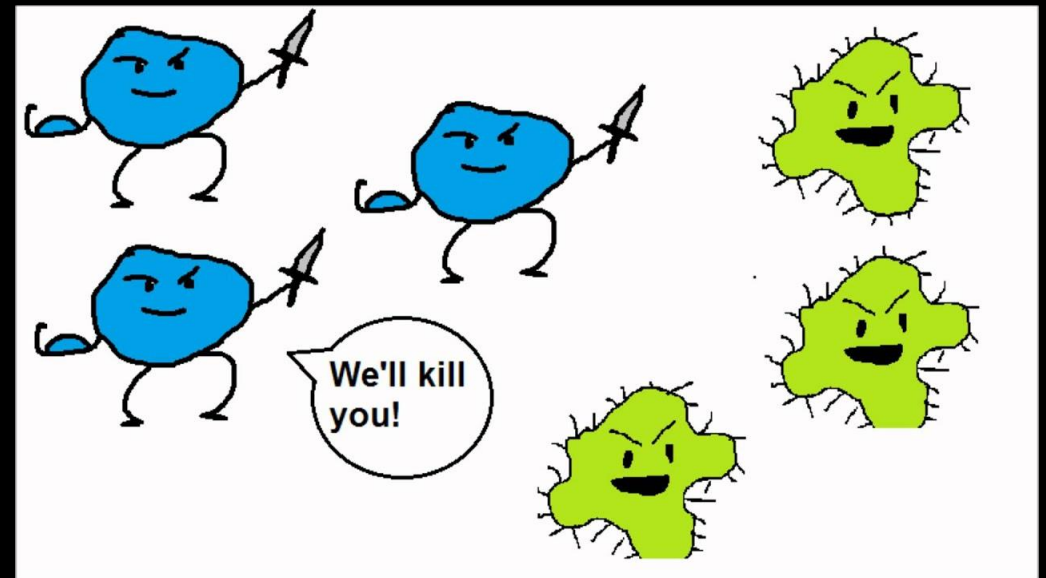
# IMMUNOLOGY

## Cell-Mediated Immunity



# IMMUNOLOGY

- Study of the immune system
- Includes
  - Autoimmune diseases
  - Hypersensitivities
  - Immune deficiency
  - Transplant rejection



# MOLECULAR DIAGNOSTICS





# MOLECULAR DIAGNOSTICS

- Collection of techniques used to analyze biological markers in the genome and proteome
- Enzyme linked immunosorbent assay (ELISA)
- Polymerase chain reaction (PCR)



# AS A MEDICAL LABORATORY SCIENTIST, YOU CAN....

- Work as a generalist at a hospital or clinic
- Work at a specialized lab or department such as ARUP, Lab Corp, Mayo Clinic, etc.
- Work for a vendor company like Sysmex, Ortho, Immucor, Stago, etc.
- Teach at a college or university
- Go on to medical school, dental school, etc.
- Microbiologist for a brewery
- Work for the USDA as a food microbiologist



Questions

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Answers

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