

INTRODUCTION TO PATHOLOGY

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PATHOLOGY

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OBJECTIVES:

The student should:

- A. Understands the role of pathology and its various subspecialties in the diagnostic process with special emphasis on histopathology and cytology.
 - B. Understands the meaning of the terminology used during the study of a disease like aetiology, pathogenesis, prognosis, sequelae, symptoms, signs, incidence etc.
 - C. Role of diagnostic pathology in disease management.
 - D. Be aware of some of the principle techniques used in pathology like light microscopy, cytology, immunohistochemistry and molecular pathology.
 - E. Have a basic knowledge of the definition of autopsy and its indications.
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DEFINITION OF PATHOLOGY

- **Pathology** is the study of disease by scientific methods. It is the study of changes which occur in cells and tissues as a result of any injury to the cell or tissue.
 - **Disease** is defined as an abnormality in structure or function of any part of the body.
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PARTS OF PATHOLOGY

- The following are the 5 major aspects studied as part of pathology of any disease.
 1. Epidemiology
 2. Etiology
 3. Pathogenesis
 4. Morphologic changes and
 5. Clinical features (signs and symptoms)
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1. EPIDEMIOLOGY

- Study of the occurrence and distribution of diseases in a population and the application of this knowledge to help the health system. It is the study of the patterns, causes, and effects of disease conditions in various populations.
 - Epidemiology studies provide information regarding the following factors:
 - a) **Sex**
 - b) **Age**
 - c) **Race**
 - d) **Occupation:**
 - workers in asbestos industry can have diseases like asbestosis or tumors like mesotheliomas.
 - workers in aniline dye industry can have urinary bladder cancer,
 - hardwood workers can have nasal cancer from inhalation of wood dust etc.
 - e) **Geographic location:** which part of the world a particular disease is common in, e.g.
 - underdeveloped countries has more malnutrition and infections like tuberculosis.
 - developed countries have more cardiac problems, obesity related diseases etc.
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1. EPIDEMIOLOGY (CONTD)

- f) **Socioeconomic strata:** what is the social and financial status of the people affected by a particular disease.
 - g) **Prevalence:** is the total number of cases of a particular disease in a particular population in a particular period of time.
 - h) **Incidence:** is the number of new cases of a particular disease in a particular population in a particular period of time (immunization programmes affect the incidence of a disease).
 - i) **Sequela:** is the complication or the consequence of a disease.
 - j) **Prognosis:** is the expected outcome of the disease based on severity of any disease.
 - k) **Morbidity:** is the presence of illness
 - l) **Mortality rate** is a measure of the number of people dead in a particular population during a particular period of time. Mortality rate can be calculated for any particular disease e.g. mortality rates are high for people with high grade cancers.
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WHAT IS THE PURPOSES OR IMPORTANCE OF EPIDEMIOLOGY?

1. To investigate the extent of a disease in a community.
2. To study natural pattern/history and prognosis of disease.
3. To identify causes and risk factors.
4. To provide good health care based on the findings.
5. To recommend and assist in various health programmes to prevent or treat disease (preventive and therapeutic measures), e.g. immunizations and screening programs for different disease etc.
6. To evaluate all health care facilities and programs.
7. Provide information on public health in order to help the health care system and develop health policies.

2. ETIOLOGY & CLASSIFICATION OF DISEASE

- Etiology means the cause of the disease.
- If the cause of the disease is unknown it is called **idiopathic/ cryptogenic/ essential** etc.
- Diseases are classified depending on the etiology and pathogenic mechanism involved. Disease can be **congenital or acquired**.

- A. CONGENITAL DISEASE:** is a condition existing at birth or before birth, or that develops during the first month of life. It can be:
- **Genetic/ chromosomal:** e.g. hemophilia (an x-chromosome linked disorder), Down syndrome (chromosomal abnormality with extra chromosome 21), inborn error of metabolism etc.
 - **Non-genetic:** an abnormal defect or deformity a child is born with e.g. a birth defect like cleft lip or spina bifida etc.

- B. ACQUIRED DISEASES:** They can be:

- **Inflammatory** e.g. rheumatoid arthritis
- **Infective:** bacterial, viral, fungal.
- **Vascular** e.g. atherosclerosis (heart attack) **or Immune mediated** e.g. vasculitis etc.
- **Degenerative** e.g. Alzheimer's and Parkinsonism
- **Neoplastic (growth disorder)** e.g. cancer
- **Therapeutic or recreational drug associated disease:** e.g. certain drugs can cause liver or kidney failure, bone marrow suppression, skin rash. Alcohol can cause liver disease, paraquat poisoning damages the lungs and excessive smoking causes lung and cardiac problems.
- **Metabolic:** e.g. gout, diabetes mellitus etc.
- **Nutritional deficiency diseases** e.g. anemia, protein energy malnutrition etc.
- **Radiation:** radiation to neck can cause thyroid cancer or radiation to skin can cause skin cancer (squamous cell carcinoma) etc.
- **Mechanical:** e.g. road traffic accident, burns etc

3. PATHOGENESIS

- Pathogenesis: it is the steps that take place in the body once the problem begins (whatever it may be) that finally lead to tissue injury (pathological manifestations).
 - The four basic pathogenetic mechanisms (or steps that usually take place in diseases) are as follows:
 - Inflammatory process
 - Degenerative process
 - Carcinogenesis: transformation of normal cells to malignant.
 - Immunological process
 - All these will be dealt with in later chapters
 - Pathogenesis leads to morphologic changes (changes in the gross or microscopic appearance of human tissue).
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4. MORPHOLOGIC CHANGES

- The morphologic changes are the structural changes that take place in cells or tissues due to any disease.
 - These morphological changes can be seen
 - grossly (called **macroscopic findings**) with the naked eye
 - or sometimes they can only be seen under the light microscope (called **microscopic/histologic findings**).
 - Commonly diseases have certain specific gross or microscopic changes and this helps in the diagnosis of that disease.
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5. CLINICAL FEATURES (FUNCTIONAL ALTERATIONS)

- When an organ is damaged by a disease, the normal function of that organ is affected and this will lead to the development certain clinical changes called **signs & symptoms**.
 - **Symptoms:** is something experienced and reported by the patient e.g. 'I am feeling tired', 'I have a headache', 'I have a pain in my stomach' etc. Basically it is what the patient will tell the doctor.
 - **Signs:** are findings discovered by the physician during examination of the patient e.g. doctor finds a swelling somewhere or doctor find a liver or spleen enlargement while examining the abdomen etc. Basically it is what the doctor will find on examining the patient.
 - The combination of signs and symptoms is called as **clinical features**.
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PATHOLOGY

- Epidemiology
 - Etiology (the cause leads to the beginning of pathogenesis)
- ↓
- Pathogenesis
- ↓
- Morphological or chemical alteration
- ↓
- Clinical features (signs and symptoms)

THEREFORE IN MEDICINE, DISEASES ARE STUDIED UNDER THE FOLLOWING HEADINGS:

- Definition
- Epidemiology of disease
- Etiology
- Pathogenesis and pathophysiology
- Morphology: it is divided into
 - Gross/ macroscopic- visible to the naked eye
 - Microscopic- visible under a microscope
- Clinical features/presentation: signs and symptoms
- Differential diagnosis: is there any other alternative diagnosis/diagnoses with similar findings
- Treatment and management
- Prognosis

COURSE OF DISEASE

- The course of a disease is the different stages in the natural history or progression of a disease in the absence of any intervention.
- The different stages in the natural history or course of a disease especially infectious are as follows:
 - a) **Exposure** to causative agents or risk factors
 - b) There is a **latent period** between exposure and onset of disease. The time period from the exposure to the development of signs or symptoms is called as **incubation (induction) period**.
 - c) **Onset of disease**: the beginning of signs or symptoms.
 - d) **Outcome and consequences of disease**: Following clinical onset, disease may follow any of the following trends:
 - Recovery/resolution of disease without complication or sequelae. Person is back to normal health.
 - The disease recovery but with sequelae.
 - Complications: development of complications in any disease can make things worse.
 - Death.

THE DIAGNOSTIC PROCESS AND THE ROLE OF PATHOLOGIST

- Any patient going to a clinic meets clinician who will take history and do clinical examination. He may ask for radiological and pathological examination in order to come to a diagnosis.
 - The common pathological examinations are blood, urine and stool tests. Sometimes the patient is also asked to undergo a cytopathology or a histopathology test or other special pathological tests in order to obtain an accurate diagnosis.
 - This way pathology plays an essential role in the diagnosis of a disease and management and treatment of patient.
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THE BRANCHES/SUBDIVISIONS OF PATHOLOGY:

1. **Histopathology:** study of tissue biopsied/excised from body
2. **Cytopathology:** study of cell morphology, exfoliated or aspirated from body.
3. **Hematology:** a study of blood, blood cells and bone marrow, used in the diagnosis of anemias & leukemias.
4. **Immunohistochemistry:** a special staining procedure is used to detect antigens in the tissue.
5. **Chemical pathology/ clinical biochemistry:** is the analysis of bodily fluids (blood, urine, etc) for diagnosis.
6. **Microbiology:** is the study of micro-organisms
7. **Immunology:** is the analysis of the immune system of the body.
8. **Toxicology:** study of various poisonous and toxic substances.
9. **Cytogenetics (clinical genetics):** is a study of chromosomal abnormalities.
10. **Molecular pathology:** e.g. fluorescent in situ hybridization, Southern blot tests etc.
11. **Autopsy:** see later

HISTOPATHOLOGY

- Histopathology is the study of tissues using light microscope. Tissues are obtained by doing biopsies and excision of organs by physicians & surgeons.
- Once the tissue is removed from the patient's body, it is immediately preserved (fixed) by putting it in a container of formalin (10% formaldehyde). The purpose of fixation is to prevent autolysis and decomposition of the tissue.
- Tissue is processed in a special multistep way and the end result is very thin slices of stained tissue (4-6 microns) glued on a slide.



HISTOPATHOLOGY CONTD...

- The most commonly used routine stain is Hematoxylin & Eosin stain. It gives the nucleus a blue/violet color & the cytoplasm a pink color.
- The pathologist will look at the slide under the microscope and give a diagnosis.
- Histopathology is usually the final/gold standard of diagnosis.
- NOTE: sometimes during surgery an urgent diagnosis is needed INSTANTLY and tissue is processed rapidly to give results in 20 minutes. This is called frozen section.



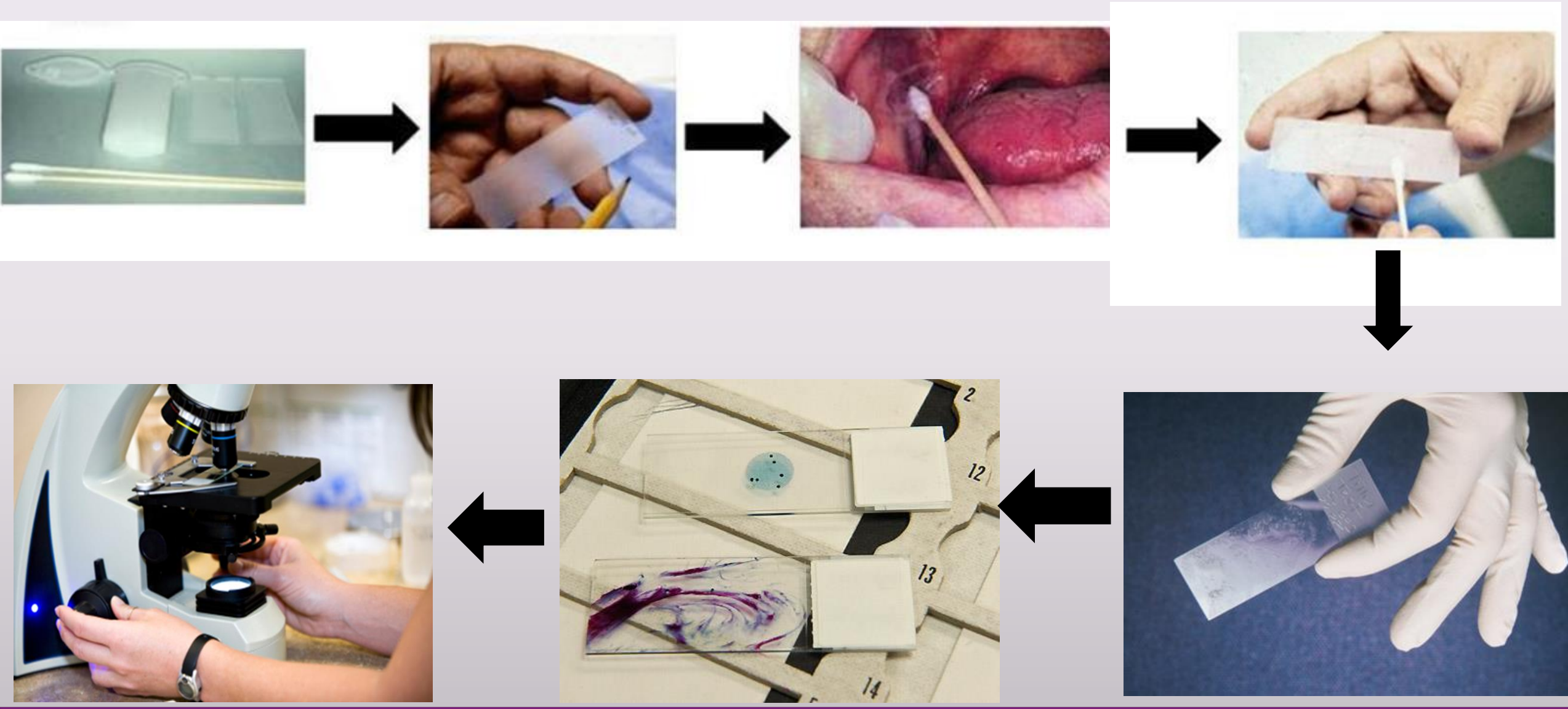
HISTOPATHOLOGY SLIDES READY TO BE EXAMINED UNDER A LIGHT MICROSCOPE



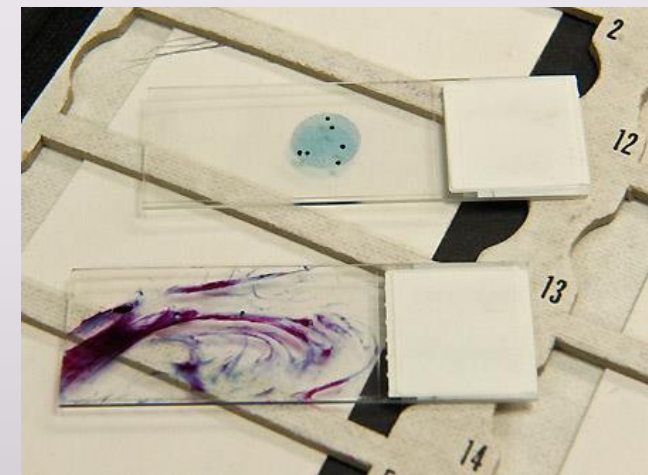
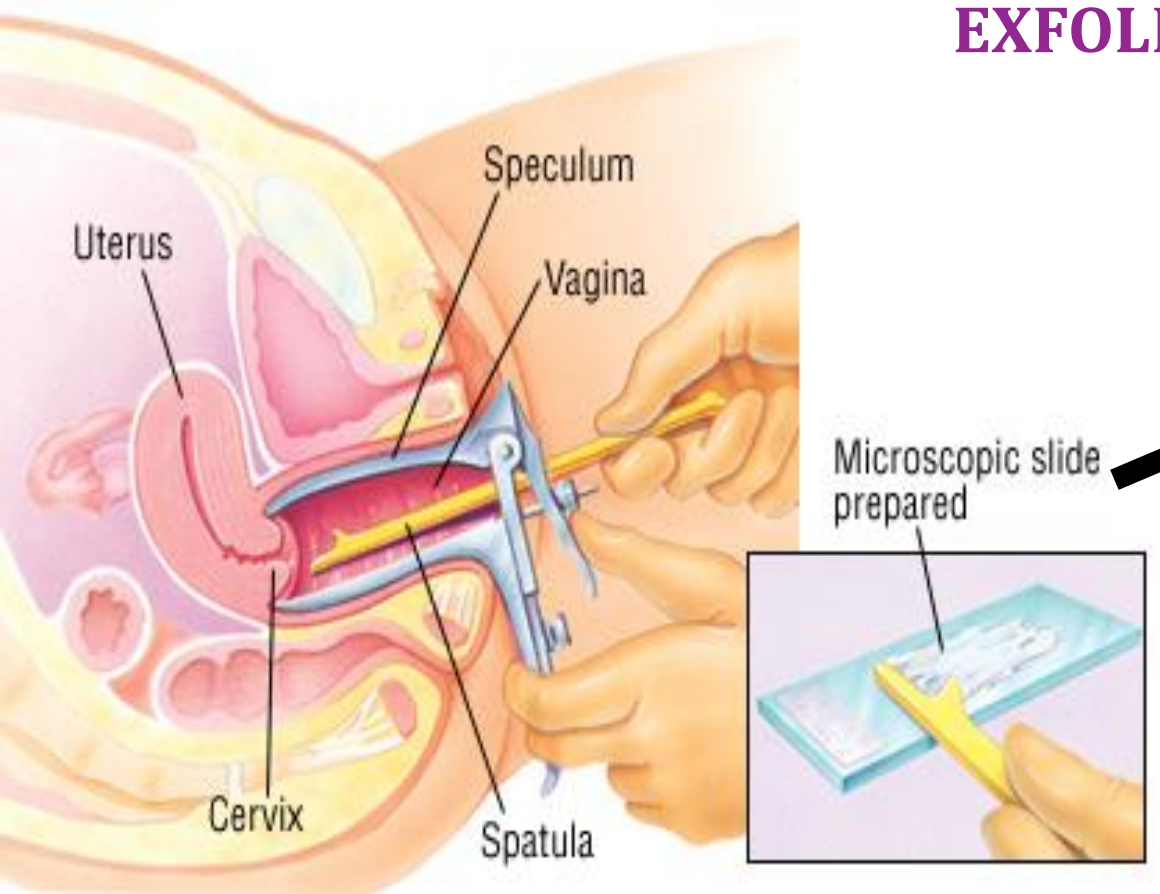
CYTOPATHOLOGY

- Cytopathology is the study of morphology of cells which are obtained by scraping (exfoliative cytology) or aspiration (fine-needle aspiration cytology) from various parts of body.
 - **Exfoliative (falling or scrapping off)cytology:** The cells are scraped of any mucosa using a spatula (e.g. cervix and oral cavity) or the cells exfoliate (fall off) themselves and collect in the respective fluids/secretion (e.g. sputum and in urinary tract disease the cells which exfoliate collect in the urine etc.
 - **Fine-needle aspiration cytology (FNAC):** In it the cells are obtained by aspiration/suction of cells from affected organ or tumor mass using a needle. The cells obtained are put on a slide, stained and examined under a microscope.
 - The morphology of the cells are studied and a diagnosis made from it. It is used for the purpose of:
 - Screening for cancer e.g. cervical cytology is used in the screening of carcinoma of cervix.
 - Diagnosing cancer
 - The advantage of cytologic techniques when compared to histopathological techniques is that the procedure is cheap, takes less time and requires no anesthesia.
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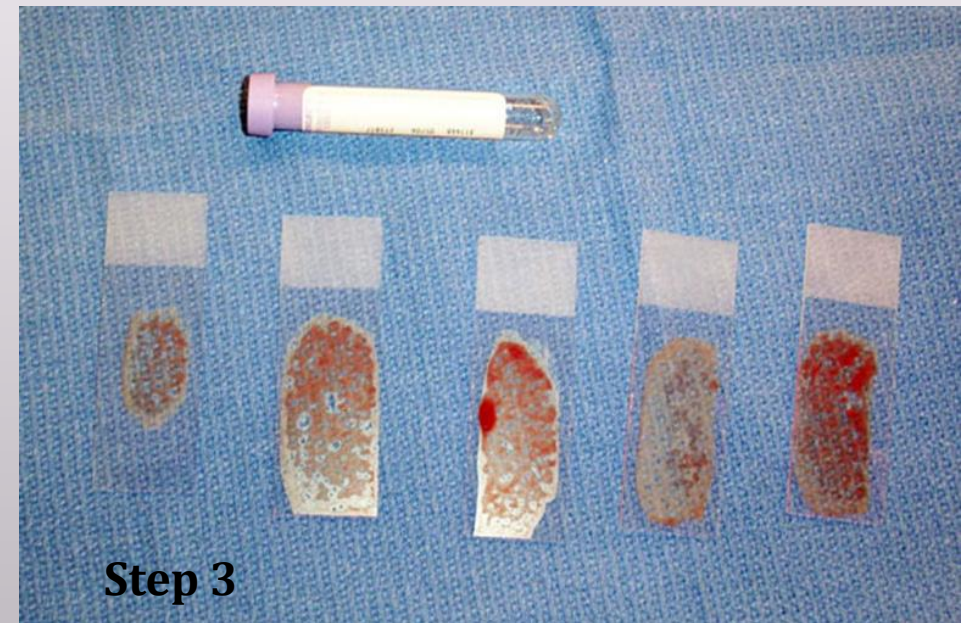
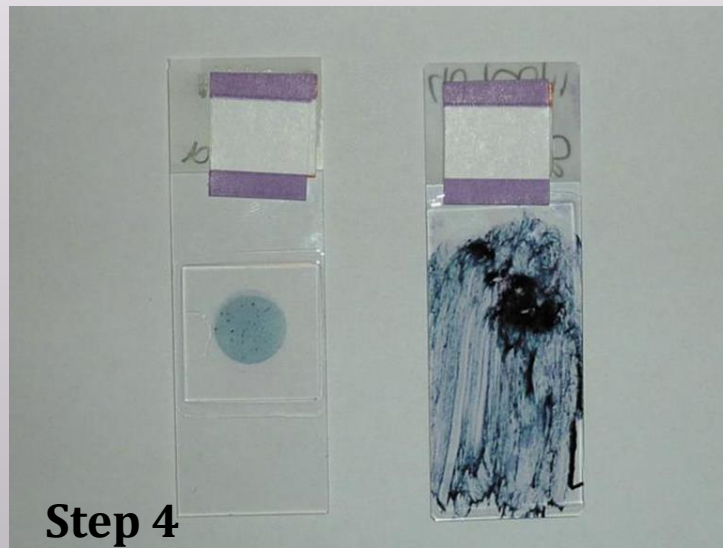
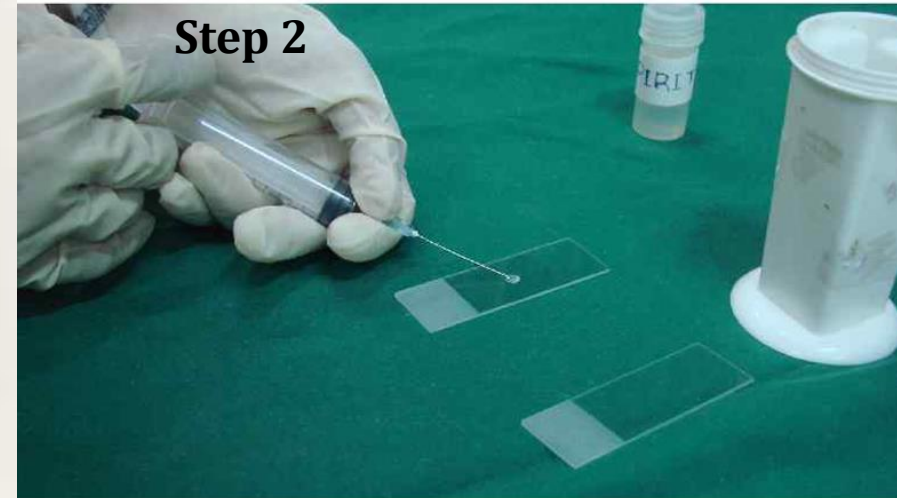
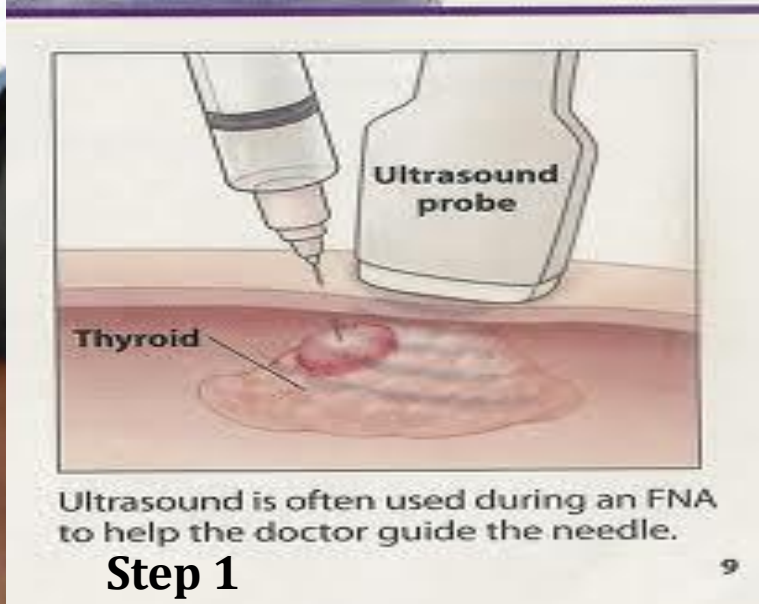
EXFOLIATIVE CYTOLOGY:



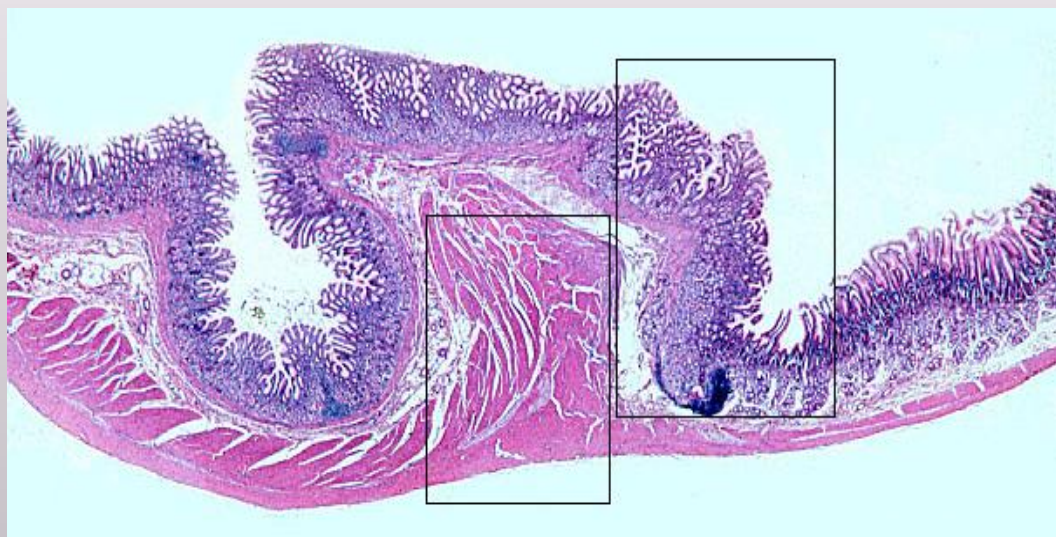
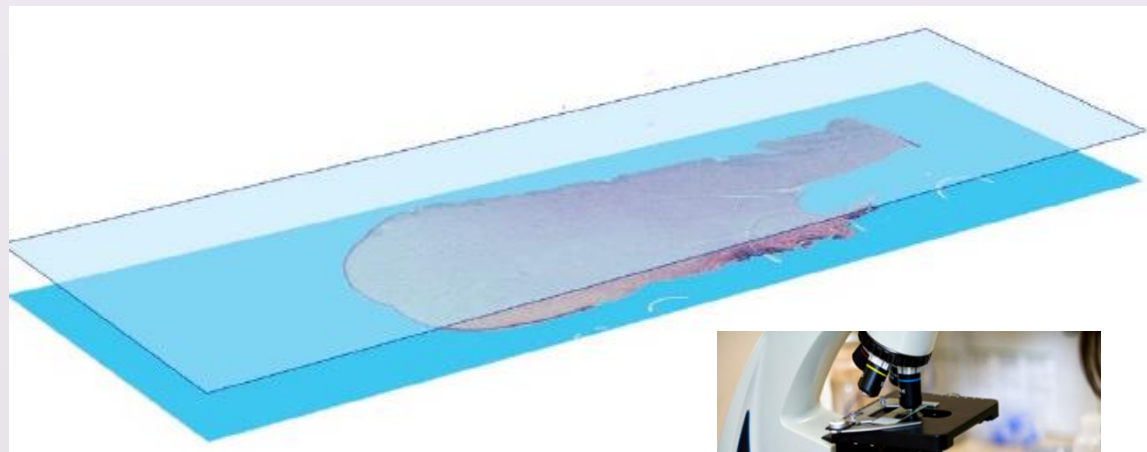
EXFOLIATIVE CYTOLOGY:



FINE NEEDLE ASPIRATION CYTOLOGY (SUCTION OF CELLS)

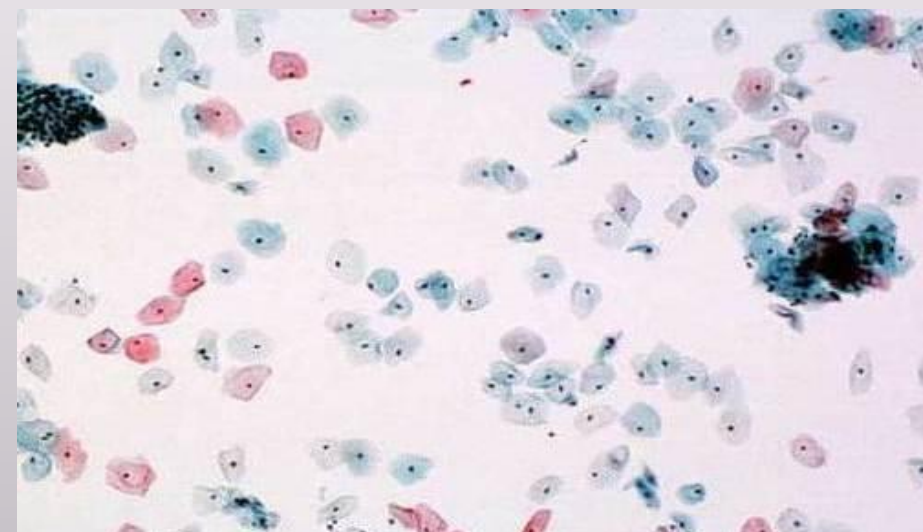
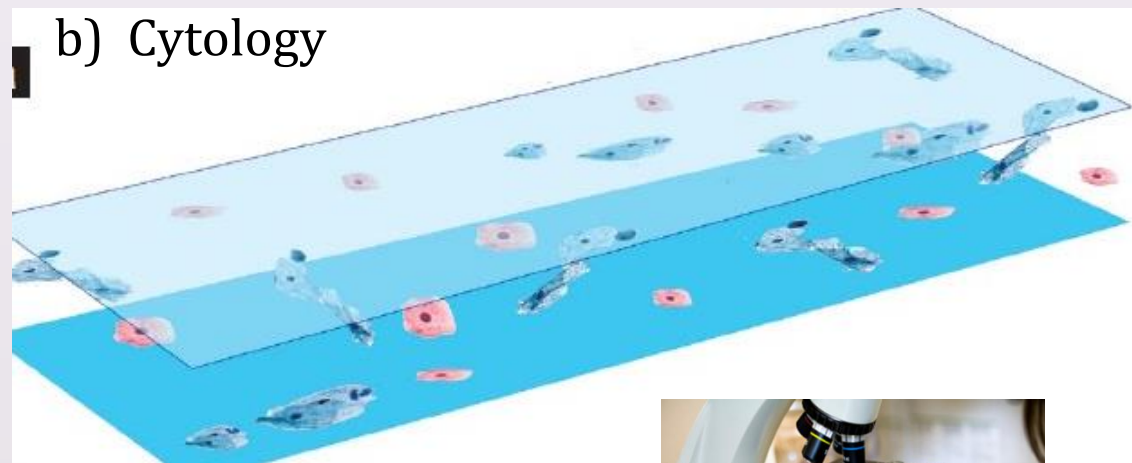


a) Histology



a) Histology under the microscope

b) Cytology



b) Cytology under the microscope

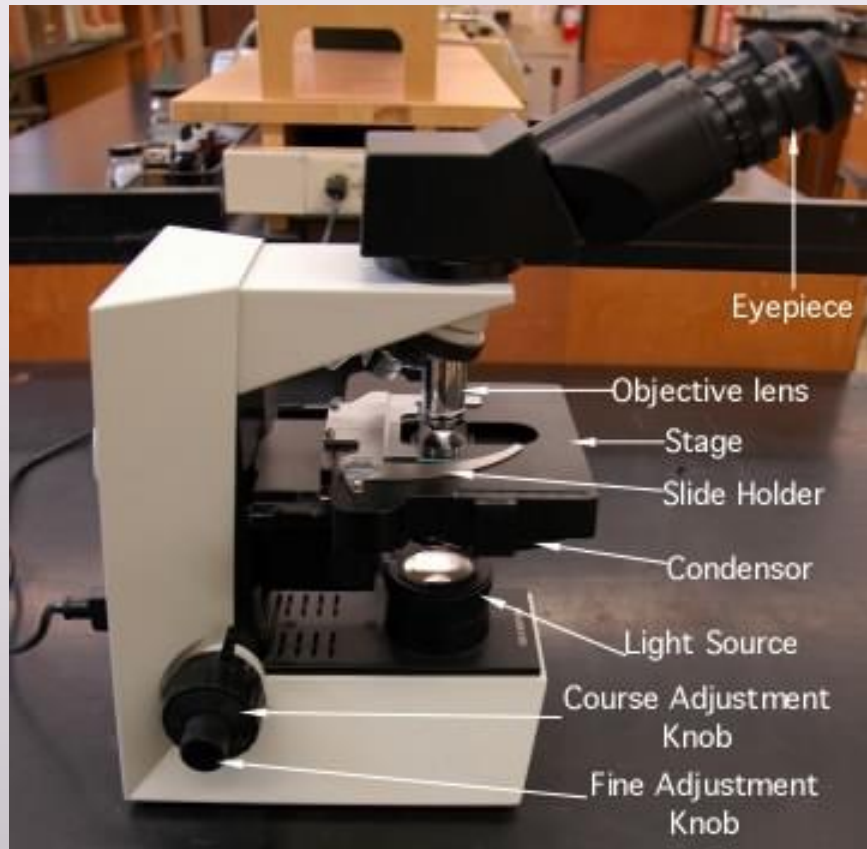
11. AUTOPSY

- It is a sub-specialty of pathology which involves examining a dead body
 - An autopsy is done to
 - To determine the cause of death (this is the main reason why autopsy is done). It can be performed in any of the following situations:
 - ❖ Homicidal
 - ❖ Suicidal
 - ❖ Accidental
 - ❖ To identify the disease
 - To provide useful information about various disease.
 - To do research.
 - Also it can be used as a tool to educate students, surgeons etc
 - Who does the autopsy? The pathologist.
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SOME INSTRUMENTS IN PATHOLOGY

- There are different diagnostic instruments used in pathology.
 - Some of the instruments used in pathology are
 - Light microscope
 - Immunofluorescence microscope
 - Electron microscope
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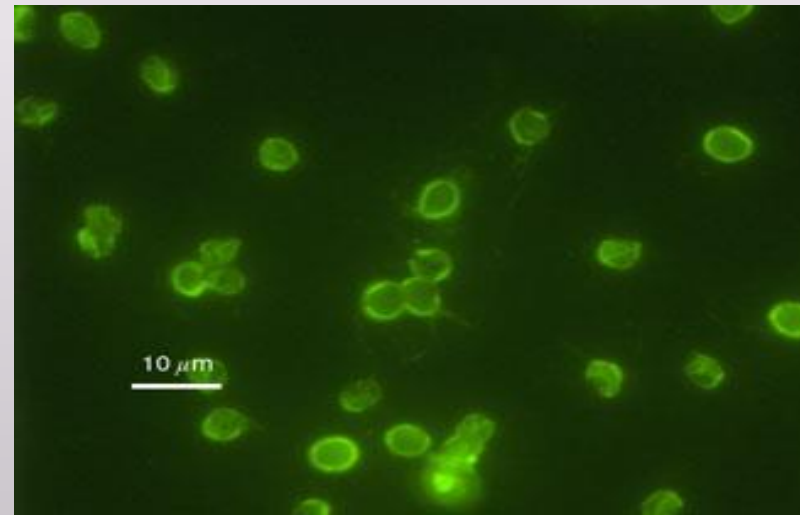
LIGHT MICROSCOPY



IMMUNOFLUORESCENCE MICROSCOPY



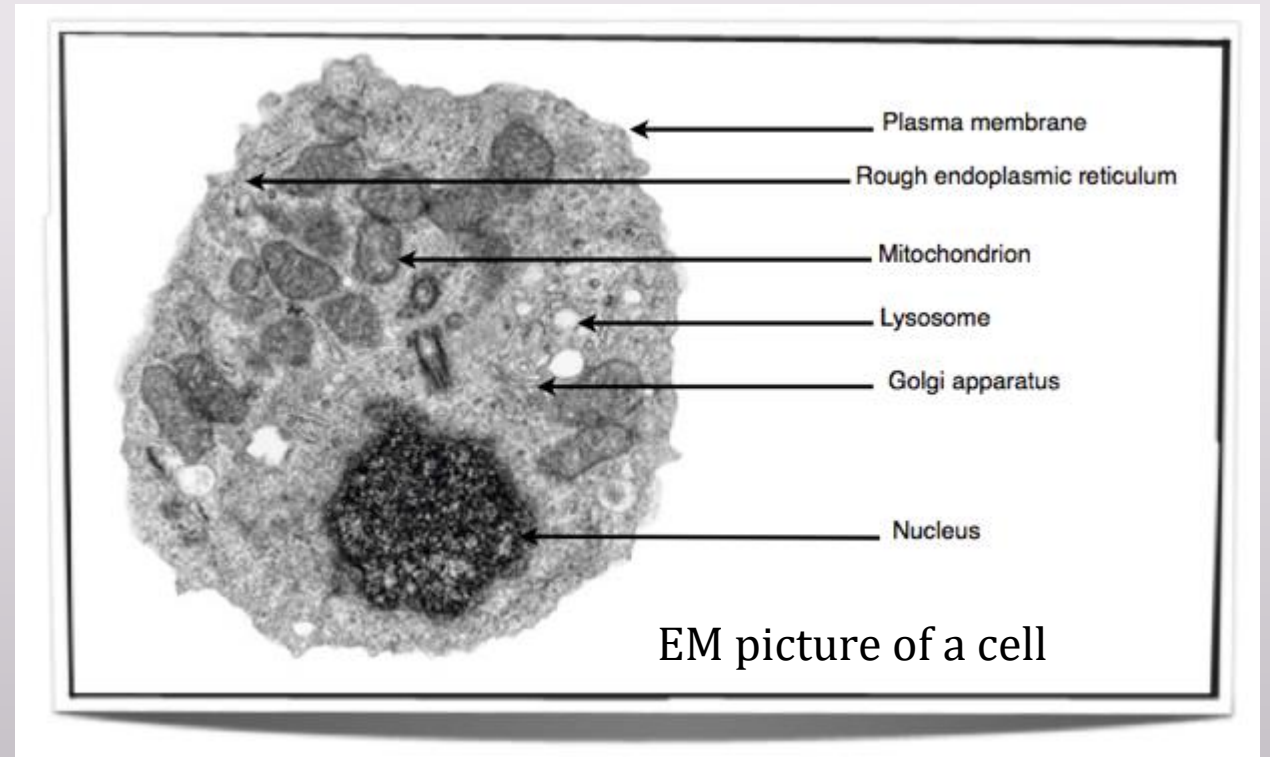
Immunofluorescent (IF) microscope: IF microscope uses a special blue filter and antibodies tagged with fluorescent green dye to identify various antigens in various cells of the body. If antigen antibody reaction takes place the green dye lights up under the IF microscope and this way we know that the antigen is present in the cell. It is used in diagnosing immunological diseases.



ELECTRON MICROSCOPE



Electron microscope: magnifies up to two million times, which is much higher than a light microscope. It enables us to see cell structure like mitochondria, endoplasmic reticulum, viral particles etc. It is also called as ultra structural studies. It is an expensive technique.



EM picture of a cell