INTRODUCTION TO PATHOLOGY

Editing File

Objectives:

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

Color Code:

Slides
Female's Notes
Male's Notes
Important
Extra

Pathology Team 441

MED441
KING SAUD UNIVERSITY

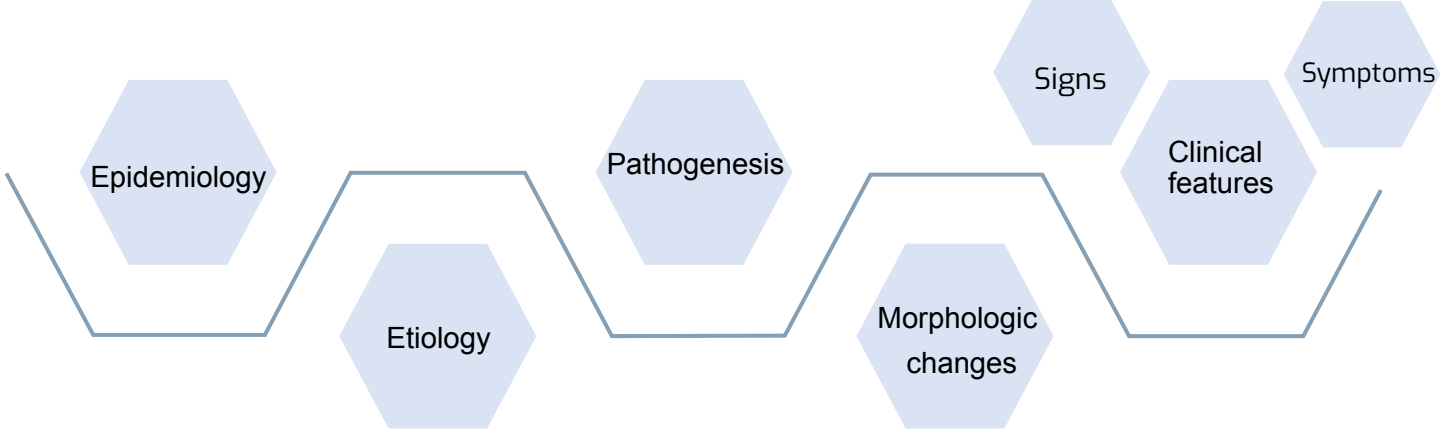
Revised & Reviewed by: Abdulaziz & Bahammam, Faye Wael Sendi

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. (Abnormality in structure leads to abnormality in function)

  - pathology provides the link between basic biological sciences and the practice of medicine.

Parts of pathology



Mnemonic: My Cat Plays Every Evening

Epidemiology

- Study of the occurrence and distribution of diseases in a population and the application of this knowledge to help the health system.

  (Where it occurs? How is it distributed? What causes it? What are the effects? We use this information to further understand the disease)

- It is the study of the patterns, causes, and effects of disease conditions in various populations.
- Age play major role in Epidemiology

It gives information regarding the following Factors

Sex | Age | Race (Ethnicity)

Occupation

-Asbestos industry: workers can have **asbestosis** or tumors like **mesotheliomas** (lining of the lungs)

-Aniline dye industry: workers can have **urinary bladder cancer**

-Hardwood workers: **nasal cancer** from inhalation of wood dust

-Pathologist/ Dentists: neck problems

-Surgeons: leg problems

Geographical location

which part of the world a particular disease is common in.

-Underdeveloped countries: suffer more **malnutrition** and **infections like tuberculosis**

-Developed (affluent) countries: have more **cardiac** problems, **obesity** related diseases etc. (Diabetes)

Socioeconomic strata

the social and financial status of the people affected by a particular disease. (In the same geographical region)

Prevalence

is the total (Grand) number of cases of a particular disease in a particular population in a particular period of time.

Incidence

is the number of new cases of a particular disease in a particular population in a particular period of time (**immunization** programs affect the incidence of a disease).

(Prevalence: Covid cases since pandemic started)

(Incidence: New Covid cases in June)

Sequelae

is the complication or the consequence of a disease.

(after it goes away) e.g. Polio makes a child crippled after it leaves

Prognosis

is the expected outcome (predicted) of the disease based on severity of any disease. Common cold: the person will be fine in a week. Cancer: not so good... (person might die)

Morbidity

is the presence of illness

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.** Mortality rate of common cold is 0.

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What is the Purpose 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. (In covid the risk factor is exposure)

4. To provide good health care based on the findings.

5. To recommend and assist in various health programs to prevent or treat disease (preventive and therapeutic measures), e.g. immunizations and screening programs for different disease etc.

6. To evaluate all healthcare facilities and programs. (High incidence of disease means poor health care and vice versa)

7. Provide information on public health in order to help the health care system and develop health policies.

Etiology & classification of disease

(The cause leads to beginning of pathogenesis)

Aetiology is the direct cause of the disease

·Etiology means the cause of the disease. Note: Also spelled aetiology
·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. (Structural)

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 (Tumor)

· **Therapeutic or recreational drug associated disease: e.g.** certain drugs can cause liver or kidney failure, bone marrow suppression, skin rash. Alcohol can causes liver disease, paraquat poisoning damages the lungs and excessive smoking causes lung and cardiac problems.

(Prescribed: Painkillers and Antibiotics, Recreational: Heroine, Cocaine and Alcohol)

· **Metabolic:** e.g. gout, diabetes mellitus (most common) etc.

· **Nutritional deficiency diseases** e.g. anemia, protein energy malnutrition etc.

· **Radiation:** radiation to neck can cause thyroid cancer or radiation to skin can causes skin cancer (squamous cell carcinoma) etc.

· **Mechanical**: e.g. road traffic accident, burns etc

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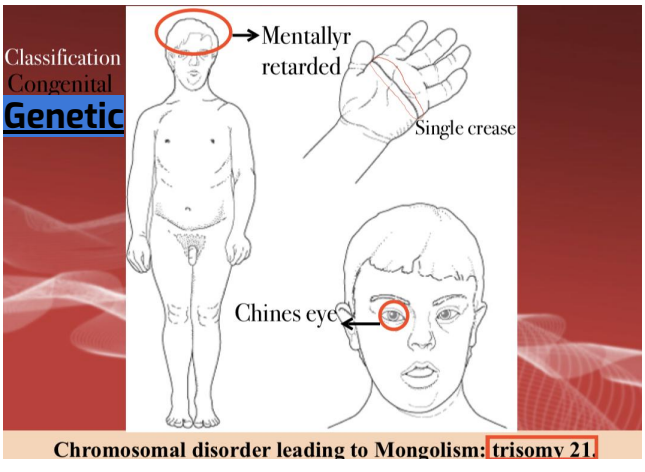
Classification of diseases based on their pathogenesis

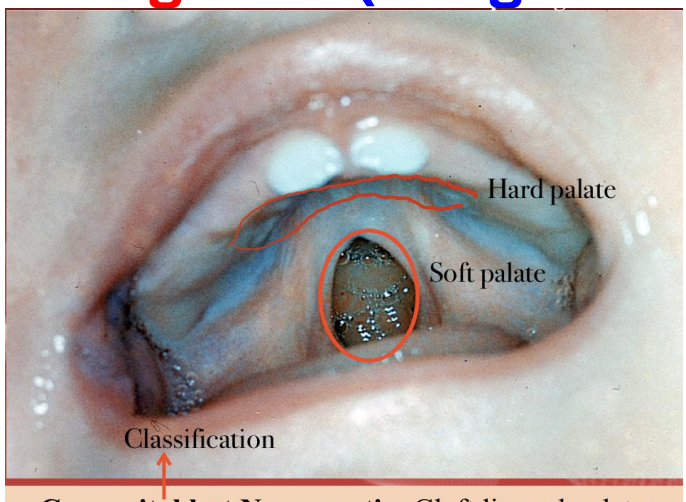
Congenital (Genetic)

Genetic Disease: Haemophilia A (X chromosome linked).



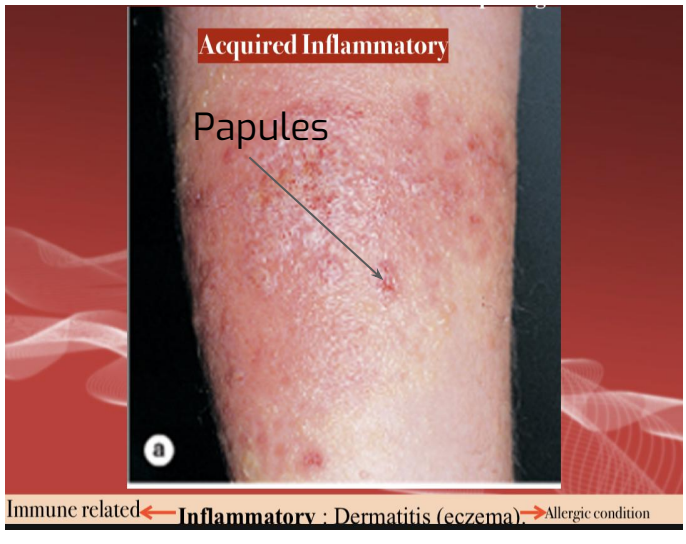
Chromosomal disorder leading to Mongolism: trisomy 21.

Congenital (Not genetic)



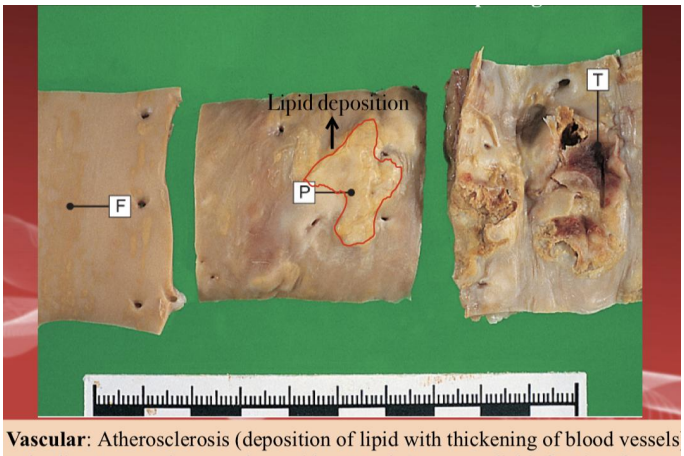
Congenital but Non-genetic: Cleft lip and palate.

Acquired (inflammatory)



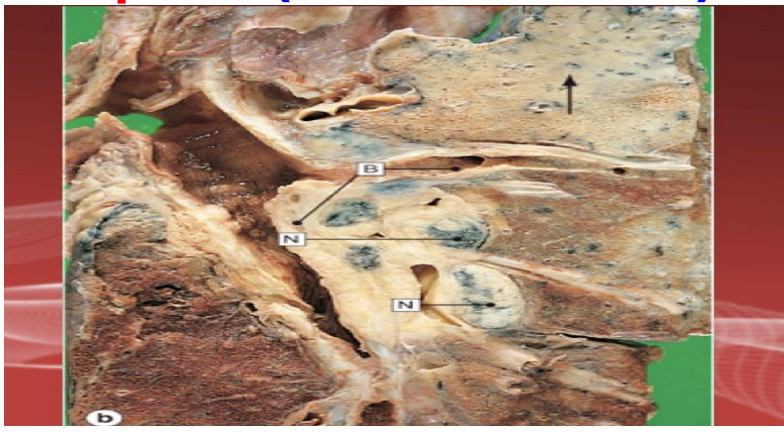
Immune related ← **Inflammatory** : Dermatitis (eczema). → Allergic condition

Acquired(vascular)



Vascular: Atherosclerosis (deposition of lipid with thickening of blood vessels leading to a cerebrovascular accident (stroke), myocardial infarction (heart

Acquired (Growth disorder)



ببساطة....

هذا مريض جا للعيادة و عنده hemoptysis اللي هو blood in sputum

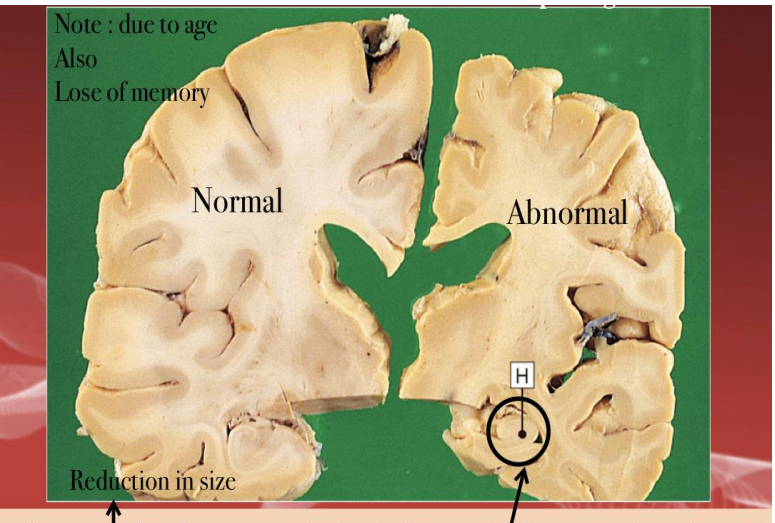
فسبب له cancer و اسمه SCC (squamous cell carcinoma)

معناته صار عندي Growth +proliferation في الخلايا يعني كثرت

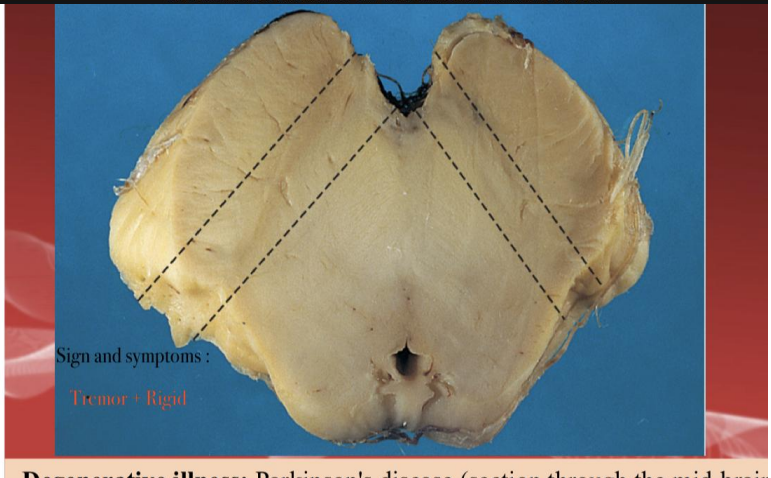
ف على هالأساس جت التسمية

Classification of diseases based on their pathogenesis

Acquired (Degenerative)

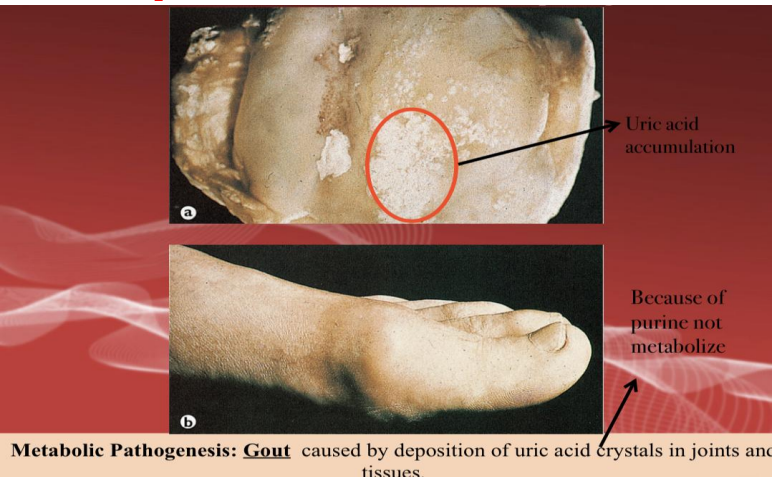


Degenerative disease : Alzheimer's disease, the diseased brain on the right side is atrophic in comparison to the normal left brain section. The letter H show the marked atrophy in the hippocampal region.



Degenerative illness: Parkinson's disease (section through the mid-brain showing loss of pigmented neurons from the substantia negra between the dotted lines.

Acquired (metabolic)

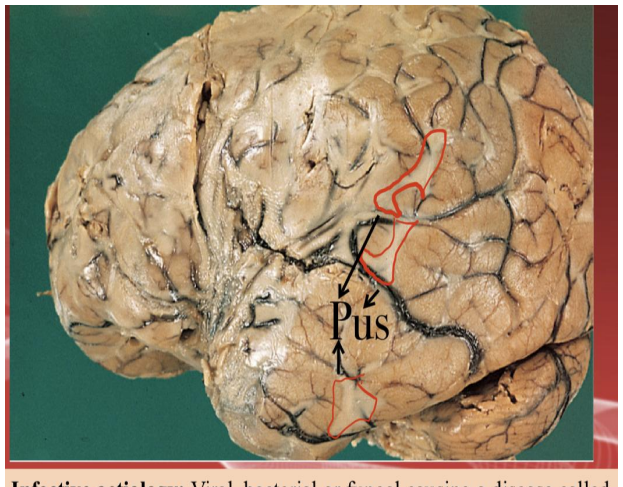


Metabolic Pathogenesis: Gout caused by deposition of uric acid crystals in joints and tissues.

Acquired (Drug induced)

Drug induced illness Causing a haemorrhagic skin rash affecting both legs.

Acquired (infective)



Infective aetiology: Viral, bacterial or fungal causing a disease called meningitis.

Infective Pathogenesis: bacterial brain abcess.

Note: Diabetes mellitus caused by abnormal metabolism of (DM) of carbohydrates and lack of insulin also example of acquired metabolic pathogenesis

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). (Change from normal to abnormal cell)

Pathogenesis is the mechanism of the disease production

· 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

· Pathogenesis leads to morphologic changes (changes in the gross or microscopic appearance of human tissue). Gross can be seen with the naked eye, while microscopic might seem normal until examined under a microscope.

Morphologic changes

(chemical Alterations)

· 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.

Clinical features

(functional alterations)

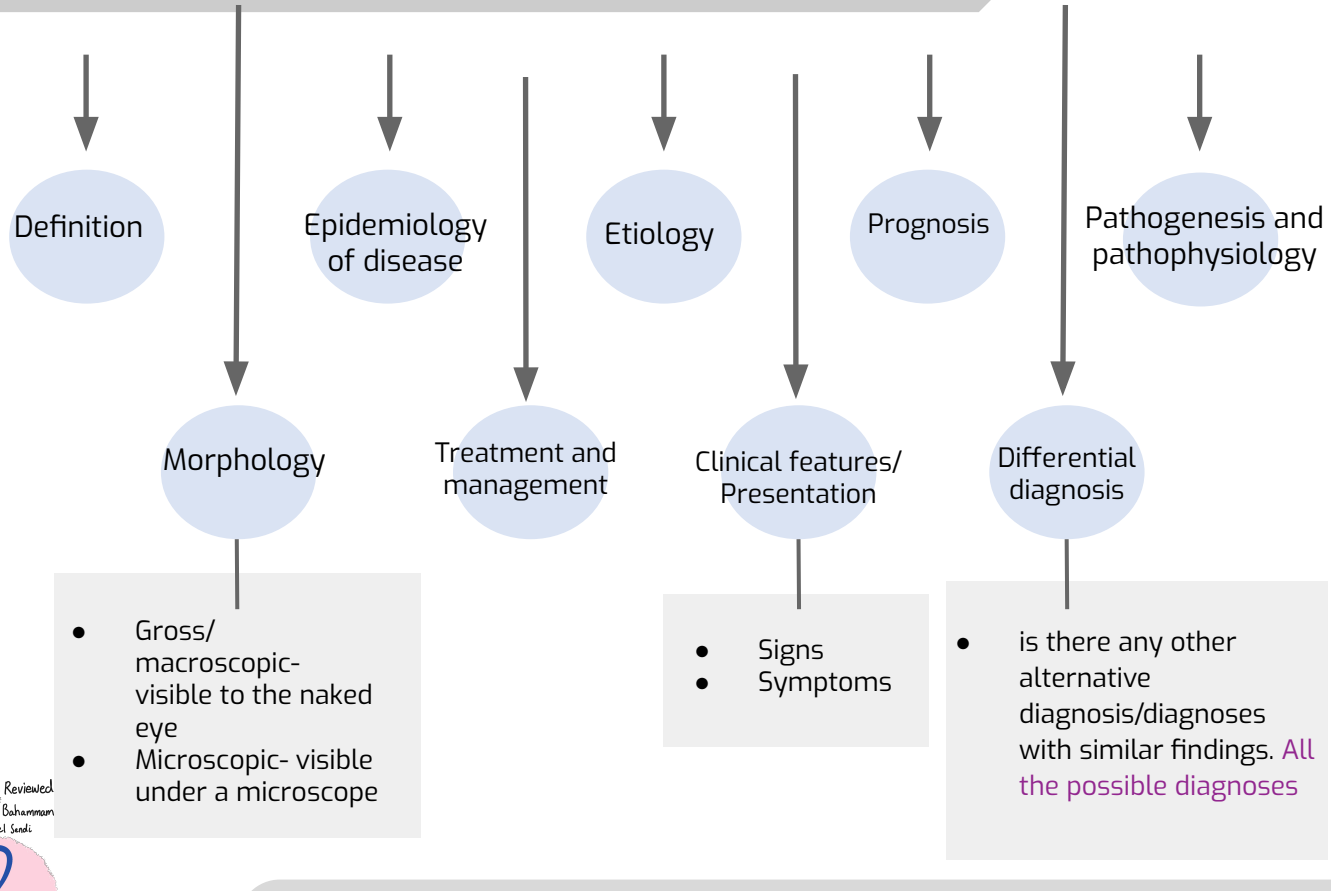
· When an organ is damaged by a disease, the normal function of that organ is affected and this will lead to the development of certain clinical changes called **signs & symptoms.**

- **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.**

Therefore in medicine, diseases are studied under the following headings:



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** (Gap) between exposure and onset of disease. The time period from the exposure to the development of signs or symptoms in 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:

1- Recovery/resolution of disease without complication or sequelae. Person is back to normal health.

2- The body recovers but with sequelae. (Eg. Burn scars)

3- Complications: development of complications in any disease can make things worse.

4 - Death.

The diagnostic process and the role of pathologist

- In investigation we use radiological approach or pathological approach
يعني يا ناخذ أشعة للمريض أو نروح إلى المختبر ونسوي الفحص* على العينة

- 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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*Investigation

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:** A post-mortem (after-death) examination of the patient to determine the cause of death or the extent of the disease.

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 + distilled water). 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.

Step 1 (Biopsied)

Step 2 (Box into machine)

Step 3 (Thin slices of tissue)

Step 4 (Slide is ready)

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- 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.

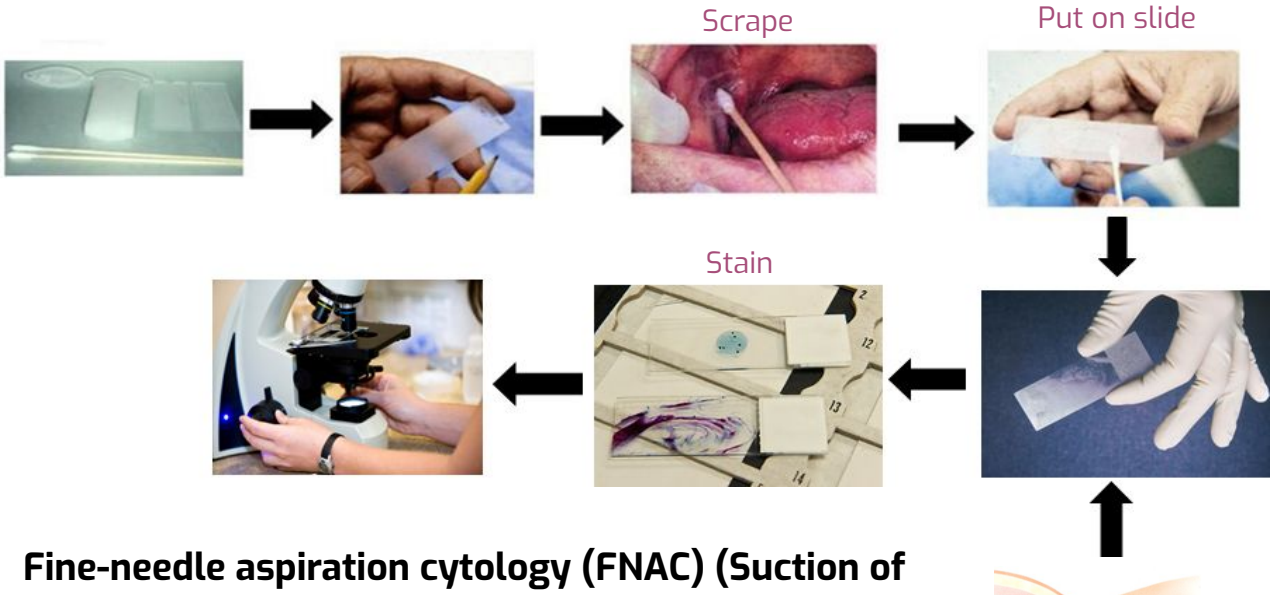
Histopathology slides ready to be examined under a light microscope

In microscope (Studying entire organ)

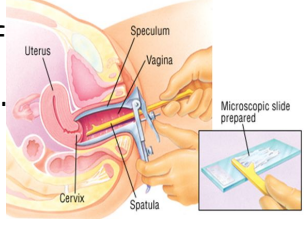
Cytopathology

Cytopathology is the study of morphology of individual cells which are obtained by scraping (exfoliative cytology) or aspiration (fine-needle aspiration cytology) from various parts of body.

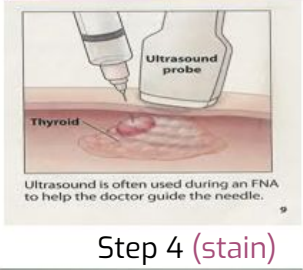
- **Exfoliative (falling or scraping off)cytology:** The cells are scraped of any mucosa using a spatula (e.g. cervix and oral cavity) or the cells exfoliate (fall off) themselves and collect in the respective fluids/secretion e.g. sputum (spitting in test tube) and in urinary tract disease the cells which exfoliate collect in the urine etc.



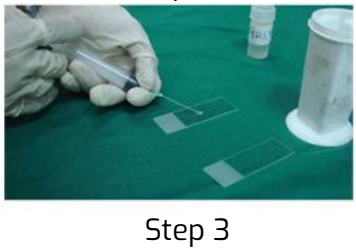
- **Fine-needle aspiration cytology (FNAC) (Suction of cells):** In it the cells are obtained by aspiration/suction of cells from affected organ or tumor mass using a needle. The cells obtained are put on a slide, stained and examined under a microscope. Suction by negative pressure.



Step 1

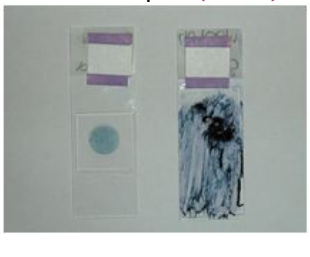


Step 2

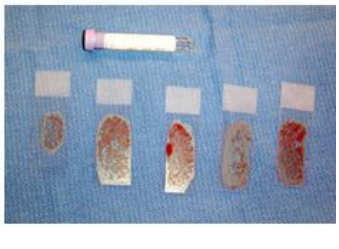


Step 5

Step 4 (stain)



Step 3



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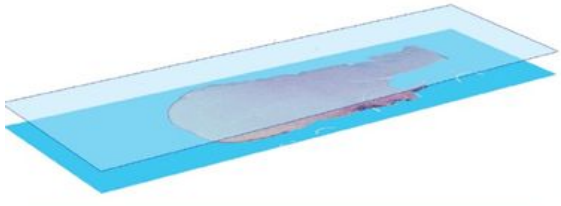
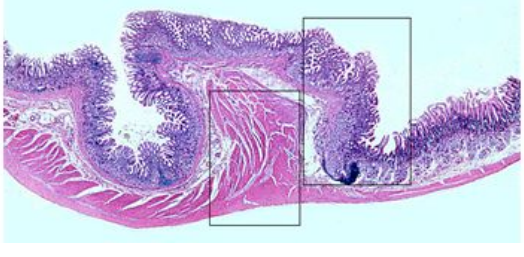
The morphology of the cells are studied and a diagnosis made from it. It is used for the purpose of:

- Screening for cancer e.g. cervical cytology is used in the screening of carcinoma of cervix.
- Diagnosing cancer

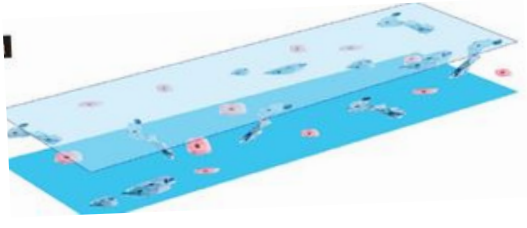
The advantage of cytologic techniques when compared to histopathological techniques is that the procedure is cheap, takes less time and requires no anesthesia.

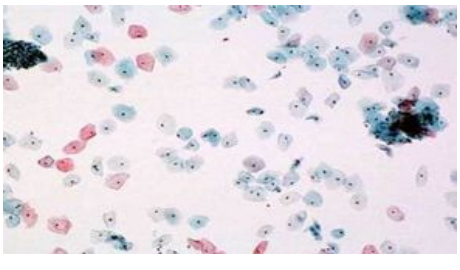
Histology Under microscope





Cytology Under microscope





Autopsy

It is a subspecialty 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.
- Auditing the clinical diagnosis.(checking accuracy)

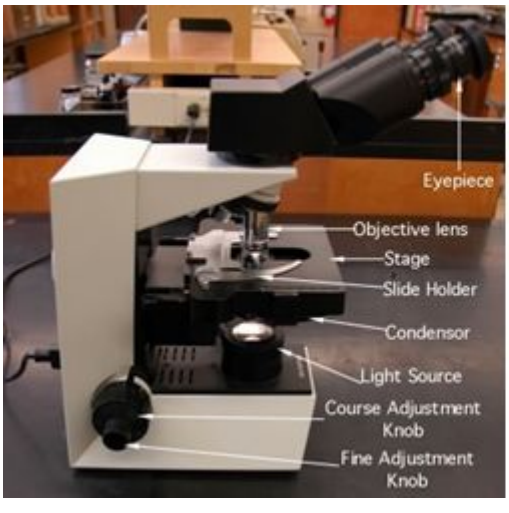
Who does the autopsy? The (forensic) pathologist.

Some Instruments in pathology:

There are different diagnostic instruments used in pathology.

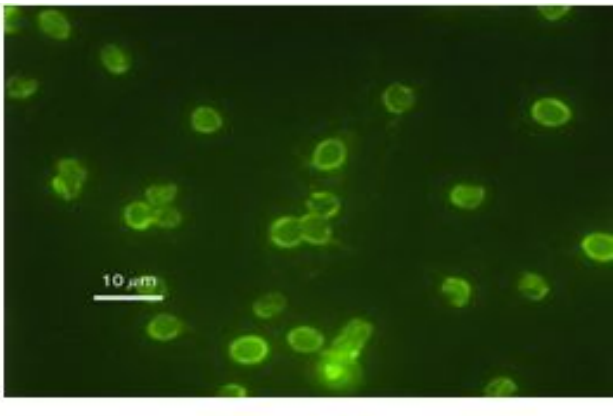
Some of the instruments used in pathology are:

- Light microscope:



- Immunofluorescence microscope:

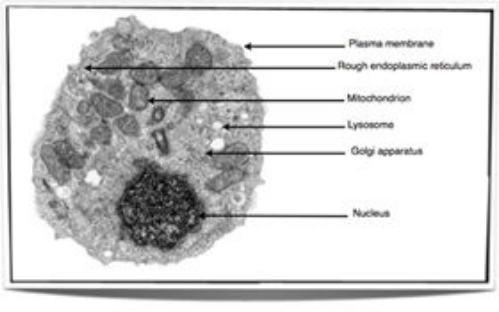
Immunofluorescent (IF) microscope: IF microscope uses a special blue filter and antibodies tagged with fluorescent green dye to identify various antigens in various cells of the body. If antigen antibody reaction takes place the green dye lights up under the IF microscope and this way we know that the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



Green light means presence of an antigen

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.



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Q&A:

1. Being crippled after getting polio is an example of:
   A- Prognosis
   B- Sequelae
   C- Signs
   D- Symptoms

2. A cleft lip is an example of:
   A- Genetic disease
   B- Non-genetic disease
   C- Neoplastic disease
   D- Degenerative disease

3. It is the total number of cases of a particular disease in a particular population in a particular period of time:
   A- Prevalence
   B- Incidence

4. which of the following isn't one of the basic pathogenic mechanisms?
   A- Inflammatory process
   B- Immunological process
   C- carcinogenesis
   D- Morphological changes

5. Are the findings discovered by the physician:
   A- Signs
   B- Symptoms
   C- clinical features

6. Is the study of the morphology of individual cells which are obtained by scraping or aspiration:
   A- Histopathology
   B- Cytopathology
   C- Histology
   D- Pathology

7. An autopsy is done to:
   A- Determine the cause of death
   B- Do research
   C- Provide useful informations about various diseases
   D- All of the above

8. List the four possible outcomes of a disease:

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Faye Wael Sendi

Answers:
1-B 2-B 3-A 4-D 5-A 6-B 7-D

Leaders:

Lama Al-Jamili

Salem Abokhanjar

Sub-Leader:

Manar Al-Abdullah

Members:

Leen Alhadlaq

Salem Abokhanjar