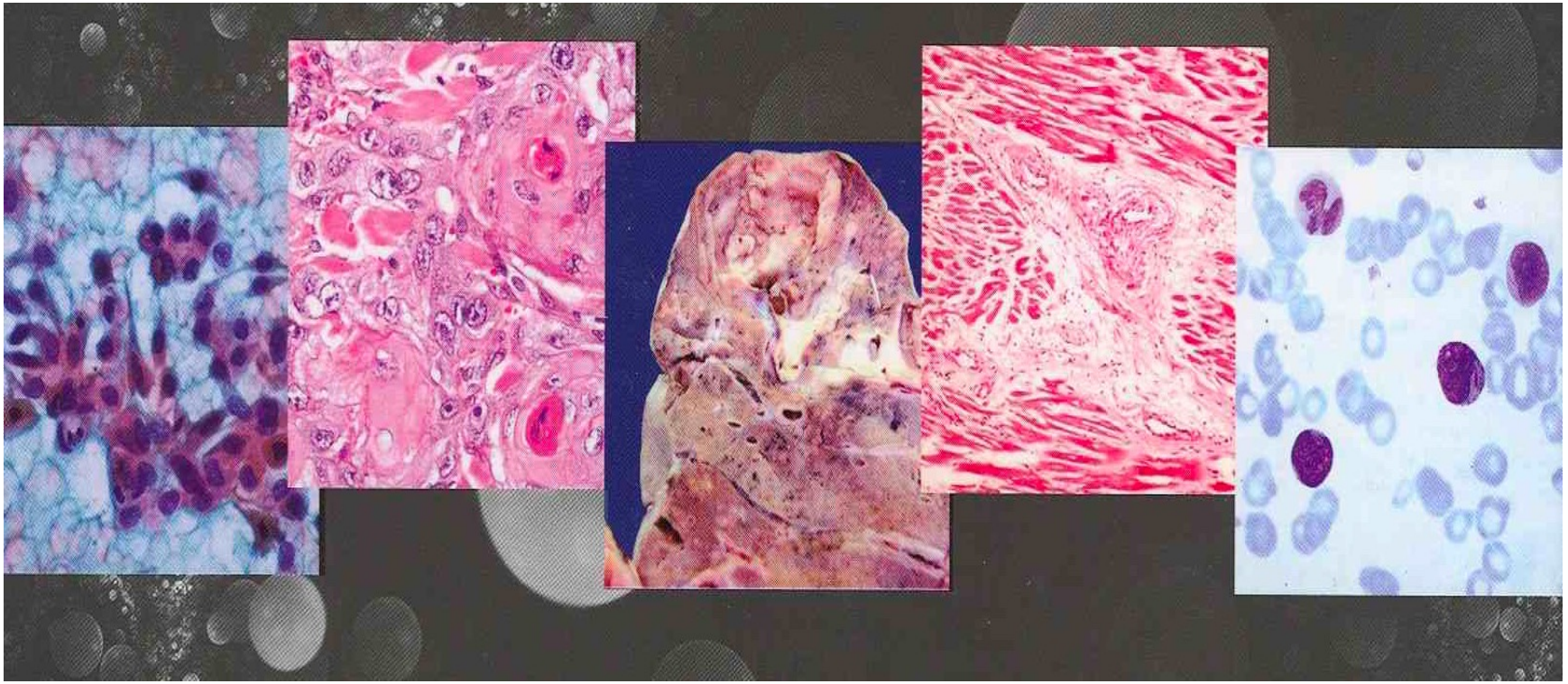
Pathological Chemistry



Pathology

- The term “pathology” is derived from the Greek words *pathos* which means *disease* and logy which means study, thus pathology is a branch of biological sciences that deals with the scientific study of all structural and functional abnormalities (at the level of cells, tissues, organs and body fluids) that that caused by the disease and these changes effects the total body functions.

Pathology

- Pathology is considered a vital link between basic sciences (anatomy, physiology, biochemistry, pharmacology…….etc) and clinical sciences (internal medicine, surgery, neurology, dermatology, the riogenology…….etc).

The Tree of Medicine

(After G. Diamandopoulos)

Diseases

- Disease may ,in turn, be defined as an abnormal variation in structure or function of any part of the body.
- Pathology gives explanations of a disease by studying the following aspects of the disease:

- **Etiology, pathogenesis, morphologic changes, clinical manifestation, diagnosis and clinical course**.

Concepts of disease and its development

- • The aspects of disease process include etiology, pathogenesis, morphologic changes, clinical manifestation, diagnosis and clinical course.
- • Etiology
- • Pathogenesis
- • Morphologic changes
- • Clinical manifestation / Clinical significance
- • Clinical course

Etiology

- The causes of disease are known as etiology. The etiologic agents are:
- **Biologic agents**: Virus, bacteria, fungi, protozoa etc.
- **Physical:** Trauma, burns, radiations
- **Chemical agents**: Poisons, alcohol, asbestos etc.
- **Nutritional excess**: Excessive fat causes obesity, excessive level of LDL (Low density lipoprotein cholesterol) causes the atherosclerosis, and Excessive sodium causes hypertension
- **Nutrition deficits**: Vit: A deficiency causes night blindness, Thiamin deficiency causes beri beri and Vit: C deficiency causes scurvy.
- **Genetics factors:** Type 1 diabetic mellitus is caused by deficiency of DR3 and DR4, hemophilia A is caused by deficiency of clotting factor V111 etc.

Pathogenesis

- Pathogenesis is the sequence of cellular and tissues events that take place from the time of initial contact with etiologic agents until the ultimate expression of the disease.
- It refers to the sequence of events in the response of the cells, tissues, organs to the injurious stimuli that may lead to a disease
- It describes mechanisms of development of disease

Morphologic changes

- Morphologic changes are concerned with both gross anatomic and microscopic changes caused by the disease.

Clinical manifestation

- Sign and symptoms are terms used to describe the structural and functional changes that accompany the disease.
- **Symptoms:**
- It is the subjective complaint noticed by person with disorder.
- Features of illness that are noticed by patients
- **Signs:**
- Clinical manifestation of the disease which are recognized by clinicians/ observer

Clinical course

- It describes the evolution of the disease. A disease can have acute or chronic course.

- **Acute disease**: Sudden onset, short term process, severe sign and symptoms.

- **Chronic disease**: Slow / Gradual onset, continuous and long term process

Professional divisions of pathology:

- Pathology includes **two major** professional divisions:
- **1. Medical pathology which** deals with the study of diseases in humans.
- **2. Comparative pathology which deals** with the study of diseases in all animal species as well as human diseases.

Academic divisions of pathology

- In academic studies, pathology (medical or comparative) is divided into two major divisions:
- 1. **Anatomic pathology:** which deals with the study of the disease effects in cells, tissues and organs.
- **2. Clinical pathology** which deals with the study of the disease effects in body fluids and secretions (blood, urine, milk…… etc.) using certain laboratory methods.

Branches of Anatomic Pathology

- **1. General pathology** which deals with the study of the common basic changes in all tissues as a result of a disease, e.g., cell injury, necrosis, inflammation and neoplasm.
- **2. Systemic pathology** which deals with the study of morphological changes in tissues and organs of a particular system as a result of a disease e. g., pathology of respiratory system, pathology of digestive system, pathology of nervous system…etc.

Branches of Anatomic Pathology

- **3. Special pathology** which deals with the application of the basic changes learned in general pathology to the various specific diseases e.g Diabetes, atherosclerosis etc.
- **4. Diagnostic Pathology** (Histopathology) which deals with the study of tissue abnormalities using gross and microscopic examination of biopsy samples.
- **Biopsy:** The biopsy is a tissue sample obtained surgically from a living body in order to be examined grossly and microscopically (by a pathologist) to help in establishing the diagnosis of the pathological condition

Branches of Anatomic Pathology

- **5. Cytopathology: which** deals with the study of cellular changes.
- **6. Surgical Pathology** which refers to histopathological examination of biopsy samples surgically removed from living bodies.
- **7. Post-mortem pathology** which deals with pathological examination of human cadaver after death. It is also known as autopsy or necropsy.

Branches of Anatomic Pathology

- **8. Forensic pathology: It is the subspecialty of pathology that focuses on the medico-legal investigation of the cause of a sudden or unexpected death by examination of a dead body.**
- **9. Physiological pathology which deals with the study of alterations in the functions of organs and systems of the body as a result to a disease. It is also known as pathophysiology; e.g., pathophysiology of indigestion, diarrhea, abortion…..etc.**

Branches of Anatomic Pathology

- **10. Immunopathology: which** deals with the study of diseases mediated by immune reactions. Such as immunodeficiency diseases, autoimmune diseases and hypersensitivity reactions.
- **11. Molecular pathology :**which deals with the study of alterations that take place at the molecular level (e.g., DNA damage) as a result to a disease.

Branches of Anatomic Pathology

- **12.Experimental pathology:**
- It is the study of diseases that have been created or induced experimentally to analyze the structural &functional abnormalities in tissue to better understand the mechanism of underline diseases.
- Usually laboratory animals used in experimental pathology (Rabbits,Rats,Mice….ect.

Illness

- **Illness: It** means that the individual is sick,means some part of the body is not functioning properly.
- But some disease conditions not companied by a clinical illness means perfectly healthy e.g.stroke&heartattack.

Pathological process

- **The pathological process consists of the following:**
- **1**. **Injury (damage)** created by the causative agent (virus, bacteria, poison, hypertension ….etc) on cells, tissues and organs**.**
- **2. Reactive changes (pathological changes)** against the injury, for example, in cases of systemic hypertension there is myocardial hypertrophy of the left heart ventricle due to increase in the resistance to blood flow through the arterioles**.**

Techniques for the Study of Pathology

- **Histopathologic techniques include**
- **1. Gross pathology (macroscopic pathology):** This refers to the changes affecting various organs and tissues in diseases as evident to the naked eye. Much of these changes have been derived from autopsy (postmortem) examinations, which is still an important investigative method. The gross pathology of many diseases is so characteristic that an experienced pathologist can give a fairly confident diagnosis of the disease before further investigations are carried out.

2. Light microscopy:

- Advances in light microscopic examination have resulted in a wealth of new information about the structure of tissues and cells in health and disease.
- If solid tissues (e.g. liver, kidney etc.) are to be examined by light microscopy, the sample must first be thinly sectioned to permit the transmission of light and to minimize the superimposition of tissue components.
- These sections are routinely cut from tissue hardened by permeation with and embedding in wax or.

2. Light microscopy:

- For some purposes (e.g. histochemistry, or when very urgent diagnosis is needed) sections have to be cut from tissue that has been hardened rapidly by freezing (frozen section technique). The sections are stained to help distinguishing between different components of the tissue (e.g. nuclei, cytoplasm, and other structures such as collagen).
- The microscope can also be used to examine cells derived from fluid within cysts or body cavities (exfoliative cytology), scraped from body surfaces e.g. cervical smears (exfoliative cytology) and from solid lesions through the use of needles (fine needle aspiration cytology).
- In fact cytology is currently used widely in cancer diagnosis and screening.

3. Histochemistry:

- Certain cells produce chemical substances the detection of which through treatment with specific reagents (histochemical stains) is of diagnostic value.

4. Immunohistochemistry and immunofluorescence

- These techniques employ antibodies (with antigen specificity) to visualize substances (for e.g. cellular proteins or surface receptors) in tissue sections or cytological cell preparations. To visualize the reaction sites; these antibodies are connected chemically to enzymes (Immunohistochemistry) or fluorescent dyes (Immunofluorescence) are used.
- In immunohistochemistry the end product is a deposit of colored material that can be seen with a conventional light microscope. The list of substances detectable by these techniques has been greatly enlarged by the development of monoclonal antibodies.

5. Electron microscopy:

- This has extended the range of pathology to the study of disorders at an organelle (subcellular) level and the demonstration of viruses in tissue samples from some diseases. The most common diagnostic use of electron microscopy, however, is the interpretation of renal biopsies i.e. helps establish the diagnosis of various glomerular diseases.

6. Biochemical techniques:

- These are applied to the tissues and body fluids and are now one of the principal factors on the growing understanding of pathological processes. The clinical role of biochemistry is exemplified by the importance of monitoring fluid and electrolyte changes that occur in many disorders.
- Determination of serum enzyme levels are used to assess the integrity and vitality of various tissues; for example, raised levels of cardiac enzymes in the blood indicate damage to cardiac myocytes and thus
- very helpful in establishing the diagnosis of myocardial infarction.

- **7. Hematological techniques**: these are used in the diagnosis and study of blood disorders. They range from relatively simple blood cells counting, which can be performed electronically, to the more sophisticated assays of blood coagulation factors.
- **8. Cell cultures**: these are widely used in research and diagnosis. They are an attractive medium for research because of the ease with which the cellular environment can be modified and the responses to it monitored. Diagnostically, cell cultures are used to prepare chromosome spreads for cytogenetic analysis.

9. Medical microbiology:

- This is the study of diseases caused by organisms such as bacteria, fungi, viruses and parasites. Techniques used include direct microscopy of appropriately stained material (e.g. pus), cultures to isolate and grow the organism, and methods to identify correctly the cause of the infection.
- In the case of bacterial infections, the most appropriate antibiotic can be selected to treat a given
- infection by determining the sensitivity of the bacteria to a variety of therapeutic agents (through the use of antibiotic discs)

10. Molecular pathology:

- Specific genes or their messenger RNA visible in tissue sections or cell preparations. Minute quantities of nucleic acids can be amplified by the use of the polymerase chain reaction (PCR) using oligonucleotide primers specific for the genes being studied. DNA microarrays can be used to determine patterns of gene expression (mRNA).

10. Molecular pathology:

- This powerful technique can reveal new diagnostic and prognostic categories, indistinguishable by other methods. Molecular pathology applications include the study, for example, of abnormal hemoglobin molecules, such as in sickle cell disease and the alterations in the genome that control cell growth, which is important part in the development of neoplasms.