Introduction

Lecture contents

- General Pathology: definitions and scope!
- General vs Systemic Pathology
- Clinical vs Molecular pathology
- Cell damage and reversible cell injury

Pathology may be referred to as the scientific study of diseases.
The term pathology comes from the Greek words "pathos" and "logy." 'Patho' means suffering or disease, and 'logy' means study or science.

Pathology is practiced as a medical discipline linking science to medicine and is regarded as the foundation of many aspects of patient care, from diagnostic testing, prognostication, and advice on treatment modalities using cutting-edge genetic technologies and preventing disease. This specialty of medical science concerned with the cause, development, structural/functional changes, and natural history associated with diseases.

General pathology (Basic Pathology)
Studies structural, biochemical and functional changes/ responses on cellular and tissue level in relation to a pathologic cause of a specific diseases.

Systemic Pathology
Studies the disease that affects specific organ in relation to etiology (cause), pathogenesis (mechanisms), morphology (gross and microscopic), functional/clinical features (signs and symptoms), and sequelae (consequence) of that disease.

Clinical pathology: involves studying the patient's illness on clinical level, focusing on analyzing the disease itself, based on specific steps and methods:

- Patient's current and past history (signs and symptoms, etc)
- Systematic clinical examination (general and specific)
- Proper investigations (qualitative and/or quantitative analysis of body fluids (blood, urine, semen, CSF, etc.)
- Diagnosis (and differential diagnosis) … and accordingly
- Treatment.

This process requires accurate systematic approach, where the clinician/pathologist collect information, observations and tests results and analyzing them accordingly using stepwise sequence of patient's evaluation.

Symptom: the complaint or something experienced or felt by an individual that may indicate the presence of a disease or condition. Symptoms can only be reported by the person experiencing them. They cannot be observed by a health care provider or other persons and do not show up on medical tests.

Sign: is an objective and observable indication detected during a physical examination or diagnostic procedure.

Vital signs: measuring the four clinical signs (body temperature, heart rate, respiratory rate, blood pressure BP). In addition to drug hypersensitivity and medical history, these signs should be assessed prior to management of every patient!

Pathognomonic features: are disease specific and distinctive features.

Lesion: An area of abnormal tissue commonly affected by a disease or causative factor/agent.

Syndrome: a set of symptoms or conditions.

Complications and sequelae (or secondary effects): the consequences and effect

Prognosis: likely outcome or course & chance of recovery or recurrence

The pathological study involves investigating the:
The ***etiology,*** which denotes the specific cause of the disease.
Pathogenesis, which may refer to the changes in the structure or function of an organism at the gross/clinical level.
Morphology: Identify changes in the gross (visible) or microscopic appearance of structural alterations in cells, tissues and organs.

Molecular pathology:
The field of scientific advances in pathology in last few decades. This methodology detects and diagnose the abnormalities caused by a disease process at the molecular level, i.e. DNA errors of the cells that leads to defects in the chemical structure of molecules.
By studying the sequence of the DNA bases that directs amino acid synthesis, using in situ hybridization technique, pathologists may identify and visualize specific genes or their mRNA in tissue sections or cell preparations.

Polymerase chain reaction (PCR) technique is a routine test to amplify minute quantities of nucleic acids using oligonucleotide primers specific for certain genes. DNA microarrays can be used to determine patterns of gene expression (mRNA).
Molecular pathology has many applications: detecting abnormal hemoglobin molecules of sickle cell anemias and alterations in genome that control cell growth of neoplasms.

Gross pathology:
macroscopic disease manifestations in organs, tissues, and body cavities.

Histopathology:
examining **specimens of affected tissues** by certain disease microscopically using light or electron microscopes.
The specimens are tissue sections prepared using paraffin-embedding using ***microtome***: which cuts thin layers of pre-prepared (fixed and stained) sections.
Histopathology may be subdivided into:

Surgical pathology
Experimental pathology.
Forensic pathology: autopsy at postmortem

Experimental pathology: when the pathologist observes and follow the effects and changes of certain manipulations on animal models (commonly mice, rats or monkeys) or specific cell cultures regarding scientific research on human diseases.

Biopsy: involves obtaining tissue samples from a living body representing a viable specimen for microscopic examination.
The procedure may be performed in different ways

incisional biopsy: only a sample of tissue is removed;
excisional biopsy: an entire lump or suspicious area is removed;
needle biopsy: a sample of tissue or fluid is removed with a needle.

When a wide needle used, the procedure is called: **core biopsy**
When a thin needle is used, it is called a **fine-needle aspiration biopsy**.

Oral and Maxillofacial Pathology (OMFP):
refers to the diseases of the oral cavity, jaws, and related structures, including salivary glands, temporomandibular joints, facial muscles, and perioral skin. It is considered to be a specialty of dentistry and pathology.

Causes of Diseases and illnesses

- Congenital/Genetic (Heritable, and non-heritable malformations) causes of diseases
- Acquired causes of Diseases

  Trauma (mechanical injury, accidents etc.)
  Nutritional deficiency diseases (e.g. macro- and micronutrient deficiency)
  Environmental or Physical agents (Heat, cold, irradiation)
  Chemical and drug injury (strong acids and alkalis)
  Infectious microorganism
  Immunological factors (autoimmune diseases like Type 1 diabetes)
  Psychologic factors
  Diseases of addiction (alcohol, tobacco, vaping, pipes and various drugs)
  Aging / Degenerative (Alzheimer's disease, Dementia, etc.)
  Neoplastic (various cancer diseases)
  Metabolic (e.g. in-born error of metabolism, porphyria etc.)
  Iatrogenic (disease caused by drugs or treatment)
  Idiopathic (unknown cause)

METHODS USED TO STUDY PATHOLOGY

1. **Histopathology**: examining a diseased tissue under light or electron microscope.
2. **Cytopathology**: examining specifically obtained samples at cellular level. It studies **abnormal cells obtained from various body sites** aiming at determining the cause, nature or type of the disease (sensitive but less specific and accurate than histopathology). The cells may be collected by suction or from *body fluids* (bronchial wash, sputum, urine, or pleural effusion) or by *fine needle aspiration* (FNA) or *scraping* from skin or mucosal surfaces (exfoliative cytology).
3. **Hematology**: Microscopic examination of blood constituents.
4. **Clinical Biochemistry**: involves studying the biochemical constituents in serum and plasma, and in other body fluids in order to identify metabolic disturbances of diseases.
5. **Microbiology**: attempting at detection of the possible causative microorganism of the disease by examining body fluids, mucosal surfaces and tissues biopsies using microscopic, culture and serological techniques.
6. **Cytogenetics**: detecting of chromosomal abnormality at cellular genetic level.
7. **Histo-chemistry**: detection of cells and tissues constituents using special immuno-histochemical techniques.
8. **Forensic Pathology/Autopsy:** involves applying pathological methods to investigate a crime or suspicious, or unexplained deaths. An autopsy examines the dead body to identify the cause of death.
9. **Toxicology**: studying the cause/effects of known or alleged poisons on the body.

Techniques in Pathology

- Anatomic Pathology
  - Gross pathology
  - Light Microscopy
  - Immunohistochemistry & immunofluorescence
  - Electron microscopy
  - Molecular pathology
- Biochemical techniques
- Hematological techniques
- Medical microbiology
- Serology
- Flow-cytometry

SPECIAL STAINS IN PATHOLOGY

- **Haematoxylin and eosin stain (H&E)**: this stain shows good histological features, Haematoxylin stains the nuclear chromatin in blue because it has special affinity to it, while the eosin has affinity towards cytoplasmic proteins, therefore stains them pink.
- **Reticulin stain**: demonstrate both reticular fiber (type III collagen of connective tissue) and basement membranes (type IV collagen and laminin).
  This stain has special use in tumor pathology.
- **Giemsa stain**: a stain used to demonstrate lymphoreticular elements.
- **Periodic acid Schiff stain (PAS)**: this special stain uncover glycogen, neutral muco-substances, basement membrane and most types of fungi and parasites.
- **Stain for microorganism**: demonstrate gram-positive and gram-negative bacteria, acid fast bacteria, fungi and parasites. e.g. Gram stain and zeihl-Neelsen stain.
- **Amyloid stain**: e.g. Congo-red stains that detect amyloid.
- **Perl's stain**: for the detection of iron.

Immunohistochemistry and Immunofluorescence

Techniques use antibodies (for specific antigen) to visualize the presence of certain cellular proteins or surface receptors in tissue sections or cytological cell preparations. These antibodies are linked chemically to **enzymes** (*Immunohistochemistry*) or **fluorescent dyes** (*Immunofluorescence*) in order to visualize reaction sites.

In immunohistochemistry, monoclonal antibodies are used to detect the end product as a colored deposit with the use a conventional light microscope.

Electron microscopy (EM)**:**
This technique has expanded the detection of pathologic disorders at the organelle (subcellular) level and the detection of viruses in tissue samples. The commonest diagnostic application of EM is in interpretation of renal biopsies of glomerular diseases.
Application of EM to diagnostic Pathology

- Tumor pathology (histogenesis)
- Renal pathology (deposits and classification)
- Vesicular disorder of skin

Forensic Pathology/Autopsy
known as a *post-mortem examination* or *necropsy*, which involves examination of a dead body. Forensic pathology applies pathological methods in investigating a crime (medico-legal issues) in order to determine the cases of sudden, suspicious, or unexplained deaths. Autopsies (morbid anatomy) are useful to determine death cause, for evaluation of the accuracy of clinical diagnoses, also for educational, research and statistical purposes.