

# CHS 2413

## Pathology and Physiopathology

**Assoc.Prof.Dr. Thavatchai Kamoltham MSc.MD.FICS.FRCST.Dr.PH**

# CHS2413 Pathology and Physiopathology 3(3-0-6)

## Course Description

The pathology of various diseases, causes, mechanisms and variant of cells, tissues and organs affected by the disease or malfunction. Describes the characteristics of various diseases, dysfunction of organs for applying in healthcare and health promotion

# Objectives

1. Disease
2. General Pathology
3. Systemic Pathology
4. Clinical Pathology
5. Nutritional Pathology
  - Deficiency
  - Excess of food stuffs
6. Pathological Physiology

# **INTRODUCTION TO PATHOLOGY AND PATHOPHYSIOLOGY**

**Assoc.Prof.Dr. Thavatchai Kamoltham  
MSc.MD.FICS.FRCST.Dr.PH**

# Objectives

1. Explain role of **pathophysiology** in diagnosis and treatment of disease
2. Use appropriate **terminology**
3. Explain importance of **homeostasis**
4. Describe **causes** and Natural of Disease.
5. **Diagnosis** of the diseases

# Basic Groups of Diseases

## Group 1 Congenital Disorders

- Hereditary Disease \* Genetics diseases
- Congenital anomaly\* Abnormal Growth &Development eg. hare lip, cleft palate etc.

## Group 2 Reaction of self defense mechanism

- \* inflammation
- \* Immune disorders

## Group 3 Formation of Tumor

- \* Non Neoplastic tumor
- \* Neoplastic tumor

## Group 4 Unclassified Diseases:

- \* most Of unclassified diseases usually are complex in nature such as **metabolic , degenerative , neuropsychic diseases ...etc...**

# What is pathophysiology?

- The study of the disturbance of normal mechanical, **physical and biochemical** functions either caused by a **disease or abnormal** syndrome or condition that may not qualify to be called a **disease** processes and how human systems are affected = **study of cell and tissue changes associated with disease.**
- Emphasis on **prevention and treatment** of disease
- What's normal and abnormal?
- An alternate definition is:
- **"the study of the biological and physical manifestations of disease as they correlate with the underlying abnormalities and physiological disturbances.**

# What the pathophysiology is

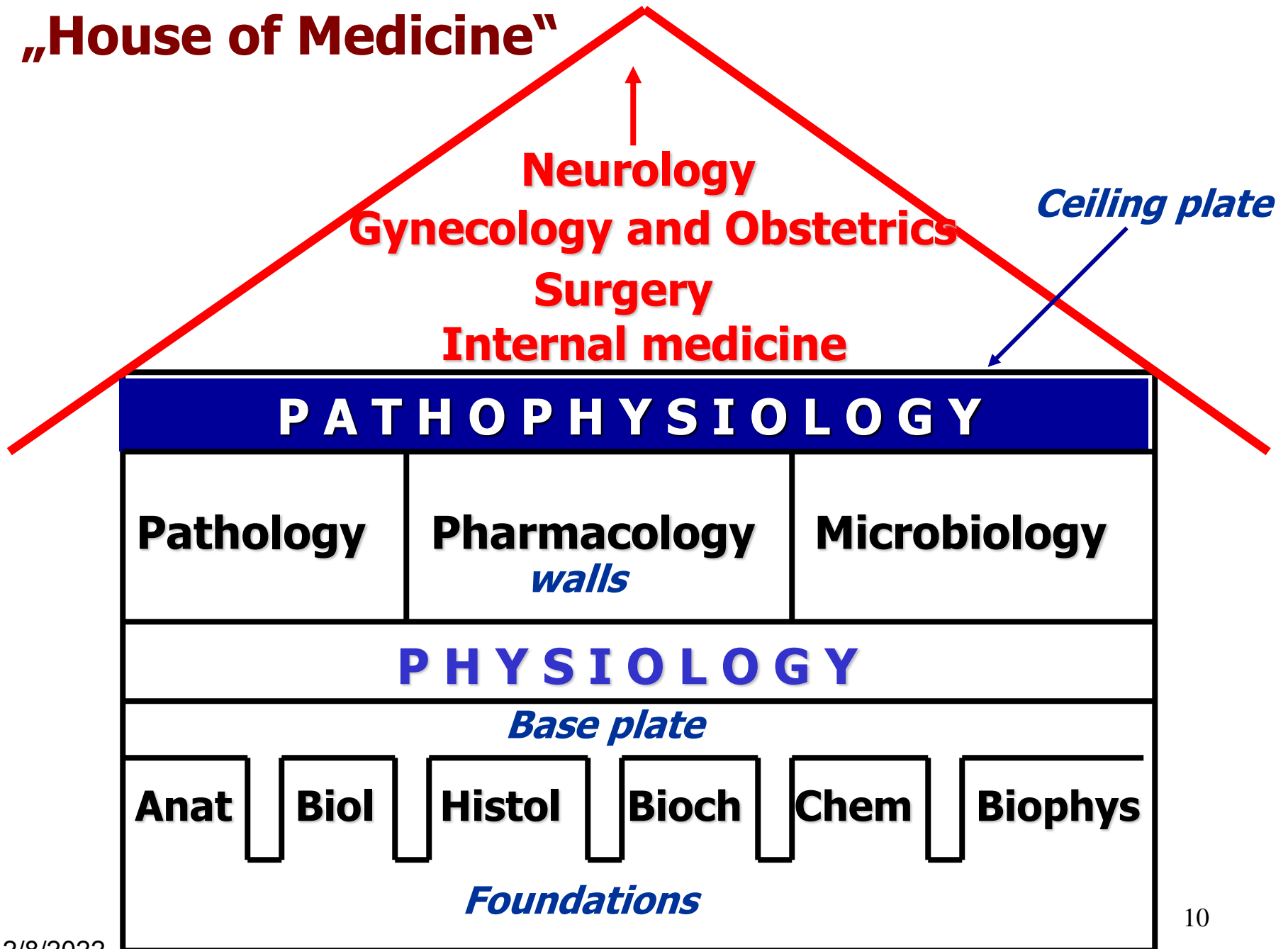
- Structure
  - **Anatomy**: alteration of the structure of the body (physically)
- Function
  - **Physiology**: The science that is concerned with the function of the living organism and its parts, and of the physical and chemical processes involved
  - **Pathophysiology**:  
The study of disordered body function (mechanical, physical and biochemical functions)  
i.e. disease.  
The basis for clinical medicine.



# The Tree of Medicine (After G. Diamandopoulos)

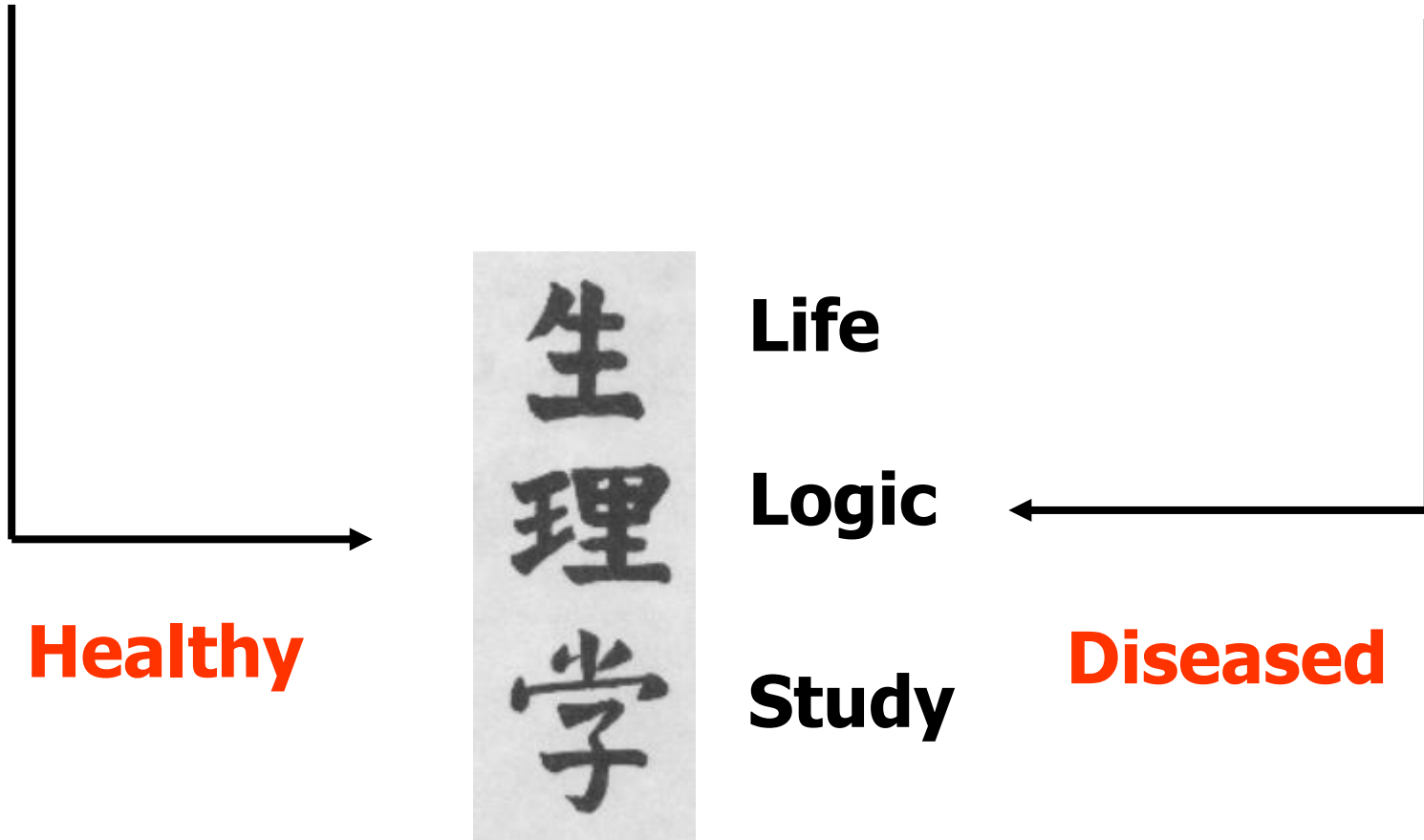


# „House of Medicine“



# Physiology

# Pathophysiology



**The calligraphy done by the Korean artis Kim Hyun-Seung**

# The Human Body - A Complex Society of Differentiated Cells

- **Cells:** the basic structural and functional unit (~ 100 trillion)
- **Tissues:** (e.g. muscles, epithelial, nervous )
- **Organs:** (e.g. kidney, heart, liver, pancreas)
- **Organ systems:** (e.g. cardiovascular, urinary)

# Terminology

- **Physiology** = study of normal function and anatomy of human body
- **Pathology** = study of disease, focus on physical changes in diseased organs and tissues
- **Pathophysiology** = the study of abnormal functioning of diseased organs associated with a specific disease
- **Pathogenesis** = the development of a disease
  - » Diseases develops in stages
  - » Infectious disease example:  
(A)incubation (b)disease (c)convalescence
- **Disease** = **loss of homeostasis** or when physical or mental capacities cannot be fully utilized (interruption, cessation or disorder in the function of an organ or system).
- **Subjective finding:** The patient's symptoms, described by the patient----(**the patient's history**)
- **Objective findings:** Health provider's findings---(**the physical exam**)
- **Diagnosis** – identification of the specific disease
- **Therapy** –the treatment of the disease to either effect a cure or reduce the patient's signs and symptoms
- **Prognosis** – prediction of a disease's outcome

# Terminology

- **Pathogenesis**- the development of the disease or the sequence of events involved in the tissue changes related to the specific disease process.
- **Onset**
  - **Acute** – sudden/quick
  - **Insidious** – gradual/slow
  - **Chronic**- on-going
  - **Sub-clinical** – no obvious manifestations are exhibited
  - **Latent**- incubation period “silent period” Most infectious in some viruses
- **Occurrence of disease defined by 2 factors**
  - **Incidence** = # **new** cases per unit of time
  - **Prevalence** = # **new & old** cases per unit of time

# Terminology

**Clinical manifestations** – indications that the person is sick

**Signs** – observable or measurable traits Ex. Lesions, redness, swelling

**Symptoms** – unobservable effects of a disease reported by the patient. Ex. Nausea, headache

**Syndrome** - a characteristic combination of signs and symptoms associated with a particular disease.

**Sequelae** – lesions or impairments resulting from a disease

**Distribution** of lesions may be:

**Local** – confined to one area of the body

**Systemic** – widely distributed throughout the body

**Organ damage** can be:

**Focal** if there are only one or more distinct sites of damage

**Diffuse** if the damage is uniformly distributed

# Disease Terminology

- **Etiology = cause of the disease (genetic, infection, dysfunction, etc.)**
- **Idiopathic = disease with unknown cause**
- **Iatrogenic = disease caused by human intervention treatment, procedure, or medical error**
- **Congenital diseases = diseases occurring at birth**
- **Syndrome = common cause of different signs & symptoms**
- **Remission = period when symptoms & signs of disease abates**
- **Exacerbation = period when symptoms & signs increase**
- **Endemic disease = disease native to local area**
- **Epidemic = many people affected in a given area**
- **Pandemic = many people affected in large areas**
- **Incubation = latent period of the disease before develop signs & symptoms**



# Disease Terminology

- **Prognosis** = probability for recovery
- **Morbidity** = disease rates within a group
- **Mortality** = death rates within a group
- **Epidemiology** = how the disease occurs & spreads through an area
- **Predisposing factors**- age, gender, ethnicity ,occupational exposure  
Once you know these, prevention is easier: Vaccines? Lifestyle changes?
- **Precipitating factors**- condition that triggers an acute episode.
- **Complications**- secondarily arise after initial disease begins but while the disease is still manifested.
- **Sequelae**- secondarily arise after disease has gone away
- **Remission**- manifestations subside
- **Exacerbation**- manifestations increase **Ex: Arthritis**

# Homeostasis

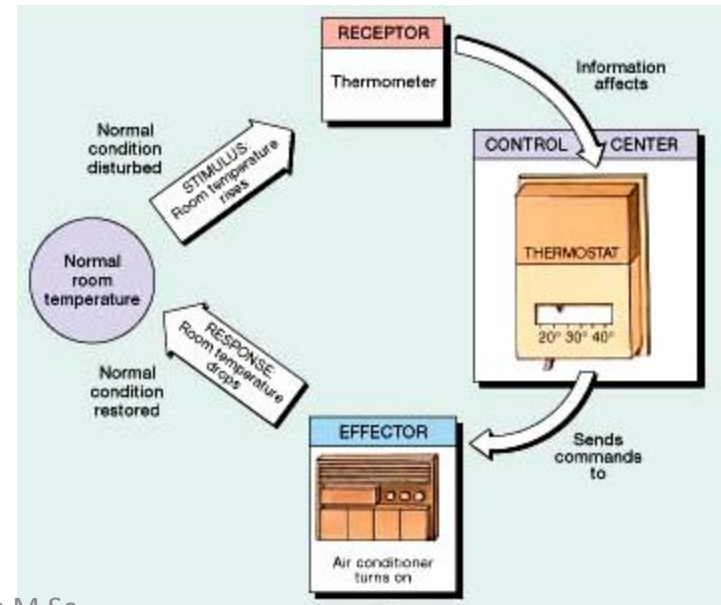
- Definition = internal constancy or a stable internal environment
- A “body in balance” is in homeostasis
- Homeostatic regulation ---- works by using feedback loops
- Feedback loops utilize 3 components
  - (1) receptor
  - (2) control center
  - (3) effector
- 2 types of feedback loops

## (1) negative feedback

- Restores any change back to normal
- Resembles “teeter-totter”
- Stabilizing
- Most common

## (2) positive feedback

- Exaggerates the change
- Resembles “domino effect”
- Stimulating
- Least common



# Homeostasis

- **Homeostasis & disease**
  - **Disease is the failure to maintain homeostatic conditions**
- **Disease mechanisms**
  - Genetic = mutated or abnormal genes
  - Pathogens (microscopic organisms)
  - Loss of control mechanisms (e. G. Diabetes, immune problems)
  - Degenerative changes (normal aging)
  - Environmental hazards (trauma, chemicals)
  - Nutritional factors
  - Tumors (benign & malignant)

# Homeostasis

The body is always striving to maintain an internal equilibrium called homeostasis,

- which is regulated by three regions in the brain
- and maintained by a number of positive and negative feedback mechanisms.
- Disease or illness may develop when homeostasis is disrupted

How would you know that a patient's body is maintaining homeostasis or not?

- Blood pressure change
- Pulse
- Temperature change
- Fluid imbalance

Therefore homeostasis can fall into an acceptable ranges (not absolute criteria)

Can be adjusted based on:

- Age
- Gender
- Genetics
- Environment
- Activity Level

# Cellular Adaptive Changes to Environmental Cell injury and Stresses

- The life cycle of a cell exists on continuum that includes normal activities and adaptation, injury or lethal changes.
- Adaptation is a normal life cycle
- 2 cellular reactions happen:
  1. Hyperfunctioning
  2. Hypofunctioning

What are some examples of body normal adaptations?

- Growth during puberty
- Body changes during pregnancy and aging process
- Stressful life style that may lead to adaptation or disease

# Therefore...Homeostasis

- The cell constantly makes adjustments to a changing, hostile environment to keep the organism functioning in normal steady state which is necessary to ensure the survival of the organism.
- Prevention of disease by the body depends on the capacity of the affected cells to undergo self-repair and regeneration i.e. adaptive-changes.

# Common Stimuli

- Physical agents
- Chemical agents
- Microorganisms
- Hypoxia
- Genetic defects
- Nutritional imbalances
- Immunologic reactions

# Four aspects of the disease

1. **Etiology**: etiologic factors: genetic and acquired (infectious, nutritional, chemical, physical, etc).
2. **Pathogenesis**: the cause operates to produce the pathological and clinical manifestations. The pathogenetic mechanisms could take place in the latent or incubation period. Pathogenesis leads to morphologic changes
3. **Morphologic changes**: The structural changes in the organ can be seen with the naked eye or they may only be seen under the microscope, the morphologic changes will lead to functional alteration & to the clinical signs & symptoms of the disease.
4. **Functional derangements and clinical significance**: the normal function of the organ determine the clinical features (symptoms and signs), course, and prognosis of the disease.

Etiology → Pathogenesis → Morphologic changes → Clinical features → Prognosis of the diseases



# In the study of pathophysiology, we usually consider the causes of disease(Etiology)

- the changes to normal anatomy and physiology (pathophysiology),
- the signs and symptoms (clinical manifestations) of the disease or illness
- diagnostic tests and treatments available
- **Categories of etiology**
  1. Genetic disease– genes are responsible for a structural or functional defect
  2. Congenital disease– genetic information is intact, but the intrauterine environment interferes with normal development
  3. Acquired disease – disease is caused by factors encountered after birth (biological agents, physical forces, and chemical agents)

# Disease and Its Etiology

What is (Disease, Illness, Ailment) ?

# Etiology

- Predisposing causes
- Exciting causes or Precipitating causes
- Physical cause of disease
- Chemical causes
- Nutritive disease
- Biological causes
- Genetic disease

# The causes of disease

Diseases can be caused by either environmental factors, genetic factors or a combination of the two.

A. **Environmental factors:** Environmental causes of disease are many and are classified into:

- 1. Physical agents
- 2. Chemicals
- 3. Nutritional deficiencies & excesses
- 4. Infections & infestations
- 5. Immunological factors
- 6. Psychogenic factors

B. **Genetic Factors:** These are hereditary factors that are inherited genetically from parents.

- 23 pairs of chromosomes: 22 homologous pairs of autosomes & one pair of sex chromosomes (XX or XY)
- DNA → transcription → RNA → translation → replication → DNA PROTEIN
- One member of each pair of
- chromosomes is inherited from the father, the other from the mother
- any alteration in the sequence of bases in
- an alteration of the protein in normal gene at a specific point in its sequence is called mutation & is the basis of genetic diseases.

# Disease and Its Aetiology

1. Infection
2. Trauma
3. Tumour Neoplasm
4. Congenital and Hereditary Disorders
5. Endocrine and Metabolic Causes
6. Accidents, Violence
7. Psychiatric Causes
8. Infestation
9. Deficiency Diseases
10. Hypersensitivity
11. Autoimmune Disorders
12. Collagen Disorders
13. Physical Agents
14. Chemical Agents
15. Other Causes

# Predisposing Factors (risk factors)

- **Age**
  - Young are prone to accidents
  - Getting diseases such as diabetes, heart disease, and certain cancers increase with age
  - Very old are prone to drug interactions
- **Sex**
  - More frequent in woman: MS, osteoporosis
  - More frequent in men: gout, Parkinson's disease
- **Lifestyle**
  - Examples of harmful lifestyle:
    - » Perilous occupation
    - » Smoking
    - » Excess alcohol
    - » Poor nutrition
    - » Sedentary activity

- **Environment**
  - Air pollution
  - Water pollution
  - Poor living conditions
  - Excessive noise
  - Chronic psychological stress
- **Heredity**
  - Deals with genetic predisposition (inheritance)
    - » Genetic predisposition + certain type of environment = mental retardation , lung cancer, etc.
- **Preventive health care**
  - **The best treatment of a disease is prevention !!**
  - Deals with altering risk factors that can be changed

# The causes of disease

## 1. Physical agents

These include trauma, radiation, extremes of temperature, and electric power. These agents apply excess physical energy, in any form, to the body.

## 2. Chemicals

With the use of an ever-increasing number of chemical agents such as drugs, in industrial processes, and at home, chemically induced injury has become very common. Their effects vary:

- Some act in a general manner, for example cyanide is toxic to all cells.
- Others act locally at the site of application, for example strong acids and caustics.
- Another group exhibit a predilection for certain organs, for example – the effect of paracetamol and alcohol on liver. Many toxic chemicals are metabolized in liver and excreted in kidney, as a result, these organs are susceptible to chemical injury.



# The causes of disease

## 3. Nutritional deficiencies and excesses

Nutritional deficiencies may arise as a result of poor supply, interference with absorption, inefficient transport within the body, or defective utilization. It may take the form of deficiency either of major classes of food, usually protein and energy, or vitamins or elements essential for specific metabolic processes, e.g. iron for haemoglobin production. Often, the deficiencies are multiple and complex.

On the other hand, dietary excess plays an important role in diseases in Western countries. Obesity has become increasingly common, with its attendant dangers of type 2 diabetes, high blood pressure and heart disease.

## 4. Infections and infestations

Viruses, bacteria, fungi, protozoa, and metazoa all cause diseases. They may do so by causing cell destruction directly as in virus infections (for example poliomyelitis) or protozoal infections (for example malaria). However, in others the damage is done by toxins elaborated by the infecting agent as in diphtheria and tetanus. Like chemicals, they may have a general effect or they may show a predilection for certain tissues.

# The causes of disease

## 5. Immunological factors

The immune process is essential for protection against micro-organisms and parasites. However, the immune system can be abnormal which can lead to diseases. The abnormalities of the immune system include:

### A. Hypersensitivity reaction

This is exaggerated immune response to an antigen. For example, bronchial asthma can occur due to exaggerated immune response to the harmless pollen.

### B. Immunodeficiency

This is due to deficiency of a component of the immune system which leads to increased susceptibility to different diseases. An example is AIDS.

### C. Autoimmunity

This is an abnormal (exaggerated) immune reaction against the self antigens of the host. Therefore, autoimmunity is a hypersensitivity reaction against the self antigens. For example, type 1 diabetes mellitus is caused by autoimmune destruction of the beta cells of the islets of Langerhans of the pancreas.

# The causes of disease

## 6. **Psychogenic factors**

The mental stresses imposed by conditions of life, particularly in technologically advanced communities, are probably contributory factors in some groups of diseases.

## **B. Genetic Factors**

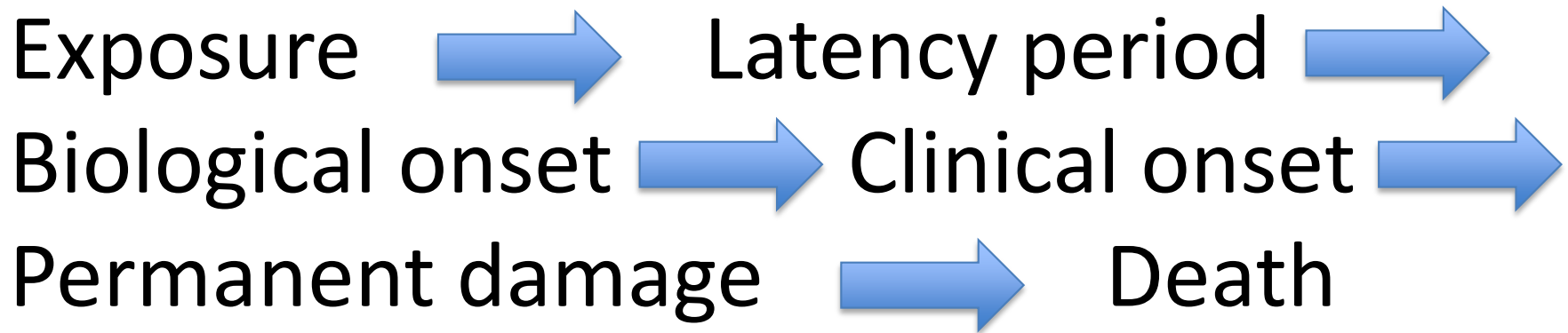
# Course of disease

The course of a disease in the absence of any intervention is called **the natural history of the disease**. The different stages in the natural history of disease include:

- a) **Exposure** to various risk factors (causative agents)
- b) Latency, period between exposure and biological onset of disease
- c) **Biological onset of disease**; this marks the initiation of the disease process, however, without any sign or symptom. Following biological onset of disease, it may remain asymptomatic or subclinical (i.e. without any clinical manifestations), or may lead to overt clinical disease.
- d) **Incubation (induction) period** refers to variable period of time without any obvious signs or symptoms from the time of exposure.
- e) **The clinical onset of the disease**, when the signs and symptoms of the disease become apparent. The expression of the disease may be variable in severity or in terms of range of manifestations.
- f) The onset of **permanent damage**, and
- g) **Death**

**Natural recovery, i.e. recovery without any intervention, can occur at any stage in the progression of the disease.**

# The natural history of the disease



# Outcome and consequences of disease

Following clinical onset, disease may follow any of the following trends:

- a) Resolution can occur leaving no sequelae,
- b) The disease can settle down, but sequelae are left, or
- c) It may result in death.

# Clinical death

- Clinical death is the reversible transition between life and biologic death.
- Clinical death is defined as the period of respiratory, circulatory and brain arrest during which initiation of resuscitation can lead to recovery.
- Clinical death begins with either the last agonal inhalation or the last cardiac contraction.
- **Signs indicating clinical death** are
  1. The patient is without pulse or blood pressure and is completely unresponsive to the most painful stimulus.
  2. The pupils are widely dilated
  3. Some reflex reactions to external stimulation are preserved. For example, during intubations, respiration may be restored in response to stimulation of the receptors of the superior laryngeal nerve, the nucleus of which is located in the medulla oblongata near the respiratory center.
- Recovery can occur with resuscitation.

# Biological Death

- Biological death (sure sign of death), which sets in after clinical death, is an irreversible state of cellular destruction.
- It manifests with irreversible cessation of circulatory and respiratory functions,
- or irreversible cessation of all functions of the entire brain, including brain stem.
- However, one should notice that there are internationally accepted criteria to diagnose biological death.



# Diagnosis

(Gr. dia “through” + gnosis “knowledge”)

Diagnoses are made by four general categories :

- **Clinical diagnosticians** identify diseases by examination of patient’s history and physical examination
- **Laboratory test** on blood, urine, sputum, pus discharge etc.
- **Radiologists** identify diseases by imaging the intact body
- **Pathologists** identify diseases by examining cells and tissues removed from the body

# Diagnostic techniques used in pathology

- Histopathology
- Cytopathology
- Hematopathology
- Immunohistochemistry
- Microbiological examination
- Biochemical examination
- Cytogenetic
- Molecular techniques
- Autopsy

# References

1. Emanuel Rubin, and John L. Farber, Essential Pathology, Philadelphia, 1990
2. William Boyd; Textbook of Pathology, structure and Function in disease, Philadelphia, 8th edition, 1987
3. James E. Pointer; Alan B. Fletcher; Basic life support, California, 1986
4. F.B. Walter and M.S Israel; General Pathology, Churchill Livingston Edinburgh and London, 4th edition, 1974
5. Macfarlane, Reid, callander, Illustrated Pathology, Churchill Livingstone, 5th edition, 2000.
6. Cotran RS, Kumar V, Collins T. Robins pathologic basis of diseases. Philadelphia, J.B. Saunders Company. 6th edition 1999
7. Muir's Textbook of Pathology 15th edition

# Test

1. Homeostasis can be defined as:
  - a) functional changes caused by disease
  - b) an unbalanced state, out of equilibrium
  - c) a steady, dynamic state of equilibrium
  - d) the exaggeration of an original response
2. Which of the following regions of the brain is not involved in maintaining homeostasis?
  - a) pons
  - b) medulla oblongata
  - c) pituitary gland
  - d) reticular formation