MEDICINE AND SURGERY

Course: Mechanism of diseases

Year: 2nd

Period: annual

Credits: 22

Objectives

Knowledge and understanding: The course will offer an integrated introduction to causes of cell, tissue and organ injury (cellular pathology) and the major genetic causes and microbial agents that cause human diseases (medical genetics and microbiology), the principal mechanisms of responses to injury and defense (inflammation and immunity), and the general processes of the most relevant causes of human diseases (immunopathology, vascular pathology and oncology).

Application of knowledge and understanding: At the end of the course students will gain understanding of:

• how the body reacts to physical and biological agents to recover homeostasis

• general pathological mechanisms leading to cell injury and death

• molecular and cellular basis for inflammatory disease states

• normal and abnormal functions of the innate and adaptive immune system

• body's immune reactions to infections

• molecular basis for neoplastic disease

• pathological mechanisms leading to thrombosis, atherosclerosis, ischemia, infarction Making judgements; Communication skills; Learning skills. By the end of the course students will have

• developed some abilities to communicate and work in team

• acquired some learning skills such as study in a group, organize knowledge, revise and retain information, select information.

Prerequisites

To take *Mechanism of diseases* exam, *Body at work 1* and *Body at work 2* exams must have been passed

Contents

The course can be divided into 5 modules: general pathology (cellular pathology, innate immunity and inflammation, vascular pathology) microbiology (basic and clinical), immunology and immunopathology, tumor biology and medical genetics. The syllabus is organized by learning outcomes specific for each lecture or for a group of lectures

FIRST SEMESTER CELLULAR PATHOLOGY

Learning objectives At the end of these lectures and activities, students should be able to

• Discuss the pathogenesis of hyperplasia, hypertrophy, atrophy, and metaplasia, and compare and contrast their possible physiologic and pathologic causes.

• Explain causes of cellular injury and describe cellular alterations during injury

• Demonstrate understanding of cellular changes during injury and cell death

Lessons

1. Mechanisms of cellular adaptation

2. Cell injury and cell death

3. Programmed cell death

4. Recap on cell pathology

INNATE IMMUNITY AND INFLAMMATION

Learning objectives At the end of these lectures and activities, students should be able to

• Describe and discuss each of the following cell type in terms of the associated type of inflammation and their role therein: mast cells/basophils neutrophils and eosinophils monocytes/macrophages, NK cells and dendritic cells

• Describe the classic vascular changes and cellular events of the acute inflammation and discuss the receptors and ligands that are responsible for these events.

• Define and use in proper context: abscess, chemotaxis, cytokine, edema, exudate, granulation tissue, granuloma, inflammation, margination, phagocytosis, purulent, pus, pyogenic, resolution, transudate, ulcer.

• Discuss the following chemical mediators of inflammation, in terms of origin (cells vs. plasma) and chief in vivo functions: vasoactive amines, complement system, arachidonic acid metabolites, platelet activating factor, cytokines/chemokines nitric oxide, lysosomal granule contents oxygen-derived free radicals

• Describe the steps involved in the isolation and destruction of an infectious agent by cells of the innate immunity. Describe important molecules involved in the process (opsonins, phagocytic receptors)

• Compare and contrast acute, chronic, and granulomatous inflammation in terms of: etiology, pathogenesis, histologic appearance, laboratory findings, characteristic cells involved, outcome, systemic effects.

• Describe the phases of tissue repair and cutaneous wound healing, the mechanisms of healing by first intention (primary union) and second intention (secondary union) and possible clinical consequences of abnormal wound healing.

Lessons

1. Origin of innate immune cells: hematopoiesis

2. The acute inflammatory response

3. Collaborative lesson on cells mediators of inflammation

4. Soluble mediators of inflammation

5. Chemokines and leukocyte recruitment

6. Pathogen recognition in innate immunity

7. The complement system

8. Pathogen killing

9. Resolution of the inflammatory response

10. Chronic inflammation, fibrosis and tissue renewal

11. Acute phase reaction and systemic inflammation

12. Collaborative lesson on sepsis

13. Recap lesson on inflammation

14. Small groups activity on WHIM syndrome

BASIC CONCEPTS OF MICROBIOLOGY

Learning objectives At the end of these lectures and activities, students should be able to

• Describe the general categories of infective agents including bacteria, viruses, fungi, and parasites.

• Discuss the pathogenesis of infectious diseases by different types of microorganisms and compare and contrast their pathologic causes.

Lessons

1 - Brief history of microbiology

2 - To describe major techniques to perform Microscopy and microbial staining

3 - To describe how we can Control microbial growth in the environment through physical and chemical methods, and in the body through antimicrobial drugs.

4 - To characterize and classify prokaryotes

5 - To characterize and classify eukaryotes

6 - To characterize and classify viruses, viroids and prions

7 - To describe mechanisms of Infection, characteristics of infectious diseases and the principles of epidemiology.

8- Collaborative lesson on sepsis

9- To revise mechanisms of pathogenesis of infectious diseases. Question time.

MEDICAL MICROBIOLOGY

Learning objectives At the end of these lectures and activities, students should be able to

• Describe Gram positive bacteria and associated diseases; describe pathogenic mechanisms and the resulting pathology at the cellular, tissue, and organism levels; and the clinical manifestations

• Compare mechanisms characteristic of infection with particular categories of bacteria.

• Describe Gram negative bacteria and associated diseases; describe pathogenic mechanisms and the resulting pathology at the cellular, tissue, and organism levels; and the clinical manifestations

Lessons

1 - Pathogenic Gram-positive bacteria

2 - Pathogenic Gram-positive bacteria

3 - Pathogenic Gram-positive bacteria

4 - Pathogenic Gram-negative cocci

5 - Pathogenic Gram-negative bacilli

6 - Pathogenic Gram-negative bacilli

7- Collaborative lesson on pyogenic lesions

8- Collaborative lesson on chronic inflammation, granuloma

9- Small group work: Focus on TB, Neisseria, tetanus, E. coli

MEDICAL GENETICS

Learning objectives At the end of these lectures and activities, students should be able to

• Describe apparently unexplained phenomena now enclosed in the term Epigenetics Describe the Waddington epigenetic landscape Learn the difference between epigenetic and genetic modification Describe the enzymatic pathways responsible for DNA methylation Describe different functions of DNA methylation

• Describe the developmental process from the DNA methylation point of view Describe how genomic imprinting works Learn the most common genetic diseases associated with genomic imprinting problems Understand the different mechanisms leading to UPD

• Describe the enzymatic pathways responsible for histone modifications Understand the concept of "Histone code" Learn the most common genetic diseases associated with aberrant pattern of histone modifications

• Describe the organization of the nucleus, in terms of pores, lamina, and internal structures/granules Describe chromosome territories and TADs Learn the most common genetic diseases associated with a disorganization of the nucleus structure

• Describe the most common classes of Regulatory RNAs Learn the basic modes of sex determination Describe the molecular mechanisms leading to X inactivation

• Describe how environmental factors can influence the epigenome

• Describe the basic molecular mechanism leading to cancer Describe the genetic landscape of cancers

• Describe the most common inherited cancer syndromes and their molecular mechanisms

• Learn the basic steps that are taken during a genetic counselling for cancer predisposition Being able to distinguish differences between FISH, NGS, dPCR (etc) Learn the concept of liquid biopsy

• Describe the biogenesis of microRNA describe the 4 main mechanisms leading to miRNA-based genetic disorders

• Acquire confidence with online tools for medical doctor and researchers in the field of molecular genetics

• Being able to get information on genes, mutations, and associated diseases starting from an anonymous sequence of DNA

Lessons

Epigenetics

Cancer genetics

MiRNA-mediated pathogenic mechanisms PPP portfolio: Abnormalities of Mood

Teaching Methods

Lectures: the main purpose of lectures is to transfer knowledge to students by guiding them through the most relevant subjects of the disciplines. Collaborative lessons with teachers of the course and recap lessons will be done in order to increase the integration of the different modules. All lectures will be held synchronously, either in presence or using Teams.

Group work activities/activation of knowledge: the purpose of these activities is to activate and solidify knowledge acquired during lectures and independent study, in a collaborative learning setting. For these activities, students will be divided in groups that will remain the same through the semester. Participation is mandatory. Student that cannot be on Campus for reasons related to the pandemics will participate in teams.

Problem based learning (PBL) during each semester a PBL will be presented and discussed with students

Verification of learning

Students' evaluation will be assessed through multiple choice examinations at the end of the year. The faculty reserves the possibility to have also an intermediate test (optional) at the end of the first semester and an oral exam.

Texts

Robbins and Cotran
Pathologic Basis of Diseases
9th edition, 2009; Elsevier

Cellular and molecular immunology
8th edition, 2011; Elsevier

Bauman RW
Microbiology with Diseases by Taxonomy
4th edition, Pearson