FISIOLOGIA I - channel 2

13 CFU - 1° and 2° Semester

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LEARNING OBJECTIVES

- **Physiology and Biophysics**
  Knowledge of the biophysical laws involved in body function regulation

  Knowledge of the basic neurophysiology, particularly related to the mechanisms underlying cell excitability

  Knowledge of the theoretical basis aimed at understanding the translation of such laws to clinical practice

DETAILED COURSE CONTENT

- **Physiology and Biophysics**

Detailed Program

THE CELL AS AN INTEGRATED SYSTEM
Dynamic balance, cell functions, the cell as a thermodynamic system, energy and entropy, the cell as a chemical system.
Gas and solute exchanges through cell membranes (Fick's law, passive diffusion, facilitated diffusion, controlled diffusion, primary and secondary active transport).
Homeostasis, steady state, regulation of cellular functions.

GAS LAWS AND THEIR APPLICATIONS
Ideal gas law, Boyle's law, Charles and Gay-Lussac's law, second law of Gay-Lussac, Avogadro's law, Dalton's law, Graham's Law, Henry's Law, Laplace's law. Applications in physiology and diseases.

FLUID COMPARTEMENTS AND HOMEOSTASIS
Human body fluid compartments: intracellular and extracellular compartments, compartments volumes and methods for their measurements. Sources and removal of body fluids. Water and salts balance.
Exchanges of water and electrolytes through biological membranes. Concentration and electrochemical gradients. Saline, isotonic and iso-osmotic solutions, and their use. Osmotic pressure: definition, units of measurements, plasma values. Van't Hoff's law, Gibbs-Donnan equilibrium. Hydrostatic pressure. Colloid osmotic and oncotic pressure: plasmas value and fluctuations. Consequences of oncotic pressure modifications. Starling's law and capillary exchanges. Edema.

PRINCIPLES OF HEMODYNAMICS AND HEMORHEOLOGY
Systemic circulation: generalities. Blood volume and velocity in different areas of the vascular system. Morphological and physiological characteristics of vessels: arteries, capillaries and veins.
Blood flow: physical factors affecting blood flow. Bernoulli's principle. Pressure, flow and resistance: Hagen-Poiseuille Law. Blood viscosity: relationship between viscosity and hematocrit. Turbulent blood flow. Laplace's law applied to vessels.
Vascular tone: nervous, hormonal and humoral control.

ION CHANNELS AND MEMBRANE POTENTIAL
Cell excitability: cell membrane polarization (ion distribution across the membrane and its genesis, polarization measurement, conductance).
Ion channels: voltage-gated ion channels for sodium, potassium, calcium, chloride (characteristics, functions, main agonist and antagonists), patch clamp, canalopathies.
Electric potentials: membrane potential, electrochemical potential, Nernst equation, Goldman equation. Genesis and characteristics of an action potential. All-or-none law. Refractory period. Membrane repolarization. Graded potentials.
Excitability conduction along cell membranes. Propagation velocity. Saltatory or continuous conduction, myelin sheath.

SYNAPTIC TRANSMISSION
Excitable cells communication. Electric and chemical synapses. Synaptic types. Neurotransmitters and neuropeptides: synthesis, transport, release and secretion, neurotransmitter release cycle, vesicle cycle (trafficking). Neuromuscular junction. Endplate potential, miniature potential, quantal neurotransmitter release.
Synaptic integration and transmission in CNS (EPSP, IPSP, spatial and temporal summation).
Ionotropic and metabotropic receptors.
Synaptic plasticity, Hebbian theory, long-term and short-term plasticity (long-term potentiation e long-term depression).

NEUROTRANSMITTERS AND RECEPTORS
- Acetylcholine, nicotinic receptors, muscarinic receptors, cholinergic synapses, main agonists and antagonists, notes on related diseases (Miastenia gravis).
- Glutamate glutamine cycle, NMDA, AMPA and Kainate receptors, metabotropic receptors, involvement in synaptic plasticity (LTP), main agonists and antagonists, glutamate excitotoxicity, notes on related diseases (Alzheimer's disease, glutamate hypothesis of schizophrenia).
- GABA, Ionotropic and metabotropic receptors, , Notes on benzodiazepine, barbiturate and alcohol mechanism of action..
- Catecholamine and their receptors, Role in SNA, Notes on stress and catecholamine
- Dopamine and its receptors, Notes on related diseases (addiction, Parkinson's disease Schizophrenia)
- Serotonin and its receptors, Drugs acting on serotonin receptors
- Endocannabinoids and opioids, notes on drug abuse (cocaine, amphetamine, heroine, hallucinogens, etc.)
- Nitric oxide pathway and retrograde transmission

MUSCLE CONTRACTION
- Skeletal muscles: structure, myofibrils, sarcomere and mechanisms of contraction, Sliding filament theory of muscle contraction, Neuromuscular junction, Excitation-Contraction Coupling, single muscle twitch and tetanus, isometric and isotonic contraction, length-tension curve, force-velocity curve, muscle energetics, oxygen consumption, muscle work, performance, and fatigue. Muscle fibers. Skeletal muscle innervation. Electromyogram.
- Smooth muscle: generalities, unitary and multiunit muscles, sctructure, contraction mechanisms, contraction regulation (arteriolar tone), biomechanics.
- Cardiac muscle: generalities, structure, contraction mechanisms, contraction regulation, biomechanics.

NERVOUS SYSTEM: GENERALITIES
- Neuron: morphologic, functional, biochemical and trophic unit of the nervous system
- Glia: macroglia and microglia. Myelin synthesis at central and peripheric level.

TEXTBOOK INFORMATION

- **Physiology and Biophysics**
  Testi consigliati: Fiorenzo Conti – Fisiologia Medica, Edi-Ermes