UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Fisiologia Umana 1 C

2627-2-H4103D007-H4103D00703

Aims

The **Cardiac and Cardiovascular Physiology** module aims to provide students with fundamental knowledge of the cellular, organ-level and systemic mechanisms regulating heart function and the cardiovascular system. The module starts from the cellular physiology of the cardiomyocyte, with particular attention to electrical excitability, cardiac automaticity and excitation-contraction coupling, and then progresses to the understanding of the mechanical function of the heart as a pump. By the end of the module, students are expected to understand the main intrinsic and extrinsic mechanisms regulating cardiac activity, the cardiac cycle, cardiac output, cardiac work and energetics, as well as the biophysical principles governing blood flow in the different vascular districts. Students are also expected to understand the functional integration of heart, vessels and blood in the maintenance of arterial pressure, tissue perfusion and cardiovascular homeostasis.

Contents

The module covers cardiomyocyte physiology, the structural and functional characteristics of the myocardium, cardiac automaticity, generation and propagation of cardiac electrical activity and excitation-contraction coupling. Neural control of cardiac activity, regulation of heart rate, cardiac pump mechanics, the cardiac cycle, cardiac output, the Frank-Starling law, measurement of cardiac output and the Fick principle will be discussed.

The module also includes the study of the cardiovascular system, with reference to blood rheology, the biophysical principles of circulation, the mechanical properties of blood vessels, arterial pressure and its regulation. The systemic and pulmonary circulations, the venous system and the main regional circulations, including coronary, splanchnic, pulmonary and renal circulation, will also be analysed.

Detailed program

The module introduces the cellular physiology of the cardiomyocyte, with reference to the electrical and mechanical properties of cardiac cells. The characteristics of contractile cardiomyocytes and cells of the cardiac conduction system will be described, together with the main ion channels involved in the generation of the cardiac action potential and the ionic basis of myocardial excitability. The action potential of contractile myocardial cells and pacemaker cells, cardiac automaticity and the mechanisms regulating heart rate will be analysed.

Part of the module will focus on rhythmic excitation and excitation-contraction coupling in the myocardium. The role of intracellular calcium, calcium release from the sarcoplasmic reticulum, actin-myosin interaction and the mechanisms that translate the electrical signal into contractile activity will be discussed. The functional specificities of cardiac muscle compared with skeletal and smooth muscle will also be highlighted.

The module will then address the structural and functional characteristics of the myocardium and the organization of the heart as an organ. The cardiac conduction system, propagation of the electrical impulse, coordination of atrial and ventricular activity and neural control of cardiac function by the autonomic nervous system will be described. The intrinsic and extrinsic mechanisms regulating cardiac function will be analysed, including the effects of the sympathetic and parasympathetic nervous systems on heart rate, conduction, contractility and relaxation.

Cardiac pump mechanics will then be discussed. The cardiac cycle, the phases of systole and diastole, pressure and volume changes within the cardiac chambers, valve function and the origin of heart sounds will be described. Cardiac work, cardiac energetics and the relationship between mechanical activity, oxygen consumption and myocardial metabolism will also be addressed.

A specific section will focus on cardiac output and its regulation. Stroke volume and cardiac output will be defined, and the main determinants of pump function, including preload, afterload, contractility and heart rate, will be analysed. The autoregulation of cardiac output according to the Frank-Starling law will be discussed in detail. The main methods for measuring cardiac output and the relationship between oxygen consumption and cardiac output according to the Fick principle will also be described.

The second part of the module will focus on the cardiovascular system. The properties of blood and blood rheology will be introduced, with reference to the factors influencing viscosity and blood flow. The main biophysical principles of circulation will be discussed, including Bernoulli’s principle, Poiseuille’s law and Laplace’s law, applied to the relationship among pressure, flow, resistance, vessel radius and wall tension.

The mechanical properties of the different vascular segments will then be analysed: arteries, arterioles, capillaries and veins. The concepts of vascular distensibility and compliance will be described, together with the function of elastic arteries, the role of arterioles in regulating peripheral resistance, capillary exchange and the function of the venous system as a volume reservoir. Blood velocity in the different vascular districts and the distribution of blood flow in the systemic circulation will also be discussed.

Finally, the module will address arterial pressure and the mechanisms involved in its regulation. The main determinants of arterial pressure, the role of cardiac output and peripheral resistance, and short- and long-term regulatory mechanisms will be analysed. The functional characteristics of the systemic and pulmonary circulations, the venous system and the main regional circulations will also be described, with particular reference to coronary, splanchnic, pulmonary and renal circulation.

Prerequisites

The prerequisite requirements to be fulfilled in order to sit the Human Physiology exam are those indicated in the Teaching Regulations of the Medicine and Surgery degree programme for the 2026/2027 academic year.

Teaching form

All lessons of 2 hours each will be in person, except in emergencies. They will begin with an initial part where concepts will be presented (lecture-based mode), followed by interaction with students that defines the subsequent part of the lesson in interactive mode.
Teaching methods will include lectures, videos, and class discussions.
Teaching activities may include, up to a maximum of 30% of the total lecture hours, the use of innovative teaching methods, including delivery under the supervision of the lecturer, co-teaching arrangements and/or remote teaching, in accordance with Ministerial Decree No. 1835 of 6 December 2024.

Textbook and teaching resource

CONTI, Fisiologia Medica, EDIERMES

GUYTON & J.E. HALL, Fisiologia medica, Piccin

GRASSI, NEGRINI, PORRO Fisiologia Medica, POLETTO EDITORE

Semester

Second year, First Semester

Assessment method

For the assessment method, please refer to the general course syllabus.

Office hours

The professors receive by appointment upon agreement by e-mail
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ilaria.rivolta@unimib.it

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | GENDER EQUALITY | REDUCED INEQUALITIES