Universitat Autònoma de Barcelona

2021/2022

Structure and Function of the Nervous System

Code: 102634
ECTS Credits: 6

Degree	Type	Year	Semester
2502445 Veterinary Medicine	FB	1	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Vicente Aige Gil
Marc Navarro Beltrán
Martí Pumarola Batlle
Teresa Giménez Candela
Marta Tafalla González

Prerequisites

It is highly recommended to have adequate knowledge of mathematics, physics and chemistry.

It is essential to have completed the first semester of the degree and have acquired the knowledge of Cell Biology and Biochemistry.

It is important to attend simultaneous subjects such as Morphology I and Ethology, and Protection and Animal Management. Some of the contents of these subjects are complementary to those of the structure Structure and Function of the Nervous System.

Objectives and Contextualisation

The Structure and Function of the Nervous System is a subject of the first year and, therefore, it is part of the basic initial subjects of the studies of the Veterinary Degree. The subject is integrated, which will explain at the same time concepts that were classically explained in the subjects of anatomy, histology or physiology. In addition, concepts related to bioethics will be explained within this subject.

The objective of the subject is that the student knows the structure and function of the nervous system. The specific objectives are that the student knows:

1- The macroscopic structure of the nervous system.

2- The great principles responsible for the correct functioning of the individual.

3- The structure and function of excitable tissues and cellular communication.

4- The structure and function of the receptors and the organs of the senses.

5- The autonomic nervous system.

6- The mechanisms and structures responsible for the control of posture and movement.

7- Fundamental elements of bioethics.

The subject must be able to establish the bases for, later, understand the possible alterations of the nervous system that the clinical veterinarian finds in his professional activity. It should also be the basis for understanding concepts that will be explained later, such as those related to the diagnosis for the image, with pharmacology, etc.

Competences

- Apply scientific method to professional practice, including medicine
- Demonstrate knowledge and understanding of the physical, chemical and molecular bases of the main processes in the animal organism.
- Demonstrate knowledge and understanding of the structure and functions of healthy animals.
- Demonstrate knowledge of the rights and duties of the veterinarian, with a special focus on ethical principles
- Recognise ethical obligations in the exercise of responsibilities in terms of the profession and society.
- Recognise when euthanasia is necessary and perform it humanely by employing the appropriate method.

Learning Outcomes

1. Apply scientific method to professional practice, including medicine
2. Describe the bioethical principles applied to the scientific method and to veterinary activity.
3. Distinguish the macroscopic and microscopic structure of the nervous system and the sensory organs.
4. Explain the basic concepts of the mechanisms of functional regulation in each system.
5. Explain the interrelation between the different organs and systems, and their hierarchical organisation.
6. Explain the main physical, chemical and molecular bases that ensure the correct functioning of the organism.
7. Foresee the qualitative and quantitative repercussions of disorder in a particular mechanism for the organism as a whole.
8. Globally analyse and describe the role and situation of veterinary science in relation to bioethics.
9. Identify the variables that enable evaluation of the functions of each system.
10. Make prudent clinical decisions based on moral deliberation of properly defended facts and values.
11. Recognise personal limitations and know when to ask for professional advice and help.
12. Recognise the magnitude and time dimension of the physiological changes that take place in the adaptation of an animal to its surroundings.
13. Recognise the mechanisms through which the environment induces changes in animals functions.
14. Recognise the social, ethical and legal conditioners of research into biomedicine and in the context of globalisation.
15. Use correct and suitable physiological terminology.
16. Use physiological concepts to solve problems related with clinical and experimental situations or related with the productive field.

Content

Theory classes (41h)

Presentation of the subject: integration and excitable tissues. What do we know and from when? (History of neurobiology). The nervous tissue in the s. XXI. (M. Pumarola)

INTRODUCTION TO PHYSIOLOGY (0.5 ECTS).

Responsible M. Jiménez

Concept of internal milieu. Homeostasis. Extracellular and intracellular fluids. Negative and positive feedback. Nervous and endocrine control. Reflex. Neuroendocrine control. Concept of Hormone, neurotransmitter and neurohormone. Paracrine and autocrine communication.

Membrane Physiology (I). Mechanism of diffusion. lipid wall and ion channels. Passive transport. Primary active transport and secondary active transport. Co-transport and counter-transport. Mechanisms of control of the intracellular calcium.

Membrane Physiology (II). Osmosis and tonicity. Mechanisms of exocytosis and endocytosis. Epithelial. Polarity of the cell membrane. Absorption and secretion. Exocrine and endocrine glands.

Intercellular communication. Intracellular receptors. Membrane receptors. Ionotropic and metabotropic. Ionic channels. G Protein coupled receptors (GPCR). Second messengers. Interactions

Function of excitable tissues (1.3 ECTS).

Responsible M. Jiménez

Membrane potential. Recording. Ionic basis. Leak channels. Nernst potential. Goldman's equation.

Action potential (I). Recording. Phases of action potential. Ionic basis. Voltage dependent sodium channels. Concept of inactivation. Potassium dependent voltage channels. Absolute and relative refractory period.

Action potential (II). Law of all or nothing. Rheobase and chronaxie. Electrical Biphasic recordings. Propagation of the action potential. Saltatory conduction. Conduction of a nerve impulse: types of fibres in relation to the diameter. Electrotonic potentials. Characteristics. Differences between the electrotonic potentialsand action potentials.

Synapse (I). Pre-synaptic calcium channels. Release of neurotransmitters. Excitatory and Inhibitory postsynaptic potentials. Relationship with ionotropic (fast) and metabotropic receptors (slow). Synaptic integration: neural networks. Types of neural communication. Convergence and divergence. Presynaptic and postsynaptic inhibition. Genesis of the action potential in a motorneuron. Concept of inhibitory interneuron.

Synapse (II) Neurochemistry and receptors. Types of neurotransmitters. Synthesis and degradation of neurotransmitters. Receptors: types and mechanisms of action. Examples: Acetylcholine, catecholamines, amino acids, polypeptides, gaseous and purinergic neurotransmitters.

Skeletal muscle. Motor end plate. Mechanism of excitation contraction coupling. Isotonic and isometric contraction. Relation voltage-length. Summation of stimuli. Tetanic contraction. Concept of motor unit. Electromyography. Neuromuscular diseases.

Cardiac muscle. Action potential of the cardiac muscle. Phases and ionic basis. Contraction of the heart. Concept of syncytium. Pacemaker potential. Conduction of cardiac action potential. Relationship between pacemaker cells and muscle cells. Regulation of the contraction by the autonomic nervous system. Starling law.

Smooth muscle. Muscle contraction. Muscle tone. Phasic contractions. Pacemaker cells in smooth muscle. Innervation of the smooth muscle. Concept of co-transmission. Inhibitory and excitatory inhibitory junction potential. Visceral and multiunit smooth muscle.

Structure Nervous System (1.2 ECTS).

MACROSCOPIC STRUCTURE

Responsible V. Aige.

Components of the nervous system (central and peripheral). The spinal cord and the meninges (development, structure, function and vascularization). Spinal nerves (somatic and visceral components).

Encephalon I: Brain development. The brain (structure and function).

Encephalon II: The cerebellum (structure and function) and the brain stem (structure and function). The ventricular system. Meninges. Vascularization of the brain.

Cranial nerves I: Components of the cranial nerves. Olfactory nerves, optic nerve, oculomotor nerve, trochlear nerve, trigeminal nerve.

Cranial nerve II: facial nerve, vestibulocochlear nerve, glossopharyngeal nerve, vagus nerve, accessory nerve, hypoglossal nerve.

MICROSCOPIC STRUCTURE

Responsible M.Pumarola

Nervous tissue (I): Embryological origin. The neuron: structure. Types of neurons. The organelles. Dendrites and axons. Axonal transport The myelin sheath. The synapses

Nervous tissue (II): Glia cells. Macroglia: astrocyte, oligodendrocyte, polydendrocytes. The fixed glia: ependymocytes and choroidal plexuses. The microglia. Glia al SNP: satellite cells and Schwann cells.

Nervous tissue (III): Meninges. The cerebrospinal fluid. The barriers of the nervous tissue. Microscopic anatomy of the brain, cerebellum, spinal cord, root ganglia and peripheral nerves. The Autonomous Nervous System.

Growth and plasticity of the nervous tissue: Growth, survival and differentiation of neurons. Neural dying and plasticity. Axonal growth and regeneration of axons. Demyelination and remyelination. Neurogenesis in adults.

RECEPTORS AND SENSORY ORGANS (1 ECTS).

Responsible M. Pumarola, M. Jiménez and M. Navarro

Receptors. Type of receptors. Activation of a receptor based on the type of stimulus. Genesis of the receptor potential. Characteristics of the action potential in the afferent pathway: Tonic and phasic receptors, intensity of the stimulus. Types of afferent neurons. Nerve pathways. Proprioception. Cortical representation.

Smell: Receptors involved. Mechanism of transduction. Afferent pathways.Detectionof pheromones. Taste: taste buds. Types of flavours. Mechanisms of transduction. Nerve pathways.

Eye: Anatomy: The eye and its annexes. Development. Parts of the eyeball. The periorbita. Intrinsic and extrinsic muscles of the eye. Vascularization. Optic pathways.

Eye: Structure of the eye and retina. Cell types and distribution of receptors. Fovea.

Vision: Basic optic laws. Photoreception mechanism. Distribution of receptors at the retinal level. Chromatic vision. Formation of the image in the retina. Functions of iris and lens. Accommodation. Cortical representation. Pupillary reflex

Ear: Development. Parts of the ear. Hearing pathways. Vestibular apparatus

Hearing: Characteristics of the sound. Functions of the external, mid and inner ear. Physiology of the ciliated cells. Discrimination of frequency and intensity. Cortical representation. Audiometry in different species. Vestibular apparatus

Pain: Pathways. Nociception. Types of nociceptors: ion channels. Afferent pathways. Chronic pain vs acute pain. Somatic pain and visceral pain. Endogenous opioids. Perception of pain: Concept of allodynia, hyperalgesia and analgesia.

Autonomic nervous system. (0.3 ECTS)

Responsible M. Jiménez and V. Aigé

Anatomy of the Autonomous Nervous System. General concepts. Central pathways. Sympathetic division (Horner's syndrome). Parasympathetic division: cranial parasympathetic (oculomotor, facial, glossopharyngeal and vagus nerves) and sacral parasympathetic (neurological control of micturition).

Sympathetic and parasympathetic system. Neurotransmitters and receptors involved. Functions of the autonomic nervous system. Afferent pathways. Enteric nervous system.

Control of posture and movement (0.7 ECTs)

Responsible M.Jiménez and V. Aigé

Organization of the movement. Reflexmovement, stereotyped and voluntary. Intrafusal fibres and Golgi tendon organ. Structure of the intrafusal fibres. Afferent and efferent pathways. Reflex monosynaptic and polysynaptic. Myotatic reflex and withdraw reflex. Concept of central pattern generator.

Cortical and subcortical control of motor activity. Cortical representation. Functions of the brain and the brainstem. Vestibular apparatus. Basal Ganglia: Parkinson's Disease. Alterations of dopaminergic neurotransmission. Pro and antipsychotic drugs.

Neuroanatomy I: Proprioceptive pathways. Vestibular system.

Neuroanatomy II: Upper motor neuron and lower motor neuron.

BIOETHICS. (1 ECTs)

Responsible M. Pumarola.

Concept of Ethics and Bioethics. Models of philosophical foundations in Bioethics Principles of bioethics applied to the scientific method and the development of veterinary activity. Legal implications.

Ethics and animals. Use of animals. From domestication to exploitation and exhibition of animals. Animal abuse

Considerations on Animal Right for Veterinarians. The animal in Spanish and European Law; prospects for the future

The use of animals for teaching and research.

PRACTICE PROGRAM (12h: 11h practical sessions + 1h seminar)

Laboratory practices (11h):

Practical session of action potential: simulation program. Chronaxie, Rheobase. Refractory Periods. Threshold of excitability. 2h practice. Computer room

Dissection of the brain. Practical session of 2 h. Dissection room

Histology of the nervous system: Practical session of 2h. Microscopy room / Computer room.

Microscopic study of receptors related to taste and smell (1h Microscopy room / Computer Room)

Dissection of the eyeball. (1h in dissection room)

Microscopic study of the eye and the inner ear (auditory system). (2 h Microscopy room / computer room).

Integration. Practical session: Structure and function of a reflex in a dog. (1h practice in small groups)

Seminars (1h):

8. Seminar on Discussion of Bioethics. The maintenance of health and the end of life. Ethical and legal aspects of palliative care. Euthanasia: historical, sociological, ethical and legal aspects

CASES. The cases will be done by groups of 3- 4 people

Case 1. Body volumes

Case 2. Electrophysiology and study of the motor end plate (Simulation program)

Case 3. Magnetic resonance imaging.

Case 4. The Circumventricular organs: structure and function

Case 5. Autonomic nervous system: pharmacological applications

Case 6. Reflex. This case will be done shortly after practice 7 (mentoring)

Case 7. Bioethics. Euthanasia. Mistreatment. Professional performance

Tutorials: (Help the student)

1h. Tutorial of the case 6. To realize after the practice 6

1h. Discussion of cases of motor alterations based on videos (1h)

Methodology

The taching methodology will involve classes of theory that we will try to make with as many participants as possible. We will also do practical sessions in groups in the dissection room, microscopy room, computer room and laboratory. For the cases, the students will have to work in groups of 4 people. The cases will be delivered, corrected and rended back to the students. For each case, a tutorial session will be scheduled in the classroom to discuss, as appropriate, the errors committed. We will also conduct a discussion seminar on Bioethics.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Computer practices	2	0.08	6
Dissection	3	0.12	3
Laboratory practices	1	0.04	1, 16
Master classes	41	1.64	8, 1, 2, 3, 4, 5, 6, 9, 10, 7, 14, 13, 12, 11, 16, 15
Microscopy practices	5	0.2	1, 3

Seminars	1	0.04	8, 1, 2, 10, 14, 11
Type: Supervised			
Tutoring	2	0.08	
Type: Autonomous			
Case resolution	30	1.2	8, 1, 2, 3, 6, 9, 10, 14, 11, 16, 15
Study	62	2.48	8, 2, 3, 4, 5, 6, 9, 10, 7, 14, 13, 12, 16, 15

Assessment

The final mark is calculated based on two exams (80% of the mark) and the qualification of the cases (20% of the mark).

Important: In order to pass the subject, students must have an average of 5 on both exams

The exams will be of type test, with macroscopic and microscopic images, graphs, tables etc. The interpretation of the student will be evaluated.

Exam 1.

First exam: 40% of the final qualification. Content evaluated:

- Structure of the nervous system (1 ECTS)

- Physiological concepts (0.5 ECTS)

- Structure and function of excitable tissues (1.5 ECTs).

Includes theory + practices + cases worked.

Minimum grade 4/10

Exam 2

Second exam: 40% of the final qualification. Content evaluated:

- Receptors and organs of the senses (1 ECTS).

- Autonomic nervous system. (0.5 ECTS)

- Control of posture and movement (0.5 ECTS)

Includes theory + practicals + cases worked.

Minimum grade 4/10

The student who does not reach the minimum mark in one of the exams must present to the recovery exam where they will be evaluate for whole subject.

A student will be considered presented if he attends an exam.

Recovery test.

To pass the course, students must have a qualification of 5 in the exam. The final qualification will be 80% exam qualification + 20% qualification of the cases.

The review will be done in tutorials, in special sessions after exams.

The particular cases will be studied pertinently.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Case evaluation	20% of the final qualification	0	0	8, 1, 2, 3, 4, 5, 6, 9, 10, 7, 14, 13, 12, 11, 16, 15
Exam 1	40% of the final qualification	1.5	0.06	1, 3, 4, 5, 6, 9, 7, 13, 12, 16, 15
Exam 2	40% of the final qualification	1.5	0.06	8, 1, 2, 3, 4, 5, 6, 9, 10, 7, 14, 13, 12, 16, 15

Bibliography

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Bioethics:

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Software

To perform a practical work about action potential a program called potaccio is used. This program is installed in the computers of the informatic teaching rooms.