

28409 - Micro-biology and Immunology

Syllabus Information

Academic Year: 2019/20

Subject: 28409 - Micro-biology and Immunology

Faculty / School: 105 - Facultad de Veterinaria

Degree: 451 - Degree in Veterinary Science

ECTS: 9.0

Year: 2

Semester: Annual

Subject Type: Compulsory

Module: ---

1.General information

1.1.Aims of the course

The Degree in Veterinary Medicine aims to train professionals in Veterinary Medicine (diagnosis, prognosis, treatment and prevention of diseases affecting domestic animals), Animal Production and Health (breeding and health of production animals, marketing of animal products for human consumption) and Hygiene, Safety and Food Technology (control of the food production chain, advice to food companies). The **general objective** of the subject of Microbiology and Immunology is to ensure that students acquire training in basic Microbiology and Immunology, which is necessary for understanding the other specific subjects of the Degree. The aims of this course are to:

- Distinguish the types of microorganisms involved in the processes referred to in the matter. Students should be able to distinguish bacteria viruses, fungi, as well as infectious proteins (prions); and within each category, their main types/strains (e.g., Gram-positive and Gram-negative bacteria).
- Know the elementary characteristics of each type of microorganism. Students must know the structure, elemental composition, metabolism, physiology, genetics, ecology, pathogenic power or virulence and way of life of each microorganism.
- Develop knowledge about Microbiology in its branches of Bacteriology, Virology and Mycology, both at a general and special level, with a marked interest in the pathology of domestic animals and its subsequent application to diagnostic techniques in infectious diseases as well as Food Microbiology and Environmental Microbiology.
- Understand and apply the basic safety rules for working with microorganisms. Students should be aware of the risks, precautions and measures to be taken when working with microorganisms, both in the laboratory and outside it (farms, industrial facilities, sampling, etc.).
- Perform basic manipulations of microorganisms in the laboratory, including fundamental tests of identification, culture and isolation. Students in the laboratory should be able to operate the optical microscope freely, perform staining, in vitro cultures, etc.
- Know the implications and consequences of the presence or absence of a microorganism in the environment or in the process in question. Students should be able to distinguish the effects produced by microorganisms: disease, degradation of substances, synthesis of substances (antibiotics, metabolites of interest), metabolic processes, etc.
- Assess the possibilities of preserving or altering the different populations of microorganisms in a system, depending on their effects. The aim is for students to know the possibilities of acting in favour (nutrients, cofactors, etc.) or against micro-organisms (antibiotics, antifungals, antivirals, physical and chemical means, etc.) and to be able to decide between alternatives.
- Acquisition of basic concepts, both theoretical and practical, that allow the student to know the components, mechanisms and fundamentals of the immune system of living beings, as well as the alterations coming from a disorder of this system.
- Know how to use the information sources of Microbiology and Immunology and critically judge the information they contain. Students should be able to look for information and value it, knowing the credibility of the sources as well as the authors.

1.2.Context and importance of this course in the degree

The subject is closely linked to the subjects: General and Propaedeutic Pathology I and II, General Pathology, Integration in ruminants, Integration in birds and rabbits, Integration in companion animals, Integration in aquatic and exotic animals,

Integration in equids, Integration in pigs, and Zoonoses, Preventive Medicine and Health Policy of the Clinical Sciences and Animal Health Module; with the subjects of Food Technology and Hygiene, Food Inspection and Control of the Hygiene, Technology and Food Safety Module and with the optional subjects of Ecology and Environment, Wildlife and Beekeeping Production and Health. It is also closely linked to basic subjects such as Biology and Biochemistry, Genetics, Cytology and Histology and Physiology.

1.3.Recommendations to take this course

This subject, of common basic training, is of a fundamental and transversal nature for other degrees and degrees that will give access to a large number of university master's degrees related to Animal Health, Human Health, Food Safety, Industrial Processes related to micro-organisms and the Environment.

Microbiology, as well as its different branches (Bacteriology, Virology, Mycology and Prions), both at a general and special level, is important in the fields of Animal and Human Health. It is basic to the process of diagnosis of infectious diseases of domestic animals, for the mechanisms of alteration of food, food processing processes and environmental contamination. It also has a direct relationship with Human Health, in terms of the existence of communicable diseases (zoonoses), toxoinfections and food poisoning.

Immunology is a broad branch of biology and biomedical sciences, with applications in numerous scientific disciplines.

Microbiological diagnosis encompasses all procedures and complementary techniques used to establish the aetiology responsible for an infectious disease, food poisoning or environmental contamination.

Due to the high theoretical load of this subject, a constant effort on the part of the student is recommended, participating actively in both theoretical and practical classes.

2.Learning goals

2.1.Competences

On successful completion of this course, students will be able to:

1. Isolate and identify the microorganisms associated with the different pathological processes that affect animals as well as those that intervene in the deterioration of food and those related to the environment.
2. Know and interpret the fundamentals of microbiological and immunological diagnostic methods.
3. Organizational capacity, autonomous work planning and information management.
4. Critical reasoning capacity (analysis, synthesis and evaluation).
5. Ability to apply theoretical knowledge to situation analysis, problem solving and decision making in real contexts.
6. Ability to communicate correctly and effectively, orally and in writing.

2.2.Learning goals

If students complete the course successfully, they should be able to

1. Know, from the basic point of view, the microorganisms under study in the different branches of Microbiology, both those that affect Animal and Human Health and those that have an industrial, food, biotechnological or ecological application.
2. It adequately defines and uses the scientific terminology used in Microbiology.
3. Differentiate microbial diversity from the systematic, physiological and ecological points of view.
4. Define mechanisms used by microorganisms in their metabolism to develop their activities.
5. Interpret what mechanisms exchange genetic information between them and what this exchange of information brings to them.
6. Know the characteristics of microbial growth and the alternatives for its control.
7. Know the importance of the mechanisms of pathogenicity, virulence factors that microorganisms possess, since they are agents that produce diseases in animals and humans.
8. Differentiate and assessing the most common sterilisation and hygienisation techniques.
9. Acquire basic knowledge of the fundamentals of the immune system of living beings.
10. Know the basic components of the Immune System.
11. Know the mechanisms involved in immune responses, as well as the alterations resulting from a disorder of that system.
12. Know the immune responses that develop specifically against different microorganisms.
13. Know the specific surveillance systems of the immune system, such as antitumor, aging, transplant rejection.
14. Plan microbiological analyses and immunological diagnostic techniques, propose methods to be used, acquire the ability to carry them out and interpret the results.
15. Work as a team, synthesize available information on a subject, present and substantiate his opinion on the subject and present it publicly and orally.

2.3.Importance of learning goals

The Livestock, Agriculture, Fishing and Food sectors represent a very important part of the economy of a country, and offer employment to university graduates in the veterinary field. For this type of professionals, knowledge of Microbiology and Immunology is essential, given the importance of microbial processes in the health of animals, plants, fish and human food (Public Health).

On the other hand, the strengthening of generic or transversal competences of an instrumental, interpersonal and systemic type will contribute, together with the rest of the subjects, to the integral formation of future Veterinary Graduates.

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

EVALUATION ACTIVITIES

The proposed activities will take place on the dates indicated in the examination schedule drawn up by the centre (global evaluation). Obtaining a score of 5 out of 10 in these tests will result in passing these contents.

Final written evaluation test consisting of multiple choice questions on the knowledge of General Microbiology, Immunology and Microbiological Diagnosis. Passing this test will accredit the achievement of learning outcomes 1, 2, 3, 4, 5, 6, 7, 8 and 9,10,11,12,13,14 and 15, and will be assessed following the criteria and requirement levels specified in section 7. The grade will be from 0 to 10 and this will represent 60% of the student's final grade in the subject. It will take place on the dates of examinations determined by the Centre. Guidance materials for the preparation of written tests will be available in the subject's ADD. In addition, and on a voluntary basis, part of this written test (corresponding to topics 1-27 of Microbiology and General Bacteriology; Special Bacteriology and Mycology) will be called on the dates assigned by the Centre (examination calendar).

Written test for the evaluation of laboratory practices

This test will consist of short questions and a case study. Passing this test will accredit the achievement of all the learning outcomes set out in this guide and will be assessed against the specified criteria and requirement levels. The grade will be from 0 to 10 and this grade will be 30% of the student's final grade in the subject:

For those students who have not attended any of the practical sessions, they will have to take an additional practical laboratory test coinciding with the celebration of the global test.

Group work It will consist of carrying out a work that integrates the theoretical and practical knowledge acquired during the course. The practice groups can choose between two options:

1. Carrying out a work to review the issues related to Applied Microbiology (Soil, Air, Water and Food) or with the identification of microorganisms as the basis for microbiological diagnosis, with serological diagnostic tests, etc.
2. Performing a microbiological research work in the laboratory.

Passing this test will prove the achievement of learning outcomes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,11, 12, 13, 14, 15 and 16 and will be evaluated according to the criteria and specified levels of requirement. The grade will be from 0 to 10 and this grade will represent 10% of the student's final grade in the subject. Students who submit to a single global test on the dates determined by the center for examinations may only carry out modality 1 (review work) individually (after assignment of the subject by the responsible teacher), and must present it orally immediately after of the written evidence. The groups will consist of approximately 5 students. At the beginning of the course and in the program of the subject, the elaboration guidelines and the presentation format of the work will be marked.

The work will be exhibited and defended by each group in seminar-type sessions. The authors will explain and argue the points contained in the work and should discuss and discuss them with the rest of those present (teachers and students). The time available for the presentation and defend of the topic during the seminar sessions will be 15 to 20 minutes.

Marking system:

According to the national regulation Law 1025/2003, 5th of September which lays down the European system of credits and marking system for the university degree.

0-4.9: FAIL.

5.0-6.9: PASS

7.0-8.9: GOOD (NT).

9.0-10: EXCELLENT (SB).

As the article 158 of the Statutes of the University of Zaragoza lays down, provisional grades will be displayed at least for 7 days and students will be able to review them on the date, time and place provided for that purpose.

4.Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The process of learning is based on:

The course is divided into 60 one-hour participatory lectures, 1 hour of seminars in which students prepare the subject in small groups, expose and respond to questions, and 30 hours of laboratory work.

Documentation for each topic is hosted within the Moodle 2 platform, under the name of the course. Thus, the student can access to it whenever s/he wants along the academic year. The available material consists of a comprehensive set of Power Point notes including all the basic concepts reviewed during the lecture. Student participation will be encouraged during the lecture through problem-based learning activities.

Laboratory practices (Microbiology 1-6) will be carried out in 1.5-hours sessions, duplicated in next day. Moreover, Laboratory practices (Immunology 1-5) will be carried out in 2.5-hours sessions. As for the lecture materials, supporting laboratory documentation will be host within the Moodle 2 platform.

In order to maintain permanent contact with students, both the use of electronic mail and personal tutorials are available. In addition, all available supporting material either for individual or group work (seminars) will be provided to the students.

4.2. Learning tasks

To achieve the expected results, the course program includes the following activities:

THEORETICAL AGENDA

The lectures correspond to 60 hours. They cover the following topics, classified into three parts of the subject:

A) GENERAL MICROBIOLOGY AND B) MICROBIOLOGICAL DIAGNOSTIC

General Descriptors for A and B:

Prokaryotic and eukaryotic organisms. Microscopic examination of bacteria. Chemical bacterial composition. Bacterial physiology. Bacterial nutrition. Bacterial reproduction. Bacterial genetics. Factors produced by bacteria. The control of bacterial populations. Bacterial identification. Bacterial taxonomy. Fungi.

Competences:

The aim of these two first parts of the subject is to acquaint the student with the general characteristics of bacteria, viruses and fungi within the microbial world, their taxonomic status, constitution, observation methods, management, metabolism, mechanisms for exchanging information and their influence in relation to food and animals.

Teaching-learning activities:

Lectures: 36 hours (General Microbiology) and 4 hours (Microbiological Diagnostic)

Laboratory session: 18 hours of laboratory work (microorganism management and identification)

Regarding the blocks in which the contents of the first part of the course is presented are:

A) GENERAL MICROBIOLOGY

- **BLOCK I. GENERAL MICROBIOLOGY AND MICROBIOLOGICAL TECHNIQUES AND TOOLS:** Current concept and historical evolution. Diversity of the microbial world. Microbiology in the current scientific context. Division of Microbiology. Microscopic examination of bacterial and fungal microorganisms.
- **BLOCK II. GENERAL BACTERIOLOGY.** Bacterial taxonomy. Bacterial structure and Anatomy. Chemical bacterial composition. Bacterial physiology. Bacterial nutrition. Bacterial reproduction. Bacterial genetics. Factors produced by bacteria. The control of bacterial populations. Bacterial identification. Bacterial biology. Toxinogenesis.
- **BLOCK III. SPECIAL AND TAXONOMIC BACTERIOLOGY:** Different bacterial groups. Microorganisms involved in Animal Health and Public Health.
- **BLOCK IV. GENERAL AND TAXONOMIC MYCOLOGY:** The aim of this second block is to acquaint the student with the general characteristics of fungi, its constitution, methods of observation, management, metabolism, mechanisms for exchanging information and their role in relation to the animals. Fungi that produces deep, superficial and subcutaneous mycoses. Mycotoxins and mycotoxicosis.
- **BLOCK V. SPECIAL AND TAXONOMIC VIROLOGY.** Concept and historical development. Nature and structure of viruses. Viral classification. Viral genetics. Methods of study of viruses. Replication of animal viruses. Techniques for virus cultures. Bacteriophages. General Clinic presentations of viral infections. General methods of diagnosis for virus diseases. Viral inactivation. DNA viruses and RNA viruses.
- **BLOCK VI. PRION:** Prion concept. Properties of prions. Replication. Bovine Spongiform Encephalopathy. Scrapie.

B) MICROBIOLOGICAL DIAGNOSIS (B):

- **BLOCK VIII. MICROBIOLOGICAL DIAGNOSTIC:** The experimental disease and microbiological techniques: Laboratory animals (study and use). Basic rules for the collection and transport of pathological microbiological samples. Safety in the microbiology laboratory. Methods Gram and Ziehl-Neelsen. Biochemical tests for bacterial identification. Antibiotic sensitivity test. Polymerase chain reaction. (PCR) in Microbiology. Methods of study of fungi. Virus: Observation techniques, culture, isolation and identification. Methods of study of viruses. Haemagglutination and Haemadsorption. Virus titration. General methods of diagnosis of virus diseases. Inhibitors of viral replication. Viral inactivation. Immunological tests for the diagnosis of animal diseases. Immunoreactions:

Agglutination and precipitation. Immunofluorescence reactions: fundamentals and techniques. Enzyme immunoassays. Vaccine development.

C) IMMUNOLOGY General descriptors:

Basic principles and applied of the immune response, with special emphasis on the innate and acquired mechanisms involved in the immune response against microorganisms of veterinary clinical significance, on the techniques performed for diagnosis, on immunopathology and finally, on immunoprophylaxis methods. Knowing the basics of the different biological agents of veterinary interest.

Competences:

The aim of this part of the course is that students will be able to perform basic techniques of immunological diagnosis to enable it to assess the state of general and specific immunity of an animal. Also, to be able to diagnose the most common diseases by using various general and instrumental techniques; and predict the immune status of an animal against a microorganism and its responsiveness to different kinds of immunogens.

Teaching-learning activities:

20 one-hour lectures

11 hours of laboratory work

120 hours of Autonomous work and study

- **BLOCK VIII. GENERAL IMMUNOLOGY:** History and current concept. Mechanisms of natural immunity. The inflammation. Acquired immunity. Characters of the antigenic molecule. Antigens and Major Histocompatibility Complex. Immunocompetent cells. Lymphoid organs. Antibodies. Immunoglobulins. Antibody synthesis. The complement.
- **BLOCK IX. IMMUNOPATHOLOGY:** Immune system disorders. Hypersensitivity reactions. Autoimmunity. Immunodeficiencies.
- **BLOCK XI. IMMUNE RESPONSE AGAINST MICROBIAL AND PARASITIC ANTIGENS:** bacterial, viral, fungal and parasite antigens.
- **BLOCK XII. IMMUNOLOGY NOT RELATED WITH MICROORGANISMS IMMUNITY AND OTHER LOCAL IMMUNOLOGICAL ASPECTS:** Immunity related with transplants. Tumour immunity. Local immune mechanisms.
- **BLOCK XII. EVALUATION OF THE IMMUNE RESPONSE:** Antigen-antibody interaction. Serological reactions.
- **BLOCK XIII. APPLIED IMMUNOLOGY:** Immunoprophylaxis. Serological prevention and serological diagnostic. Immunomodulation and immunosuppression. Allergies.

PRACTICAL SESSION

It has 30 hours of compulsory student attendance. They will be developed in the laboratories of the Microbiology and Immunology Unit, established groups in advance by the Secretariat of the Centre. The content of the practical sessions is as follows:

1. GENERAL MICROBIOLOGY AND B) MICROBIOLOGICAL DIAGNOSTIC

Six practice sessions will be held on two consecutive days and will last an hour and a half each day.

Session 1. Standards for working at microbiology laboratories. Common material and equipment. Equipment's Cleaning and maintenance. Distribution of laboratory areas. Equipment sterilization and preparation of culture media. The handling of the optical microscope. Simple staining.

Session 2. Sampling. Culture of aerobic and anaerobic microorganisms on solid medium and broth. Plating techniques. Gram staining. Special staining. Microscopic observation of bacteria.

Session 3. Identification of bacterial microorganisms. Biochemical and physiological identification. Conventional systems, API galleries.

Session 4 Quantitative study of bacterial populations. Bacterial colonies counting by filtration. Environmental Microbiology: air sampling (gravimetric and volumetric techniques) and surface sampling.

Session 5. Systems for assessment the antimicrobial susceptibility. Techniques: plate (Kirby-Bauer method), minimum inhibitory concentration (MIC) and minimum bactericidal concentration (CMB). Bacterial genetics (bacterial transformation).

Session 6. Identification of fungi and yeasts.

1. GROUP WORK

Session 1. Seminar on tutored projects, presented by the students. Individual work: 5 hours spent reviewing the different topics in the seminars.

C) IMMUNOLOGY

Five practical sessions (in the latter, seminars lasting 1hr develop), and will last 2h30 'will be held.

Session 1. Agglutination and precipitation techniques on serological reactions

Session 2. Immunofluorescence technique on serological reactions

Session 3. Microorganism identification through immunological reactions. This practice will be taught in English

Session 4. Vaccination principles. Immunization systems.

PERSONAL TUTORIALS

A fixed schedule for personal tutorials is not set, however professors will be available to students by appointment and through email.

4.3.Syllabus

Lectures

A) GENERAL MICROBIOLOGY

Block I: GENERAL MICROBIOLOGY AND MICROBIOLOGY TECHNIQUES

Lecture 1. Introduction to Veterinary Microbiology.

Lecture 2. Microscopic examination of bacteria.

Block II: GENERAL BACTERIOLOGY

Lecture 3. Prokaryotic and eukaryotic organisms.

Lectures 4 and 5. Constant elements of bacteria.

Lecture 6. Inconstant elements of bacteria.

Lecture 7. Chemical constitution of bacteria.

Lecture 8. Bacterial physiology and metabolism for synthesis.

Lecture 9. Bacterial nutrition.

Lecture 10. Bacterial reproduction.

Lecture 11. Physical and chemical agents that act on the life of microorganisms.

Lecture 12. The genetic transfer phenomena.

Lecture 13. Bacterial and extra-bacterial factors.

Lecture 14. Toxin-genesis

Block III. SPECIAL AND TAXONOMIC BACTERIOLOGY

Lecture 15. Bacterial taxonomy. Gram Negative Bacteria

Lecture 16. α -PROTEOBACTERIA and β -PROTEOBACTERIA.

Lecture 17. γ -PROTEOBACTERIA.

Lecture 18. δ -PROTEOBACTERIA.

Lecture 19. CHLAMYDIA, FUSOBACTERIA AND BACTEROIDES.

Lecture 20. SPIROCHETES.

Lectures 21 and 22. Low G+C Gram Positive Bacteria

Lecture 23. High G+C Gram Positive Bacteria

Block IV: SPECIAL AND TAXONOMIC MYCOLOGY

Lecture 24. Mycology. General characteristics of fungi.

Lecture 25. Fungi that produces deep, superficial and subcutaneous mycoses.

Lecture 26.- Mycotoxins and mycotoxicosis.

Block VII MICROBIOLOGY DIAGNOSTIC

Lecture 27.- Bacteriology and Mycology Diagnostic. Case reports.

Block V: SPECIAL AND TAXONOMIC VIROLOGY and Block VII MICROBIOLOGY DIAGNOSTIC

Lecture 28.- General virology.

Lecture 29.- General Pathology of virus diseases.

Lecture 30.- Animal viruses replication.

Lecture 31. Bacteriophages.

Lectures 32 y 33.- DNA/2 and DNA/1viruses.

Lecture 34.- RNA/1 viruses (inverse transcriptase).

Lecture 35.- RNA/1 viruses (negative sense).

Lecture 36 and 37.- RNA/1 viruses (positive sense).

Block VI: PRIONS

Lecture 38.- Prions

B) IMMUNOLOGY

Block VIII GENERAL IMMUNOLOGY

Lecture 39.- Immunology. History and current concept. Types of immunity.
 Lecture 40.- Mechanisms of the Natural Immunity.
 Lecture 41.- Acquired Immunity: characteristics.
 Lecture 42.- Antigen and Major Histocompatibility Complex. Blood types.
 Lecture 43.- Immunocompetent cells. Myeloid and lymphoid lineages.- T and B lymphocytes.
 Lecture 44.- Others immunocompetent cells: ADCC, NK cells, Citokines. Lymph organs.
 Lecture 45.- Antibodies.
 Lecture 46.- Domestic animals Immunoglobulins.
 Lecture 47.- Theories of antibodies synthesis.
 Lecture 48.- Complement. System.
 Block IX IMMUNOPATHOLOGY
 Lecture 49.- Immune system disorders. Hypersensitivity reactions type I y II.
 Lecture 50.- Type III and Type IV Hypersensitivity reactions. Inespecific Hypersensitivity reaction.
 Lecture 51.- Autoimmunity. Immunodeficiencies.

Block X IMMUNE RESPONSE AGAINST MICROBIAL AND PARASITIC ANTIGENS:

Lecture 52.- Synthesis of microbial antigens and immunological mechanisms against infections of bacterial, viral, fungal and parasitic antigens.

Block XI IMMUNOLOGY NOT RELATED WITH MICRORGANISMS. IMMUNITY AND OTHER LOCAL IMMUNOLOGICAL ASPECTS:

Lecture 53.- Immunity related with transplants. Tumors and aging related immunity.
 Lecture 54.- Local immune mechanisms.

Block XII EVALUATION OF THE IMMUNE RESPONSE:

Lecture 55- Antigen-antibody interaction. Serological reactions.

Block XIII APPLIED IMMUNITY

Lecture 56.- Immunoprophylaxis.
 Lecture 57.- Serological prevention and serological diagnostic.
 Lecture 58.- Immunosuppression.

Block VII MICROBIOLOGY DIAGNOSTIC

Lecture 59.- Immunological tests for microbial identification.

Practical sessions

A) GENERAL MICROBIOLOGY AND B) MICROBIOLOGICAL DIAGNOSTIC

Session 1. Standards for working at microbiology laboratories. Common material and equipment. Equipment's Cleaning and maintenance. Distribution of laboratory areas. Equipment sterilization and preparation of culture media. The handling of the optical microscope. Simple staining.

Session 2. Sampling. Culture of aerobic and anaerobic microorganisms on solid medium and broth. Plating techniques. Gram staining. Special staining. Microscopic observation of bacteria.

Session 3. Identification of bacterial microorganisms. Biochemical and physiological identification. Conventional systems, API galleries.

Session 4: Quantitative study of bacterial populations. Bacterial colonies counting by filtration. Environmental Microbiology: air sampling (gravimetric and volumetric techniques) and surface sampling.

Session 5. Systems for assessment the antimicrobial susceptibility. Techniques: plate (Kirby-Bauer method), minimum inhibitory concentration (MIC) and minimum bactericidal concentration (CMB). Bacterial genetics (bacterial transformation).

Session 6. Identification of fungi and yeasts.

B) GROUP WORK

Session 1. Introduction to bibliographic search. Beginning of group work in Microbiology and Immunology.

C) IMMUNOLOGY

Session 1.- Agglutination and precipitation techniques on serological reactions **Session 2.-** Immunofluorescence technique on serological reactions

Session 3.- Microorganism identification through immunological reactions. This practice will be taught in English.

Session 4.- Vaccination principles. Immunization systems.

Session 5.- Seminar on tutored projects, presented by the students.

4.4. Course planning and calendar

The dates and key milestones of this subject are described in detail, along with the other subjects of the second year in the in the Faculty of Veterinary Medicine website

Planning MICROBIOLOGÍA subject in ECTS Credits: 9 ECTS (225 hours of autonomous work and study)

Students and groups: 150 students, two groups of theoretical teaching and 12/24 of practical teaching. Experimentally factor: 3

4.5.Bibliography and recommended resources

<http://psfunizar7.unizar.es/br13/egAsignaturas.php?codigo=28409>