2019 Admission Onwards (BSc Botany)

Programme Outcomes

PO 1. Critical Thinking:
1. Acquire the ability to apply the basic tenets of logic and science to thoughts, actions and interventions.
2. Develop the ability to chart out a progressive direction for actions and interventions by learning to recognize the presence of hegemonic ideology within certain dominant notions.
3. Develop self-critical abilities and also the ability to view positions, problems and social issues from plural perspectives.

PO 2. Effective Citizenship:
1. Learn to participate in nation building by adhering to the principles of sovereignty, socialism, secularism, democracy and the values that guide a republic.
2. Develop and practice gender sensitive attitudes, environmental awareness, the ability to understand and resist various kinds of discriminations and empathetic social awareness about various kinds of marginalisation.
3. Internalise certain highlights of the nation's and region's history; especially of the freedom movement, the renaissance within native societies and the project of modernisation of the post-colonial society.

PO 3. Effective Communication:
1. Acquire the ability to speak, write, read and listen clearly in person and through electronic media in both English and in one Modern Indian Language
2. Learn to articulate analysis, synthesis, and evaluation of situations and themes in a wellinformed manner.
3. Generate hypothesis and articulate assent or dissent by employing both reason and creative thinking.

PO 4. Interdisciplinarity:
1. Perceive knowledge as an organic comprehensive, interrelated and integrated faculty of the human mind
2. Understand the issues of environmental contexts and sustainable development as a basic interdisciplinary concern of all disciplines.
3. Develop aesthetic, social, humanistic and artistic sensibilities for problem solving and evolving a comprehensive perspective.

Programme Specific Outcomes

PSO1: Skill development for the proper description using botanical terms, identification, naming and classification of life forms especially plants and microbes.
PSO2: Acquisition of knowledge on structure, life cycle and life processes that exist among plant and microbial diversity through certain model organism studies.
PSO3: Understanding of various interactions that exist among plants, animal and microbes; to develop the curiosity on the dynamicity of nature.
PSO4: Understanding of the major elements of variation that exist in the living world through comparative morphological and anatomical study.
PSO5: Ability to explain the diversity and evolution based on the empirical evidences in

morphology, anatomy, embryology, physiology, biochemistry, molecular biology and life history.
PSO6: Skill development for the collection, preservation and recording of information after observation and analysis- from simple illustration to molecular database development.
PSO7: Making aware of the scientific and technological advancements- Information and Communication, Biotechnology and Molecular Biology for further learning and research.
PSO8: Internalisation of the concept of conservation and evolution through the channel of spirit of inquiry.

Course Outcome

Sl. No.	Name of Course (paper)	Outcomes	
1	**CORE COURSE- 1- CYTOLOGY AND ANGIOSPERM ANATOMY**		1. Knowledge on general terms with updated information used in cell biology. 2. Observation of variations that exist in internal structure of various parts of a plant and as well as among different plant groups in support for the evolutionary concept. 3. Skill development for the proper description of internal structure using botanical terms, their identification and further classification. 4. Induction of the enthusiasm on internal structure of locally available plants. 5. Understanding various levels of organization in a plant body with an outlook in the relationship between the structure and function through comparative studies.
2	**CORE COURSE-2 REPRODUCTIVE BOTANY**		1. Observation and classification of the floral variations from the premises of college and house. 2. Understanding the various reproductive methods sub-stages in the life cycle of plants 3. Observation and classification of the morphological variations in fruits and seeds of angiosperms. 4. Enthusiasm to understand evolution based on the variations in reproduction among plants.
3	**CORE COURSE-3 PLANT DIVERSITY I- ALGAE AND BRYOPHYTES**		1. Understanding diversity in morphology, anatomy, reproduction and life cycle in lower groups of plants, algae and bryophytes.

			2. Skill Development in collection and preservation of algae and bryophytes. 3. Realizing the economic/ecological importance of Algae and Bryophytes. 4. Understanding the evolutionary lineages in algae and bryophytes
4	**CORE COURSE- 4- PLANT DIVERSITY II – PTERIDOPHYTES AND GYMNOSPERMS**		1. A comparative knowledge of lower vascular plants and lower group of flowering plants. 2. Skill development for the proper description, identification and classification through morphological, anatomical and life cycle studies. 3. Awareness on the morphological, anatomical and reproductive features of primitive and advanced plants with an evolutionary link between them. 4. Skill development in collection preservation and studies in diversity studies of pteridophytes and gymnosperms.
5	**CORE COURSE-05-CORE PRACTICAL -1**		1.Learning the fundamental techniques used in a botany lab. 2.Understands the working of science by first-hand experience. 3.By comparing different plants and their vegetative and reproductive structures a generalisation in evolutionary concept is attained. 4.Internalisation of practical skills for further application in free, independent, individual needs and helps in designing scientific experimentation.
6	**CORE COURSE 6-ANGIOSPERM SYSTEMATICS AND ETHNOBOTANY**		1. Understanding the main features in Angiosperm evolution. 2. Skill development in identification and classification of flowering plants.

			3. Ability to identify, classify and describe a plant in scientific terms, thereby. 4. Identification of plants using dichotomous keys. 5. Recognition of locally available angiosperm families and plants. 6. Recognition of economically important plants. 7. Appreciation of human activities in conservation of useful plants from the past to the present.
7	**CORE COURSE-7- PLANT PHYSIOLOGY AND METABOLISM**		1. Preliminary understanding of the basic functions in a plant body. 2. Awareness on the interdisciplinary nature of botany, chemistry and physics by studying the principles of plant life, growth and reproduction. 3. Recognising the wonderful mechanism of transport and the Interrelationships existing between metabolic pathways thereby gaining an idea about the importance of plants in the dynamicity of nature. 4. Enhance research interest among students by introducing the historical aspects of physiological research.
8	**CORE COURSE- 8- MICROBIOLOGY, MYCOLOGY, LICHENOLOGY AND PHYTOPATHOLOGY**		1. Understanding and appreciating the unity and diversity of microbes and fungi, 2. Understanding the significance of microbes in nature's dynamicity. 3. Develop skill in studying the fungal diversity through the study of representative taxon and methodology. 4. Understanding the inter-relationship between plants and microbes is both beneficial and harmful.

			5. Skill development to diagnose plant disease and to apply general control measures.
9	**CORE COURSE-9-RESEARCH METHODOLOGY, INSTRUMENTATION AND BIOSTATISTICS**		1. Learning of the fundamental characteristics of science as a human enterprise, product and intellectual process 2. Understanding the working of science for further application in free, independent, individual needs and in designing scientific experimentation. 3. Appreciation of several scientific works and assessment of its influence on society. 4. Acquire knowledge on the principles, components and applications of various scientific equipment in biology. 5. Foundation knowledge in the basic concepts, components and functions of informatics. 6. Appreciate the importance of statistical principles in biological research.
10	**CORE COURSE -10-ENVIRONMENTAL SCIENCE AND PHYTOGEOGRAPHY**		1. Understanding the fundamental concepts in ecology, environmental science and phytogeography. 2. Concept development in conservation, global ecological crisis, Sustainable development and pros and cons of human intervention. 3. Enable the student to appreciate bio diversity and the importance of various conservation strategies, laws and regulatory authorities. 4. Recognition of the need for more research to create a baseline data for sustainable exploitation- Think globally and Act locally 5. Analyse the interrelationship between the geography and pattern of distribution of plants.

			6. Appreciate key concepts from economic, political, and social analysis as pertained to the design and evaluation of environmental policies and institutions. 7. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems. 8. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
11	**CORE COURSE -11-GENETICS, MOLECULAR BIOLOGY AND PLANT BREEDING**		1. Identify the basic principles and current trends in classical genetics. 2. Recognise the historical process of the evolution of molecular genetics from classical genetics. 3. Review the relevance of the application of genetic principles in agriculture, medicine, research and industry. 4. Outlining the use of genetic principles for conservation, defining and better understanding of nature. 5. Develop theoretical background on molecular genetics to provide a strong support for the student for future research and employability. 6. Appreciate the way scientists work in understanding biological processes and the organization of cells. 7. Cite examples for scientific interventions to human and plant life through brief exposure to plant breeding principles. 8. Modify the concept of gender, human diseases and their management based on the study of genetic principles of human beings.

12	**CORE COURSE-12-BIOTECHNOLOGY AND BIOINFORMATICS**		1. Develop knowledge of the fundamental techniques of biotechnology and the history of its development. 2. Recognise theoretical knowledge on the equipment used in biotechnology which will give support during future prospects. 3. Connect the genetic engineering principles in agriculture, medicine, research and industry for a better world. 4. Identify the significance of nanobiotechnology results for updated knowledge in that field. 5. Appreciate and criticise the information technology aided advancements in biology. 6. Develop awareness on the economic, social and environmental problems of gene manipulation.
13	**CORE COURSE-13-EVOLUTION AND PALAEOBOTANY**		1. Understand the basic principles and current trends in classical evolution. 2. Develop awareness on the historical process of plants and animals with an emphasis on human beings. 3. Relate the evolutionary principles with agriculture, medicine, research and industry. 4. Apply the principles of genetics and evolution in conservation, defining and better understanding of nature.
14	**CORE COURSE- 14- CORE PRACTICAL II**		1. Learning the fundamental techniques used in a botany lab related to Mycology, Microbiology, Angiosperms systematics 2. Understands the working of science by first-hand experience. 3. Comparison skill is attained by comparing different plants and their vegetative and reproductive structures.

			4. Inculcation of practical skills for further application in free, independent, individual needs and helps in designing scientific experimentation.
15	**CORE COURSE- 15- CORE PRACTICAL III**		1. Learning the fundamental techniques used in a botany lab related to Mycology, Microbiology, Angiosperms systematics 2. Understands the working of science by first-hand experience. 3. Comparison skill is attained by comparing different plants and their vegetative and reproductive structures. 4. Inculcation of practical skills for further application in free, independent, individual needs and helps in designing scientific experimentation.
16	**CORE COURSE 16- PROJECT/FIELD STUDY/VIVA VOCE**		1. Learning the fundamental techniques used in a research 2. First-hand experience in doing science. 3. Development of the skill to communicate science. 4. Internalisation of skills for further application in designing scientific experimentation.
17	**COMPLEMENTARY ELECTIVE COURSE IN BOTANY– 1 MICROBIOLOGY, PHYCOLOGY, MYCOLOGY AND LICHENOLOGY**		1. Understanding of the fundamental concepts in classification of plants. 2. Concept development in structure and reproduction of lower plants. 3. Enable the student to appreciate biodiversity, sustainable development with the help of their core subject and subsidiary subject botany. 4. Induce to experiment on the subject in an intensive way to facilitate an Interdisciplinary profession/enterprise/entrepreneurship
18	**COMPLEMENTARY ELECTIVE COURSE IN BOTANY– 2**		1. Understanding of the fundamental concepts in classification of Bryophytes, Pteridophytes, Gymnosperms.

	BRYOLOGY, PTERIDOLOGY, GYMNOSPERM BIOLOGY, PALAEOBOTANY, PHYTOPATHOLOGY AND ANGIOSPERM EMBRYOLOGY		2. Concept development in structure and reproduction of lower plants. 3. Enable the student to appreciate biodiversity, evolution and sustainable development with the help of their core subject and subsidiary subject botany. 4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/ enterprise/ enterpreneurship
19	**COMPLEMENTARY ELECTIVE COURSE IN BOTANY– 3 ANGIOSPERM MORPHOLOGY, ANATOMY AND SYSTEMATICS**		1. Understanding of the fundamental concepts in classification of Angiosperms. 2. Concept development in diversity that exists in angiosperms through studies in morphology, anatomy and systematic. 3. Enable the student to appreciate the economic importance of plants belonging to the specified families. 4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/ enterprise/ entrepreneurship
20	**COMPLEMENTARY ELECTIVE COURSE IN BOTANY – 4 PLANT PHYSIOLOGY, ECOLOGY AND APPLIED BOTANY**		1. Understanding of the fundamental concepts in Physiology 2. Concept development in plant ecology. 3. Enable the student to appreciate biodiversity, sustainable development with the help of their core subject and subsidiary subject botany in Its biotechnology era. 4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/ enterprise/ entrepreneurship.
21	**COMPLEMENTARY ELECTIVE COURSE IN BOTANY-5- COMPLEMENTARY BOTANY PRACTICAL**		1.Learning the fundamental techniques used in a botany lab. 2.First-hand experience in doing science.

			3.Internalisation of practical skills for further application in free, independent, individual needs and helps in designing scientific experimentation.

2014 - 2018 Admission (BSc Botany)

Programme Outcomes

Bachelor of Science (BSc) offers theoretical as well as practical knowledge about different subject areas. These subject areas include Physics, Chemistry, Mathematics and Biology and other fields depending on the specialisation a student opts. This programme course is most beneficial for students who have a strong interest and background in Science and Mathematics. The course is also beneficial for students who wish to pursue multi and interdisciplinary science careers in future. Following are the various programme outcomes:

1. This course forms the basis of science and comprises the subjects like physics, chemistry, biology, zoology and mathematics.

2. It helps to develop scientific temper and thus can prove to be more beneficial for the society as the scientific developments can make a nation or society to grow at a rapid pace.

3. After the completion of this course students have the option to go for higher studies i.e. M. Sc and then do some research for the welfare of mankind.

4. After higher studies students can join as scientists and can even look for professional job oriented courses.

5. This course also offers opportunities for serving in Indian Army, Indian Navy, Indian Air Force as officers.

6. Students after this course have the option to join Indian Civil Services as IAS, IFS etc..

7. Science graduates can go to serve in industries or may opt for establishing their own industrial unit.

8. After the completion of the B.Sc degree there are various other options available for the science students. Often, in some reputed universities or colleges in India and abroad the students are recruited directly by big MNC’s after their completion of the course.

9. Apart from the research jobs, students can also work or get jobs in Marketing, Business & Other technical fields. Science graduates are also recruited in the bank sector to work as customer service executives. Students can also find employment in government sectors.

Programme Specific Outcomes

The syllabus for B.Sc. programmes in Botany offer eighteen core courses including three practical courses, one elective and one project which could attain 54 credits. The theory core papers are of different credits. Each practical course consists of four credits. These eighteen core courses offered at the Undergraduate level are designed systematically maintaining the interrelationship between the courses intending the students to have a clear understanding of the subject matter. The study of the methodology of science helps the students to get a better classroom interaction in the core courses instead of relying on rote memory and knowledge.More over it promotes scientific attitude and scientific temper in students. A course on Data analysis in biology is incorporated in the beginning of the programme which promotes problem solving skills of the students which is required for their success in the core courses like genetics, molecular biology, environmental science, physiology, evolution and bioinformatics and for better understanding of various biological phenomena . An option is provided for the students to choose open courses from other departments in 5th and 6th semesters. Seminars, assignments, field survey, project, study tour etc.

Course Outcome

Sl. No.	Name of Course (paper)	Outcomes	
1	**CORE COURSE -Theory I ENVIRONMENTAL SCIENCE AND PHYTOGEOGRAPHY**	i	1. To enable the students to understand the fundamentals of environmental science 2. To enable them to contribute meaningfully in the conservation of the environment. 3. To make them aware of the current global problems of the environment due to human intervention and the need of developing a sustainable way of life 4. To appreciate bio diversity and the importance of conservation strategies. 5. To make them aware of the global ecological crisis.
2	**CORE COURSE – Theory II ANGIOSPERM ANATOMY AND MICROTECHNIQUE**	i	1. To observe and differentiate the variations existing in the internal structure of plants. 2. To create interest in plant anatomy and to appreciate the function of a particular

			tissue or organ correlated with its structure. 3. To enable the student understand the anatomical features within the system instead of merely memorizing the technical terms and the textbook figures. 4. To identify different plants with respect to its anatomical features though they are not studied as part of the syllabus. 5. To enable a comparison existing among different parts in different plants. 6. The student in identifying different plants by anatomical peculiarities.
3	**CORE COURSE – Theory III PHYCOLOGY, MYCOLOGY AND LICHENOLOGY**		1. To have a general understanding about the diverse groups of organisms. 2. To enable the student to identify the different organisms by morphological and anatomical studies. 3. To understand the evolutionary link between organisms. 4. To appreciate the fantastic commonness exists among organisms. 5. The student will be able to appreciate the uniqueness of different groups and the way they are classified.
4	**CORE COURSE – Theory IV BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY**		1. To attain knowledge on different groups of plants and their life cycle. 2. To understand the interrelationships between plants. 3. To make the students aware of the morphological, anatomical and reproductive features of primitive and advanced plants and their evolutionary link.

			4. To enable the student to appreciate their ecological importance and the need of conserving them. 5. To develop curiosity in observing and identifying different groups of plants
5	**CORE COURSE – PRACTICAL -I**		1. To train the students in the use and maintenance of scientific equipment in biology. 2. To develop in them the skills and the scientific way of studying different groups of organisms to study the inter relationship exist between different groups of plants and other organisms. 3. To enable the students to identify different organisms by morphological and anatomical studies
6	**CORE COURSE – Theory V TAXONOMY, MORPHOLOGY AND ECONOMIC BOTANY**		1. To observe the variations among plants, especially angiosperms. 2.To understand the description of a plant. 3. To study the floral characters with an aim to identify the taxa authentically. 4. To prepare taxonomic keys with the help of morphological and floral characters and to classify plants based on similar/dissimilar characters 5. To study the distribution of flora in Northern Kerala 6. To apply taxonomic data into various other fields. 7. This study enriches the systematic Botany which can be utilized for botanical diagnosis of fragmentary crude drugs.

			8. This study will be useful in identifying medicinal and other useful plants.
7	**CORE COURSE – Theory VI MICROBIOLOGY AND PLANT PATHOLOGY**		1. To understand the evolutionary link between organisms. 2.To appreciate the fantastic commonness that exists among organisms. 3. The student will be able to appreciate the uniqueness of different groups and the way they are classified. 4. To understand the symptomatology and prevention of plant diseases.
8	**CORE COURSE - TheoryVII PLANT PHYSIOLOGY AND BIOCHEMISTRY**		1. To make the students aware of the way by which life originated and how animate and inanimate matter differ each other with same types of molecules 2. To impart up-to-date knowledge in the field of biochemistry 3. To understand the interrelationships existing between metabolic pathways
9	**CORE COURSE – Theory VIII BIOINFORMATICS, INSTRUMENTATION AND RESEARCH METHODOLOGY**		1. To review the basic concepts & functional knowledge in the field of informatics. 2.To review functional knowledge in a standard office package and popular utilities 3. To create awareness about nature of the emerging digital knowledge society 4. To create awareness about social issues and concerns in the use of digital technology 5. To create awareness about major informatic initiatives in India and Kerala

			6. To impart skills to enable students to use digital knowledge resources in learning 7.To train the students in the use and maintenance of scientific equipment in biology
10	**CORE COURSE – Theory IX PLANT TISSUE CULTURE, EMBRYOLOGY AND PALYNOLOGY**		1. To identify different plants with respect to its anatomical features though they are not studied as part of the syllabus. 2. To enable a comparison existing among different parts in different plants. And enable 3. The student in identifying different plants by anatomical peculiarities. 4. To know the development and to understand the life cycle of angiosperms and variations existing among them from flower to seed.
11.	**CORE COURSE – Theory X GENETICS, BIOSTATISTICS AND EVOLUTION**		1. To understand nature and the evolution of life. 2. To enable them to investigate the evolutionary phenomena with out prejudices rather than reaching into hasty conclusions. 3. To enable them to correlate the origin and evolution of life and how genetic studies contributed in understanding evolution. 4. Enable students to understand the current trends in genetics. 5. Make student aware of the historical process through which modern genetics evolved. 6. To orient them in such a way that they will be able to apply the knowledge of

			classical and molecular genetics in agriculture, medicine, research and industry 7. To create interest and develop appreciation in the tremendous growth of genetics and
12.	**CORE COURSE – Theory XI BIOTECHNOLOGY AND CROP IMPROVEMENT**		1. To know the fundamental techniques of biotechnology and the history of its development. 2. To orient them to apply the technology in agriculture and other fields. 3. To make them aware of the economic, social and environmental problems of gene manipulation 4. To acquaint and train them in the use of the equipments in biotechnology 5. To understand the application of bio technology and nanobiotechnology.
13	**CORE COURSE – Theory XII CELL AND MOLECULAR BIOLOGY**		1.To create in them a scientific approach in understanding nature and its evolution, beginning with atoms to its complexity through the cell. 2. To enable them to appreciate the way scientists work in understanding evolution and the organization of cells. 3. To understand the mechanism of cell reproduction and its biological consequences.
14.	**CORE COURSE – PRACTICAL-II TAXONOMY , MORPHOLOGY AND ECONOMIC BOTANY**		1. To train the students in the use and maintenance of scientific equipment in biology. 2. To develop in them the skills and the scientific way of classifying, describing and identifying plants.

			3.To enable the students to identify different angiosperms by morphological and anatomical studies. 4. To enable the student to understand the fundamentals of environmental science 5. To study the inter relationship exist between different plants.
15	**CORE COURSE – PRACTICAL-III- PLANT TISSUE CULTURE, EMBRYOLOGY AND PALYNOLOGY GENETICS, BIOSTATISTICS AND EVOLUTION BIOTECHNOLOGY AND CROP IMPROVEMENT CELL AND MOLECULAR BIOLOGY**		1. To train the students in the use and maintenance of scientific instruments in biology and to do experiments in physiology and biochemistry. 2. To develop in them the skills to do problems in genetics 3. To enable the students to prepare cytological squash preparations and to identify cell division phases. 4. To enable the student to understand the fundamentals of informatics and bio informatics.
16	**6B16BOT/PLS PROJECT**		1. Project work will kindle the spirit of research and invention among the students and will expose them to the realities outside their classrooms. It will impart sufficient academic and practical experience and motivate them to become self employed in the particular field. 2. To have an acquaintance with scientific report writing, data analysis *etc*. 3. Field visit/ Study tour provides an opportunity to appreciate the environment, ecology and biodiversity aspects of plants. The dynamic nature of biosphere, interrelationships among individuals *etc*. can impart a need for conservation in students.
17	**OPEN COURSE - ENVIRONMENTAL SCIENCE**		1. To enable the students to understand the fundamentals of environmental science

			2. To enable them to contribute meaningfully in the conservation of the environment. 3. To make them aware of the current global problems of the environment due to human intervention and the need of developing a sustainable way of life 4. To appreciate bio diversity and the importance of conservation strategies. 5. To make them aware of the global ecological crisis.
18	**COMPLEMENTARY – 1** **DIVERSITY OF LIFE-MICROBES & THALLOPHYTES**		1.To have a general understanding about the diverse groups of organisms 2.To understand the nature and evolution of life 3.To enable the students to identify the different microorganisms by microscopic studies. 4.To get a comparative account of organisms with an evolutionary link
19	**COMPLEMENTARY COURSE – 2** **ARCHAEGONIATAE, PALAEOBOTANY AND REPRODUCTION IN ANGIOSPERMS**		1.To have a general understanding about the diverse groups of plants 2.To understand the nature and evolution of plant life 3.To enable the students to identify the different plants by morphology and anatomy. 4.To get a comparative account of plants with an evolutionary link
20	**COMPLEMENTARY COURSE – 3** **ANGIOSPERMS–MORPHOLOGY,SYSTEMATICS,UTILITY,PLANT BREEDING AND PLANT PATHOLOGY**		1.To observe the variations among plants, especially angiosperms. 2.To understand the way of description of a plant. 3. To study the floral characters with an aim to identify the taxa authentically.

			5. To study the various types of floral distribution in Northern Kerala 6.To apply all these data into various other fields. 7.This study will be useful in identifying medicinal and other economically important taxa.
21	**COMPLEMENTARY COURSE – 4** **ANGIOSPERM - ANATOMY AND PHYSIOLOGY**		1. To understand the physical principles which is needed to explain the mechanism of plant living and growth 2. To enable the students in understanding the function of plants with respect to its environment and structure. 3. To develop appreciation in the wonderful mechanism of transport systems exists in plants. 4. To create research interest and observation skill by introducing the way by which plant physiology researches were carried out.
22	**COMPLEMENTARY-5** **BOTANY COMPLEMENTARY PRACTICAL**		1. To train the students in the use and maintenance of scientific equipment in biology. 2. To develop in them the skills and the scientific way of studying different groups of organisms to study the inter relationship exist between different groups of plants and other organisms. 3. To enable the students to identify different organisms by morphological and anatomical studies