

LSM Courses - For Academic Year AY2024/2025 (Updated 19 July 2024)

[For course scheduling information, please refer to NUSMods.](#)

[For course syllabus, please refer to website LSM Courses.](#)

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Code	Title	For SPN?	Prerequisite(s)	Semester	Department	Course Coordinators (NUS email contacts)	Course Description
LSM1111	Biological Challenges and Opportunities for Humankind	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1 and 2	Biological Sciences	Prof Antonia Monteiro antonia.monteiro@nus.edu.sg (Sem 1); Dr Wu Jinlu dbswjl@nus.edu.sg (Sem 2)	Designed as a gateway for the Life Sciences Major, this course explores biological challenges faced by humankind today and how solutions are being developed. We will use three main case studies to illustrate current struggles and how distinct approaches from sub-disciplines of Biology contribute to providing solutions. The nature of scientific inquiry and concepts in genetics, ecology, and evolutionary biology will be explained via the case studies.
LSM1301	General Biology	No	Nil (GCE A-Level or H2 Biology, or equivalents)	1 and 2	Biological Sciences	Dr Zeehan Jaafar jaafarz@nus.edu.sg (Sem 1); Dr Nalini Puniamoorthy nalini@nus.edu.sg (Sem 2)	This is an introductory course that explores what a living thing is, the basics of life, and the science behind it. The course will introduce the chemistry of life and the unit of life. The question of how traits are inherited will be discussed and the field of biotechnology, including its applications and the ethical issues involved be will introduced. The diversity of life on earth will be explored, with discussions how life on earth possibly came about and how biologists try to classify and make sense of the diversity. The course will also introduce the concept of life functions from cells to tissues and from organs to systems. The concept of how organisms maintain their internal constancy and organisation of major organ systems will be discussed. The focus will be to introduce the unifying concepts in biology and how they play a role in everyday life.

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LSM1303	Animal Behaviour	No	Nil (For Life Sciences Major/Minor and BES student, please appeal via CourseReg for requisite waiver.)	2	Biological Sciences	Mr N. Sivasothi sivasothi@nus.edu.sg	Understanding animal behaviour awakens the individual to the complexity of daily phenomenon in the animal kingdom - how animals live and survive in their environment. Much of this occurs around us every day and everywhere we go. But the city-dweller lives in increasing isolation of animals and understands little of the world around them. This course will highlight behaviours such as learning, sociality, territoriality, predation and defense, courtship and communication, with examples from across animal diversity. How behaviors have evolved to fit specific ecological conditions will be examined. Students will gain understanding of and empathy for animals.
LSM2105	Molecular Genetics	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1 and 2	Biological Sciences	Assoc Prof Chew Fook Tim dbscft@nus.edu.sg	This course covers topics on (i) the patterns of inheritance, (ii) the molecular properties of genes and chromosomes, (iii) transcription and translation, (iv) genetic methods and technology, and (v) genetic analysis of individuals and populations. This will include an in-depth understanding of mendelian patterns of inheritance and variations that could occur due to multiple alleles, lethal genes, chromosomal variations, linkage, gene interaction and other genetic phenomena. Emphasis is placed on the understanding of the underlying molecular and biochemical basis of inheritance. Quantitative and population genetics will also be discussed with the emphasis of understanding the processes and forces in nature that promote genetic changes.
LSM2106	Fundamental Biochemistry	No	GCE 'A' Level or H2 Biology or equivalent or LSM1301, and GCE 'A' Level or H2 Chemistry or equivalent or CM1417/CM1417 X	1 and 2	Biochemistry	Assoc Prof Deng Lih Wen bchdlw@nus.edu.sg (Sem 1); Dr Adrian Teo bchtkka@nus.edu.sg (Sem 2)	The objective is to provide the student with a firm and rigorous foundation in current concepts of the structure and functions of biomolecules in molecular cellular biology. These fundamental concepts form the basis of almost all recent advances in biological and the biomedical sciences. The lectures will introduce various cellular organelles as models to gain insights into how structures and functions of classes of biomolecules participating in important cellular processes.

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LSM2107	Evolutionary Biology	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1 and 2	Biological Sciences	Dr Nalini Puniamoorthy nalini@nus.edu.sg (Sem 1); Dr John Ascher dbsajs@nus.edu.sg (Sem 2)	Evolutionary biology covers the history of life on our planet and the processes that produced the multiple life forms of Earth. Topics include: the origins of life, the eukaryotic cell, and multicellularity; the generation of genetic variation and the sorting of that variation through random processes and through natural and sexual selection; the origin of new traits, new life histories, and new species; the origins of sex, sociality, and altruism; the evolution of humans; and applications of evolutionary biology to solving modern-day problems.
LSM2191A	Laboratory Techniques in Life Sciences	No	LSM2105 or LSM2106	1 and 2	Biological Sciences	Dr Lim Xin Xiang xinxiang@nus.edu.sg Assoc Prof Lu Gan dbsganl@nus.edu.sg	This course introduces the theory and practical applications of techniques used in molecular biology and protein biochemistry. Factual knowledge in recombinant DNA techniques, such as RNA isolation, reverse transcription, polymerase chain reaction, recombinant DNA construction and recombinant protein expression; and in protein purification, such as liquid chromatography, polyacrylamide gel electrophoresis and western blotting, will be integrated with laboratory practice. <i>[Have final exam.]</i>
LSM2191B	Laboratory Techniques in Life Sciences	No	LSM2105 or LSM2106	1 and 2	Microbiology and Immunology / Biochemistry	A/P Norbert Lehming micln@nus.edu.sg; Dr Lee Seow Chong bchlees@nus.edu.sg	This course introduces the theory and practical applications of techniques used in molecular biology and protein biochemistry. Factual knowledge in recombinant DNA techniques, such as RNA isolation, reverse transcription, polymerase chain reaction, recombinant DNA construction and recombinant protein expression; and in protein purification, such as liquid chromatography, polyacrylamide gel electrophoresis and western blotting, will be integrated with laboratory practice. <i>[No final exam.]</i>

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LSM2212	Human Anatomy	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1	Anatomy	Dr Jai Santosh Polepalli jpolepalli@nus.edu.sg	This course provides a basic introduction to human structure and function, comprising gross anatomy integrated with microscopic anatomy. Histological organization of the primary tissues: epithelial, connective, muscular and nervous tissues will also be covered. Clinical relevance of the anatomical structures will be discussed.
LSM2233	Cell Biology	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1 and 2	Biochemistry	Assoc Prof Yeong Foong May bchyfm@nus.edu.sg (Sem 1); Assoc Prof Thilo Hagen bchth@nus.edu.sg (Sem 2)	This course provides a comprehensive understanding of sub-cellular structures, functions and interactions in unicellular and multi-cellular systems. Emphasis is on cellular functions. Topics include structures and functions of organelles, organelle biogenesis (including organelle inheritance and import of proteins into organelles), intracellular protein trafficking, the cytoskeleton, and cell movements. In addition, students will be introduced to the current concepts of intercellular and intracellular signalling, molecular basis of cell proliferation and apoptosis.
LSM2234	Introduction to Quantitative Biology	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	2	Biological Sciences	Dr Chii Jou Chan, Joe dbschii@nus.edu.sg	Over the past 30 years, there has been an explosion in the amount of quantitative biological data. This is due to advances in imaging, genetics, and sequencing. This course introduces methods necessary for understanding and analysing such quantitative biological data. We use systems from across biology, from photosynthesis to human sleep cycles, to demonstrate the power and applicability of these approaches. We introduce the mathematical and physical concepts necessary through the course. This course is suitable for all Life Sciences students regardless of background in the physical sciences.
LSM2251	Ecology and Environment	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1 and 2	Biological Sciences	Mr N. Sivasothi sivasothi@nus.edu.sg (Sem 1); Dr Lim Jun Ying jylim@nus.edu.sg (Sem 2)	This course introduces students to the science of ecology and its role in understanding environmental processes. It covers both the major concepts and their real-world applications. Topics will include models in ecology, organisms in their environment, evolution and extinction, life history strategies, population biology, ecological interactions, community ecology, ecological energetics, nutrient cycling, landscape ecology.

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LSM2252	Biodiversity	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1 and 2	Biological Sciences	Mr N. Sivasothi sivasothi@nus.edu.sg; Dr Theresa Su theresasu@nus.edu.sg	The course aims to inculcate in students an understanding for the need of a diverse and intricate balance of nature and the morality of conservation. It involves an introduction to the diversity of major groups of living organisms, and the importance of maintaining diversity in natural ecosystems. Emphasis is on the need for conservation of biodiversity to maintain a balance of nature. The course will highlight to the students the biodiversity in the major habitats and vegetation types in and around Singapore.
LSM2254	Fundamentals of Plant Biology	No	LSM2105 or LSM2106	2	Biological Sciences	Assoc Prof Lau On Sun onsunlau@nus.edu.sg	This course introduces students to contemporary plant biology. It focuses on the flowering plants (angiosperms), one of the most successful plant groups that sustains all life on earth, and examines how they are organized, grow, and respond to the environment. A major theme that the course will highlight is that plant growth is highly dynamic – plants control growth and development through integrating intrinsic and external signals to best adapt to the changing surroundings. The concepts and techniques of gene manipulation for studying plants, as well as their applications in plant biotechnology, will also be discussed.
LSM2291	Fundamental Techniques in Microbiology	No	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1 and 2	Microbiology and Immunology	Dr John Chen miccjj@nus.edu.sg (Sem 1); Assoc Prof Chu Jang Hann miccjh@nus.edu.sg (Sem 2)	Embark on a captivating exploration of Microbiology where students will gain a deeper understanding of microbes and techniques for studying them, through a combination of theoretical knowledge and hands-on experiments. Students will delve into the invisible world of microbes, investigating microbiomes of skin, soil and water, and exploring the role of probiotics. Moreover, students will have the unique opportunity to visit a microbiology-related industry and witness real-world applications of their learnings. By the end of the course, students should possess fundamental knowledge of microbiology and the experimental tools used and will be inspired to probe deeper into this exciting field.

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LSM3201	Research and Communication in Life Sciences	No	Nil (Concurrently doing LSM2288 or LSM3288 or LSM4199 or LSM4288 variant)	1 and 2	Biological Sciences	Assoc Prof Lam Siew Hong dbslsh@nus.edu.sg	This course introduces students to the philosophy, principles and processes of life sciences research and communication. It aims to equip students with the essential knowledge that complements the hands-on research training which students undertake for UROPS and Honours projects' requirements. The course covers the essentials of scientific research including: importance and pitfalls of problem formulation and hypothesis generation; essentials of experimental designs; practical tips and pitfalls during experimental execution; good and bad practices of data collection, analysis and evaluation; form and function of scientific communication; and research ethics.
LSM3210A	Metabolism and Regulation	Yes - BMS	LSM2106	1	Biochemistry	Assoc Prof Yew Wen Shan bchyws@nus.edu.sg	Overview of the biosynthesis and catabolism of carbohydrates, proteins, lipids and nucleic acids in the context of human health and disease. Emphasis on the integration and regulation of metabolic pathways in different tissues and organs. Principles of bioenergetics and mitochondrial energy metabolism, free radicals, enzyme deficiencies in metabolic disorders will also be covered.
LSM3210B	Metabolism and Regulation	Yes - BMS	LSM2106	2	Biological Sciences	Dr Lin Zhewang zlin@nus.edu.sg	Overview of the biosynthesis and catabolism of carbohydrates, proteins, lipids and nucleic acids in the context of human health and disease. Emphasis on the integration and regulation of metabolic pathways in different tissues and organs. Principles of bioenergetics and mitochondrial energy metabolism, free radicals, enzyme deficiencies in metabolic disorders will also be covered.

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LSM3211	Fundamental Pharmacology	Yes - BMS	LSM2106 or PHS1111 or PHS2102	1 and 2	Pharmacology	Prof Wong Wai-Shiu Fred phcwongf@nus.edu.sg (Sem 1); Dr Seah Bee Kee, Serena s.seah@nus.edu.sg (Sem 2)	This course aims to provide basic principles of receptor pharmacology and of pharmacokinetics with emphasis on molecular and cellular mechanisms of action, clinical uses and adverse effects using lectures, tutorials and practicals. The lecture topics will start with the classical drug receptor theory followed by pharmacokinetics and molecular pharmacology of drug receptors and their regulation including receptor-mediated signal transduction and membrane ion channel function. Autonomic pharmacology (adrenergic and cholinergic) will be introduced. The course also focuses on the pharmacology of autacoids, non-steroidal anti-inflammatory agents, corticosteroids, immunosuppressants, anti-asthma drugs, and anti-arthritis drugs.
LSM3212	Human Physiology: Cardiopulmonary System	Yes - BMS	LSM2106	1	Physiology	Dr Zakaria Almsherqi phszama@nus.edu.sg	The heart and lungs are central to the maintenance of homeostasis in the human body by bringing essential materials to and removing wastes from the body's cells. This course covers the basic physiology of the cardiovascular and pulmonary systems using exercise to illustrate the onset of homeostatic imbalances and the body's responses to restore homeostasis. Students will be able to identify the benefits that exercise imparts to cardiorespiratory fitness and overall health.
LSM3214	Human Physiology - Hormones and Health	Yes - BMS	LSM2106	2	Physiology	Assoc Prof Thai Tran phstt@nus.edu.sg	This course covers several human physiological systems using hormonal control of homeostasis as a basis for understanding normal function and health. The student will be able to appreciate the interactions occurring amongst the endocrine, digestive, renal, and reproductive systems, and be able to relate them to the body's biological rhythms (or clocks), growth, responses to stress, and reproductive processes. Major Topics Covered: endocrine system, central endocrine glands, peripheral endocrine glands, digestive system, digestive processes, energy balance, urinary system, fluid processing, fluid balance, reproductive system, male reproductive physiology, female reproductive physiology.

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LSM3215	Neuronal Signaling and Memory Mechanisms	Yes - BMS	LSM2106	1	Physiology	Assoc Prof Saji Kumar Sreedharan phssks@nus.edu.sg	The course will provide fundamental knowledge about how neuronal signaling and its higher functions, such as encoding and retrieval of memory, occur in our brain. Learning and memory mechanisms are conserved in all organisms. This course covers topics including the ionic basis of resting and action potentials, molecular biology of ion and TRP channels, ion channelopathies, and the auditory system. It also focuses on neurotransmission with particular emphasis on the glutamate receptors and neuropharmacology. In addition, it touches the cellular and molecular basis of learning and memory, and energy utilization in the brain.
LSM3216	Neuronal Development and Diseases	Yes - BMS	LSM2233	2	Physiology	Dr John Chua Jia En phsjc@nus.edu.sg	This course will focus on key events that take place in different stages of vertebrate nervous system development including neural induction, neurogenesis, glial biology, neuronal growth and polarity, axonal guidance, synapse formation, and regeneration. Pathological states such as muscular dystrophy, spinal cord injury, Parkinson's disease, and other neurodegenerative diseases will be studied, both in terms of understanding the deficits as well as examining potential solutions to improve the outcomes of these neuronal diseases. Latest findings will be discussed, allowing students to learn the current state of research in developmental neurobiology.
LSM3217	Human Ageing	Yes - BMS	LSM2233	1	Physiology	Dr Tsai Shin-Yin phsts@nus.edu.sg	This course will explore the physiological changes during ageing. Cardiovascular disease is a leading cause of mortality globally and sarcopenia is a major cause of disability and frailty among older adults, which decrease healthy lifespan. We will review the mechanism underlying the functional deterioration of system ageing. Moreover, we will also discuss the emerging evidence to explain how motor neuron and immune cells might contribute and respond to system ageing.

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LSM3218	Cardiopulmonary Pharmacology	Yes - BMS	LSM3211	2	Pharmacology	Dr David Fann Yang-Wei david.fann@nus.edu.sg	This course focuses on the pharmacological drugs used to treat cardiovascular and pulmonary diseases, with emphasis on the molecular and cellular mechanisms of action, pharmacokinetics, clinical and contra-indications, and adverse effects through lectures, tutorials, and laboratory sessions. The course will commence with lecture topics on the basic anatomy and physiology of the cardiovascular and pulmonary systems, followed by an understanding of the pharmacological drugs that are used to treat common cardiovascular and pulmonary diseases. Overall, this course aims to demonstrate the principles and clinical applications of these drugs in cardiovascular and pulmonary diseases.
LSM3219	Neuropharmacology	Yes - BMS	LSM2106 or PHS2102	2	Pharmacology	Assoc Prof Judy Sng phcsngj@nus.edu.sg	This course introduces the pharmacological treatment of nervous system. It covers the actions of drugs and how they affect cellular function in the nervous system, and the neural mechanisms through which they influence behavior. Examples of drugs used to treat diseases and disorders of the nervous systems will be discussed.
LSM3220	Genes, Genomes and Biomedical Implications	Yes - BMS	LSM2105 and LSM2106	1 and 2	Biological Sciences	Dr Phua Siew Cheng sc.phua@nus.edu.sg (Sem 1); Dr Xue Shifeng shifengxue@nus.edu.sg (Sem 2)	This course deals with the structure, organization and function of genes and genomes in both prokaryotes and eukaryotes (e.g. DNA topology, hierarchy of packaging of DNA in chromosomes and relationship to gene activity and genome dynamics). The functional roles of DNA regulatory cis-elements and transcription factors involved in gene expression will be examined. The molecular events in the control and regulation of transcription; post-transcriptional modifications and RNA processing; temporal and spatial gene expression will be examined in detail. The cause and/or effect of dysfunction of gene expression in diseases will be discussed.

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LSM3222	Human Neuroanatomy	Yes - BMS	LSM2105 or LSM2106 or LSM2212	2	Anatomy	Prof Ong Wei Yi antongwy@nus.edu.sg	A working knowledge of human neuroanatomy is essential for many fields of biomedical science, practice and research. The purpose of this course is to cover the basic functional neuroanatomy of the human nervous system, including overview, neurohistology, peripheral nervous system, autonomic nervous system and central nervous system. It takes a regional-systemic approach to understanding human nervous system structure and function - that parallels the core knowledge used in clinical practice. Emphasis is placed on the unique anatomical features and neurochemistry of different parts of the central and peripheral nervous system, while demonstrating their synaptic connectivity and interrelatedness of their functions.
LSM3223	Immunology	Yes - BMS	LSM2233 or PHS3123	1 and 2	Microbiology and Immunology	Assoc Prof Lu Jinhua miclujh@nus.edu.sg (Sem 1); Assoc Prof Zhang Yongliang miczy@nus.edu.sg (Sem 2)	This course provides the central concepts of immunology and the foundation for understanding how immunity functions. The subjects of innate immunity and haematopoiesis introduce the origin and role of different cell types in immunity. The mechanisms of how the body protects itself from disease are explored in relation to T and B cell biology, antibodies, cytokines, major histocompatibility complex and antigen presentation. Other topics include hypersensitivity, immunodeficiencies, tolerance, autoimmunity, resistance and immunization to infectious diseases.

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LSM3225	Molecular Microbiology in Human Diseases	Yes - BMS	LSM2105 or LSM2106 or LSM2233 or LSM2291	2	Microbiology and Immunology	Assoc Prof Tan Yee Joo mictyj@nus.edu.sg	By the application of advanced technologies in molecular biology to studying microbes, we can identify and detect microbes, as well as treat and prevent diseases caused by both existing and newly emerged pathogens. In this course, students will be taught molecular principles of physiological processes involved in the life cycles of different types of microbes, and how these affect human health. Emphasis will be placed on the importance of using multiple methodologies to discover, detect and study pathogens. Specialised talks by guest lecturers will illustrate the use of molecular microbiology in laboratories handling the diagnosis and surveillance of infectious diseases.
LSM3226	Medical Mycology and Drug Discovery	Yes - BMS	LSM2233 or LSM2252 or LSM2291	2	Biochemistry	Assoc Prof Yeong Foong May bchyfm@nus.edu.sg	With the growing aging population and number of immunocompromised patients, fungal infections are increasingly becoming relevant. This course will re-examine Koch's postulates in relation to the roles opportunistic and primary fungal pathogens play in mycoses. Issues surrounding the molecular, physiological and biochemical aspects of fungal cells that make them successful microbial pathogens will be discussed. Key mechanisms of anti-fungal resistance in relation to challenges facing the discovery of new therapeutics will be examined. Students will have the opportunity to design and conduct a typical drug susceptibility screen and drug discovery process.
LSM3227	General Virology	Yes - BMS	LSM2105 or LSM2106	1	Biological Sciences	Dr Wu Jinlu dbswj@nus.edu.sg	This course explores virology, which is the study of viruses that infect different forms of living organisms. It introduces general concepts related to the viral structure, host spectrum and replication. We will elaborate how viruses are identified, how viruses go "viral" and how we can live with viruses. The impacts of viral diseases on human health, food security and environment will be discussed. The course also includes new developments in how viruses can be used as vectors for drug delivery, nanomaterials and bio-control agents. Students will have chances to practice virus culture, isolation and infectivity assay.

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LSM3228	Microbiomes and Biofilms	Yes - BMS	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1	Microbiology and Immunology	Dr Ch'ng Jun Hong micchn@nus.edu.sg	In nature, microbes exist as multispecies communities (microbiota) interacting with each other and also the environment/host. This typically occurs in the context of biofilms where organisms are in close proximity within a protected environment of the biofilm matrix. This course primarily explores the human microbiome and its effect on development and disease and explore the role of pre- and probiotics in health. Mechanistic insights into microbial communities can also be gained through more controlled studies focusing on experimental biofilms. Appreciating the biology of biofilms allows us to understand the context that both human and environmental microbiota operate in.
LSM3231	Protein Structure and Function	Yes - BMS	LSM2106	1	Biochemistry	Assoc Prof Maxey Chung bchcm@nus.edu.sg	This course aims to provide a strong foundation in the study of protein structure and function. The following topics that will be covered: structures and structural complexity of proteins and methods used to determine their primary, secondary and tertiary structures; biological functions of proteins in terms of their regulatory, structural, protective and transport roles; the catalytic action of enzymes, their mechanism of action and regulation; various approaches used in studying the structure-function relationships of proteins.
LSM3232	Microbiology	Yes - BMS	LSM2105 or LSM2106 or LSM2291	1 and 2	Microbiology and Immunology	Assoc Prof Justin Chu miccjh@nus.edu.sg (Sem 1); Dr Chris Sham miclts@nus.edu.sg (Sem 2)	Principles of Microbiology, with emphasis on the properties, functions and classification of the major classes of microorganisms, especially bacteria, fungi and viruses. Understanding microbial activities and their influence on microbial diseases, industrial applications, ecology, food and water quality.

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LSM3233	Developmental Biology	Yes - BMS and EEB	LSM2233	1	Biological Sciences	Assoc Prof Christoph Winkler dbswcw@nus.edu.sg	This course will showcase and examine embryogenesis, starting from fertilisation to birth in the case of animal development; and to germination, growth and differentiation in plants. Students will be exposed to concepts, principles and mechanisms that underlie development in plants and animals. Different organism models will be studied to demonstrate the rapid advances in this field of life sciences.
LSM3234	Biological Imaging of Growth and Form	Yes - BMS	LSM2233	1	Biological Sciences	Assoc Prof Cynthia He dbshyc@nus.edu.sg	Growth and form are fundamental to all living organisms, crucial to health and diseases. Development in imaging methods and tools has transformed biological and biomedical sciences. This course will introduce basic concepts in imaging and their applications. The major topics include basic optics, light and electron microscopy, fluorescence and related methods. Introduction of each imaging technology will be linked with a set of biological problems of fundamental interests and biomedical implications.
LSM3235	Biomedical Applications of Human Epigenetics	Yes - BMS	LSM2105	1	Physiology	Dr Tee Wee Wei phstee@nus.edu.sg	This course introduces the concept of epigenetics, the relationship between the genome and the epigenome, and the translational applications of epigenetics in relation to human health and diseases. It focuses on helping students understand the relevance of epigenetic processes in human physiology (e.g., embryonic development, ageing) and how their mis-regulation underlies diseases such as cancer. It also highlights how the study of epigenetic mechanisms is important for modern biomedical research such as regenerative medicine therapies (e.g., induced pluripotency and trans-differentiation). Students will be exposed to various state-of-the-art next-generation (epi)genomic sequencing technologies widely used in biomedical research.

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LSM3236	Pattern Formation and Self-organisation in Biology	Yes - BMS	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1	Biological Sciences	Dr Yuchen Long yuchen.long@nus.edu.sg	From zebra stripes and rose petal spirals to swarming bird flocks, the biological world is full of mesmerizing patterns. How do these patterns form, and what is the underlying mechanism that explains these seemingly unrelated phenomena? This course takes an interdisciplinary approach to introduce how complex biological phenomena can emerge from simple rules. Through interactive lectures, guided reading and hands-on tutorials and simulations, students will learn to appreciate how basic concepts like feedback and robustness generate biodiversity across multiples scales.
LSM3242	Translational Microbiology	Yes - BMS	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	2	Microbiology and Immunology	Dr Volker Patzel micvp@nus.edu.sg	This course covers the underlying principles and wide-ranging industrial, environmental, pharmaceutical, and biomedical applications of microbiology. The objectives are (a) to gain an understanding of the role of microorganisms for biotechnology applications in the fields of medicine, agriculture, organic chemistry, synthetic biology, public health, biomass conversion, bioremediation, and biomining; and (b) to review advances in genetics and molecular biology of industrial microorganisms, enzyme engineering, environmental microbiology, food microbiology, and molecular biotechnology. A particular focus will be on the meaning and impact of microbiology on human health and the development of new therapeutic approaches.
LSM3243	Molecular Biophysics	Yes - BMS	LSM2106	2	Biological Sciences	Prof Yang Daiwen dbsydw@nus.edu.sg	This course provides a physical background of macromolecular conformations and a description of biophysical techniques for studies of structure, dynamics and interactions of biomolecules. Topics will include conformation of biological macromolecules, protein folding, protein-ligand interaction, biological membrane, and biophysical techniques.

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LSM3244	Molecular Biotechnology	Yes - BMS	LSM2105	2	Biological Sciences	Dr Robert Lieu Zi Zhao dbslzz@nus.edu.sg	Traditional genetic engineering has been relatively successful for modern applied biotechnology, however its limitations in direct manipulation of genome is apparent. For this, genome engineering has emerged as the next wave in biotechnology. Genome engineering is a direct and precise approach to whole-genome design and mutagenesis to enable a rapid and controlled exploration of an organism's phenotypic landscape for biotechnology. Key advances included de novo genome synthesis, and genome-editing technology. This course will focus on how genome engineering is used together with existing or new applications of biotechnology to tackle global problems ranging from human and animal health to agriculture.
LSM3245	RNA Biology and Technology	Yes - BMS	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1	Microbiology and Immunology	Dr Volker Patzel micvp@nus.edu.sg	This course examines the roles of RNA, coding and in particular non-coding (ncRNA), in regulation of gene expression, host-pathogen interaction, and catalysis as well as their applications in research, diagnosis, and therapy of human diseases. The topics cover the 'RNA world hypothesis', the relation between structure and function of RNA, the mechanisms of regulation and dysregulation of gene expression by ncRNAs, selection and design of functional RNAs, features and usage of ncRNAs, the role of RNA in early-stage pharmaceutical developments, and RNA-based drug development.

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LSM3246	Synthetic Biology	Yes - BMS	LSM2105 or LSM2106	1	Biochemistry	Assoc Prof Matthew Chang bchcmw@nus.edu.sg	The ability to rationally engineer living cells has been a long-anticipated goal dating back for more than half a century. With the advent of DNA synthesis and genome engineering tools, biological systems can now be systematically designed for a myriad of industrial applications including disease prevention, biochemicals production and drug development. This course aims to provide basic principles to the engineering of biology with emphasis on the design and construction of synthetic gene circuits in living cells. The course also discusses current and emerging applications driven by synthetic biology, and the socio-ethical responsibilities that are required of synthetic biologists.
LSM3247	Practical Synthetic Biology	Yes - BMS	LSM2105 or LSM2106	2	Biochemistry	Assoc Prof Matthew Chang bchcmw@nus.edu.sg	Synthetic biology is the science of engineering biology, and is very much an experimental science. Building on the basic principles of synthetic biology introduced in the theoretical course LSM3246, this course aims to emphasize on the experimental techniques required for the design and construction of synthetic metabolic pathways and genetic circuits in living cells. The course also introduces advanced experimental protocols including CRISPR-Cas genome editing tools that are revolutionising fields in life and biomedical sciences.
LSM3252	Evolution and Comparative Genomics	Yes - EEB	LSM2107 or LSM2252	2	Biological Sciences	Assoc Prof Huang Danwei huangdanwei@nus.edu.sg	The objectives are to build on the students' foundation in evolutionary concepts and to advance their knowledge and skills related to comparative biology. The lectures present the theory of evolution as the unifying discipline in biology, and enhance the integrated understanding of four main themes: natural selection, palaeobiology, the tree of life and comparative genomics. Overall the course emphasises the importance and application of evolutionary biology for explaining a wide variety of phenomena in biology, from the history of life to genes, genomes and cellular processes.

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LSM3254	Ecology of Aquatic Environments	Yes - EEB	LSM2251	1	Biological Sciences	Assoc Prof Darren Yeo Chong Jinn darrenyeo@nus.edu.sg	Aquatic environments make up more than 70% of the Earth's surface. They host a huge diversity of life and ecosystems, many of which are vital to man. Topics covered in this course include diversity and ecology of freshwater and marine habitats and organisms, the impacts of humans on these environments, and the conservation and management of these critical resources. Overall learning outcomes include an appreciation and understanding of aquatic habitats, their physical and biological properties and their associated ecosystems. The importance of both marine and freshwater environments to Singapore will be highlighted.
LSM3255	Ecology of Terrestrial Environments	Yes - EEB	LSM2251	2	Biological Sciences	Dr Chua Siew Chin siewchin@nus.edu.sg	This course will introduce students to principles of terrestrial ecology. Major topics will include diversity and distributions of terrestrial environments, soils and nutrient cycling, animal-plant interactions [pollination, seed dispersal, herbivory], disturbance ecology and succession, energy flow and food webs, population biology, and fragmentation. The course will have a strong quantitative focus. The course will also cover ecological processes in rural (agricultural) and urban terrestrial environments.
LSM3256	Tropical Horticulture	Yes - EEB	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	2	Biological Sciences	Dr Amy Choong dbscmfa@nus.edu.sg	This course introduces students to the fundamentals of tropical horticulture, with emphasis on the situation in Singapore, a tropical garden city. Topics include plant growth and development and factors affecting them, pests and diseases and their control, growing media, plant nutrition, tropical urban horticulture of ornamentals, vegetable and fruit crops, and native plants, vertical and roof greening, turf grass management, landscape design, organic methods and impact of horticulture on conservation. Field trips, demonstrations, and projects will enable students to enjoy hands-on experience in cultivating plants.

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LSM3257	Applied Data Analysis in Ecology and Evolution	Yes - EEB	LSM2107 or LSM2251 or LSM2252	2	Biological Sciences	Dr Ian Chan ianchan@nus.edu.sg	Managing, analyzing, interpreting and displaying data to support-decision making has become a fundamental skill for environmental biology. This course will train students with the skills and knowledge to design and perform data analysis on typical problems in the areas of ecology, conservation and environmental sustainability. Students will learn the R language with an emphasis on spatial data, on the-ground ecological data collection and geographic information systems. Students will use the collected spatial data to support environmental impact assessment and sustainability reporting.
LSM3258	Comparative Botany	Yes - EEB	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	1	Biological Sciences	Dr Amy Choong dbscmf@nus.edu.sg	This course explores the basic relationships between the diverse forms and functions in plants. Each plant group shares a common basic structural plan but contains many members that deviate from the basic plan in response to selection pressures from the environment. Knowledge of organismal biology is enhanced through selected topics in morpho-anatomical designs and functional adaptations.
LSM3259	Fungal Biology	Yes - EEB	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	2	Biological Sciences	Dr Amy Choong dbscmf@nus.edu.sg	This course provides an overview of the diversity of fungi which include the mushrooms, yeasts, molds, rusts, and toadstools. Fungal symbionts such as lichens and mycorrhizae are also covered. Fungi are one of the four main eukaryotes on Earth (the other three being animals, plants and protists). Without fungi, decomposition and nutrient recycling will be severely impacted. Almost all land plants form symbiotic relationships with fungi which help the living plants absorb scant minerals such as phosphates and nitrates and to protect the hosts from diseases. Fungi are exploited for food, medicine, bioremediation and biotechnology.

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LSM3260	Plant-Microbe Interactions	Yes - EEB	GCE 'A' Level or H2 Biology or equivalent, or LSM1301	2	Biological Sciences	Dr Ying Chang ying.chang@yale-nus.edu.sg	Plants and microbes interact with each other on different levels and in various ways. Plant-microbe interactions have played a vital role in shaping the ecosystems since the emergence of plants on the planet. This course covers different types of plant-microbe interactions at general and detailed levels. Students will learn about the microbial infection mechanisms, establishment of symbiotic relationships, and plant immunity system responses to different microbes. There will be discussions on the broad impact of plant-microbe interactions from evolutionary, ecological and economical perspectives.
LSM3265	Entomology	Yes - EEB	LSM2251	1	Biological Sciences	Dr John Ascher dbsajs@nus.edu.sg	Insects and other related terrestrial arthropod groups are the most diverse forms of life on earth. Insects are ideal models for studies in evolution, ecology, behaviour and the environment as the same body plan has been adapted to diverse functions, in almost all terrestrial environments, and in most human endeavour. This course will equip students with knowledge in insect identification, phylogeny, ecology, beneficial and pestiferous interactions with humans, and methods for their control.
LSM3266	Avian Biology and Evolution	Yes - EEB	LSM2252	1	Biological Sciences	Assoc Prof Frank Rheindt dbsrfe@nus.edu.sg	Birds are widely studied and constitute a model for many scientific disciplines from genetics to ecology. This course explores bird biology from an evolutionary perspective. Topics include: (1) birds' dinosaur origins; (2) present-day diversity with emphasis on Asian bird families; (3) evolutionary processes that may have led to avian flight, small genome size and other avian traits; and (4) challenges birds face in Earth's modern extinction crisis. This course is suitable for students passionate about biological processes ranging from organismic evolution at the molecular level to broad ecological and biogeographic contexts.

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LSM3267	Behavioural Biology	Yes - EEB	LSM2251	2	Biological Sciences	Dr Lim Lek Min, Matthew matlim@nus.edu.sg	This course provides an in-depth coverage of the relationships that organisms have with each other and with the environment. Key concepts in organismal interactions, illustrated with examples from general diverse animals and ecological systems, to ultimate and proximate explanations of animal interactions and other life history characteristics, will be covered. Students will be given the opportunity to assimilate and critically evaluate contemporary literature on relevant current issues. Experimental studies will be designed, proposed and carried out by students to improve the understanding of animal behaviour and to appreciate the significance of behaviour in ecology as well as other related disciplines.
LSM3272	Global Change Biology	Yes - EEB	LSM2251 or LSM2251 (Precludes BES students and pass in ENV1101)	2	Biological Sciences	Dr Lim Lek Min, Matthew matlim@nus.edu.sg	The objective of this course is to promote an understanding of Global Change Biology from a multidisciplinary approach. Students will discuss and explore selected themes of prevailing environmental, biological, socio-economical and technological issues and solutions through lectures based on literature reviews and documentaries of relevant themes, field trips and group projects.
LSM4210	Topics in Biomedical Science: Brain, Metabolism, Ageing	Yes - BMS	LSM2233 or LSM3210 or LSM3220	2	Biological Sciences	Assoc Prof Christoph Winkler dbswcw@nus.edu.sg	Biomedical science is the spectrum of Life Sciences that addresses human health and diseases. From genetics to metabolism, developmental biology to ageing, neurobiology to physiology, these key topics interplay to build up our understanding of the human body and how it responds to internal disruptions and external disturbances especially in disease conditions. This course puts a focus on selected topics in biomedical science with strong emphasis on the techniques used to study metabolic disorders and ageing, and how the human brain faces both challenges.

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LSM4211	Toxicology	Yes - BMS	LSM3211	1	Pharmacology	Dr Rajkumar Ramamoorthy rajkumar@nus.edu.sg	This course is designed to provide students with a good understanding of the basic principles and modern concepts of toxicology. It explores the adverse effects of chemicals on humans and the biosphere, emphasising the skills needed to make quantitative risk assessments and understand the intricacies of exposure to hazardous compounds. The course delves into the extrapolation from animal data and the linkage of adverse effects at the molecular level to overall toxic responses in humans.
LSM4213	Systems Neurobiology	Yes - BMS	LSM3215 or LSM3216	1	Physiology	Dr Andrew Tan phstya@nus.edu.sg	The primary goal of this course is to understand how (a) neurons, assembled into circuits, mediate behaviour and (b) pathophysiology of neurons leading to dysfunctional cellular and molecular processes and behaviour. It draws on basic knowledge of the cell biology and physiology of neurons, as well as the use of elementary calculus which will be gently introduced from scratch and needs no prior background in calculus.
LSM4214	Cancer Pharmacology	Yes - BMS	LSM3211	1 and 2	Pharmacology	Assoc Prof Gautam Sethi phcgs@nus.edu.sg	This course will introduce students to the general principles of drug actions that underpin their therapeutic applications against cancers, from conventional (non-specific) chemotherapy to target-specific drugs. It will provide details of drugs used in specific cancer types, ranging from those with proven efficacy in clinics (e.g. Gleevec) to experimental agents in trials. Conceptual and theoretical targets (e.g. RNAi and gene therapies) will also be introduced.
LSM4215	Extreme Physiology	Yes - BMS	LSM3212	2	Physiology	Dr Ivan Low Cherh Chiet phsilcc@nus.edu.sg	This course describes how the human body responds to exposure and exercise in environmental extremes such as hypoxic and hyperbaric conditions, thermal stressors, microgravity and trauma. Latest research findings, including some of the controversial topics, will be presented and discussed. Students will understand what the physiological changes are under extreme conditions and how acute and chronic adaptations occur in response to these stresses. This will allow students to appreciate how the human body adapts to changing environments.

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LSM4216	Molecular Nutrition and Metabolic Biology	Yes - BMS	LSM3210	1	Biochemistry	Dr Long Yun Chau bchlongy@nus.edu.sg	Nutrients are essential for sustenance. Nutrients and metabolites have a deep impact on cellular response and adaptation at the genetic, epigenetic and signalling level and vice versa. Nutrients also have an effect on intestinal microbiota, which in turn alters the absorption and utilization of nutrients. This course will cover interactions between nutrients and genes, epigenetics, cell signalling and microbiota. Molecular approaches to conduct nutrition related research would be discussed.
LSM4217	Functional Ageing	Yes - BMS	LSM3217	2	Physiology	Asooc Prof Manoor Prakash Hande phsmph@nus.edu.sg	Populations around the world are rapidly ageing and it is important to understand the functional decline in ageing populations. Functional age is defined as a combination of chronological, biological and psychological ages. Molecular processes governing ageing will be covered during the first half while the second half will be on societal perception, burden of disease, healthy ageing interventions and ageless society. The ageing process will be explained based on the experimental and epidemiological studies. This course will integrate biology and sociology of ageing which will provide avenues for better understanding of ageing in a society.
LSM4218	Biotechnology and Biotherapeutics	Yes - BMS	LSM2106	1 and 2	Biological Sciences	Assoc Prof Ge Ruowen dbsgerw@nus.edu.sg	The revolutionary advances of modern biotechnology and biomedical science have had significant impacts on how a drug is discovered and developed. This course focuses on the contributions of biotechnology to the advancement in drug discovery and development by exploring how genes, proteins and cells are transformed into biotherapeutic drugs. Topics covered include: recombinant protein and peptide drugs, antibody and nanobody therapeutics, DNA and siRNA drugs, cell therapeutics, new technology in vaccine generation and cancer vaccines, diagnostics-based targeted therapeutics (theranostics), as well as how the omics technology (genomics, proteomics and metabolomics) changes drug discovery.

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LSM4220	Molecular Basis of Human Diseases	Yes - BMS	LSM2233 or LSM3210 or PHS3123	2	Biochemistry	Assoc Prof Yeong Foong May bchyfm@nus.edu.sg	This course aims to provide students with in-depth knowledge of the basic molecular mechanisms of common human diseases, such as genetic diseases, metabolic diseases, cancers and infectious diseases. The course is structured around discussions of data and ideas from current research articles and reviews. Students are expected to participate in presentations and discussions. As the focus of this course is on the molecular mechanisms underlying the pathogenesis of each disease, prospective students should have basic knowledge of molecular and cell biology, genetics and general human physiology before registering for this course.
LSM4221	Drug Discovery and Clinical Trials	Yes - BMS	LSM3211	1 and 2	Pharmacology	Assoc Prof Edward Kai-Hua Chow phcekc@nus.edu.sg (Sem 1) Dr Le Thi Nguyet Minh phcltnm@nus.edu.sg (Sem 2)	This course will cover the stages that a drug that is developed for clinical use goes through before it is marketed: discovery/synthesis, preclinical studies, clinical drug trials, registration and post-market surveillance. The different phases of clinical drug trials and the guidelines for ethics and good clinical practice will be discussed. Students are also divided into groups to design clinical trials. At the end of the course the students will have an overview of the processes involved in bringing a drug from the laboratory to the market.
LSM4222	Advanced Immunology	Yes - BMS	LSM3223	1 and 2	Microbiology and Immunology / Biochemistry	Dr Kaiwen Chen kaiwen.chen@nus.edu.sg (Sem 1); Assoc Prof Gan Yunn Hwen bchganyh@nus.edu.sg (Sem 2)	The objective of this course is to provide students with a current and up-to-date view of immunology. Breakthrough areas will certainly vary from year to year, but the broad subject matter will remain. The highly competitive areas of immunology research focus on innate immunity, macrophage and dendritic cell biology, anti-viral defence, molecular mechanisms of cell death and inflammation, mucosal immunity and host-microbiome interaction, lymphocyte development and differentiation, induction of tolerance, mechanism of autoimmunity and allergy, and vaccine development.

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LSM4223	Advances in Antimicrobial Strategies	Yes - BMS	LSM3225 or LSM3232	1	Microbiology and Immunology	Dr Jaishree Tripathi jtmic@nus.edu.sg	An advanced course in the study of infectious diseases of man with emphasis on new and emerging infections as well as those of major clinical/economic importance. Core topics include understanding the principles and practice of Medical Microbiology, the nature and emergence of antimicrobial resistance, changing epidemiology of infections and laboratory diagnosis using classical diagnostic techniques and current molecular approaches. Seminars will be conducted as team presentations to explore current topics on infectious diseases in depth. A strong practical component is included.
LSM4225	Genetic Medicine in the Post-Genomic Era	Yes - BMS	LSM2105	2	Biochemistry	Assoc Prof Lee Guat Lay, Caroline bchleec@nus.edu.sg	This course is intended to provide a good foundation and stimulate students' interest in specialized topics in Genetics and Genomics related to translational research. The course will provide students with knowledge of current practices in Genetic Medicine. Students will also know how gene identification, diagnostic and therapeutic strategies are formulated and performed. They will also be expected to show how to translate new genetic and genomic discoveries into novel diagnostic and therapeutic strategies. Major topics covered are gene identification, genetic diagnosis, and gene therapy. Ethical, legal, and social issues (ELSI) in genetic medicine will also be covered.

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LSM4226	Infection and Immunity	Yes - BMS	LSM3223 and either LSM3225 or LSM3232	1	Microbiology and Immunology	Assoc Prof Sylvie Alonso micas@nus.edu.sg	This course aims at providing an in-depth knowledge in the field of host-pathogen interactions, i.e., how the immune system deals with pathogens, and how the pathogens deal with the host's immune system. An introductory lecture series covers the basics in microbiology (bacteriology, virology, parasitology), immunology, vaccinology, and general principles of host-pathogen interactions. Selected diseases illustrate host-pathogens interactions along with the consequences for vaccine and drug design. The following set of lectures covered by clinicians and professionals focus on patient management, field study, as well as safety aspects when working with pathogens in a research lab. Tutorials are broken into 'journal club', 'article write-up exercise' and 'problem-based study' and are directly related to the topics developed during the lectures.
LSM4227	Stem Cell Biology	Yes - BMS	(LSM2232 or LSM3220) and LSM2233	1 and 2	Biological Sciences	Assoc Prof Chan Woon Khiong dbscwk@nus.edu.sg	This course will provide a detailed and critical introduction in the biology of stem cells and regenerative medicine. Students will investigate the origin of embryonic and adult stem cells and learn biological concepts relating to pluripotency, self-renewal, transdifferentiation, reprogramming and regeneration. The cell-fate determination and differentiation of selected types of cells, with a focus on their potential biological and medical applications, will be presented. Specialized topics on cancer stem cells, wound healing and tissue regeneration will provide a glimpse of how mankind's future could be further shaped.

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LSM4228	Experimental Models for Human Disease and Therapy	Yes - BMS	LSM2105	Not offered until further notice	Biological Sciences -		Experimental models including animal and cellular models are pivotal for the study of human diseases and development of therapeutics. They help to characterize disease pathophysiology, evaluate the mechanism of action of existing drugs, discover and validate new drug targets and candidates, establish pharmacodynamic/pharmacokinetic (PK/PD) relationships, estimate clinical dosing regimens and determine safety margins and toxicity. Recent advancement of genomic and gene editing technology facilitated the establishment of more disease models that can closely mimic human diseases, including diseases that involve environmental factors. In this course, we will discuss the technology, application as well as limitations of the current experimental models.
LSM4229	Therapeutic and diagnostic agents from animal toxins	Yes - BMS	LSM3211 or LSM3231	Not offered until further notice	Biological Sciences -		Toxins are thought as villains as they cause death and debilitation. In reality, they have contributed more to improving our lives than cause death. This course will introduce the contributions of toxins to our knowledge in biomedical and pharmacological fields. Toxin research has helped in understanding molecular mechanisms of a number of processes such as neurotransmission, blood coagulation and platelet aggregation. Toxins have been useful in the development of therapeutic agents, diagnostic reagents and research tools. The course will examine the recent advances and future prospects in toxin research.
LSM4231	Structural Biology	Yes - BMS	LSM2106, and GCE 'A' Level or H2 Mathematics/Further Mathematics or equivalent or MA1301 or MA1301X	2	Biological Sciences	Prof Yang Daiwen dbsydw@nus.edu.sg	This course provides an overall view on the structure determination of protein molecules, protein complexes, protein-DNA complexes and viral assemblies. Topics will include the theory and practice of the three major methods - electron microscopy (EM), nuclear magnetic resonance (NMR) and X-ray crystallography.

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LSM4232	Advanced Cell Biology	Yes - BMS	LSM2233	1	Physiology	Dr Tsai Shih-Yin phsts@nus.edu.sg	Technological advances allow us to study and modulate various cellular processes generated from the dynamic remodeling of cytoskeleton in cells and explore the roles and interplay of mechanical forces and biochemical signaling on how they migrate the cell, mediate intracellular trafficking and eventually move our body. This course explores the mechanism of cytoskeleton dynamics and apply it to the process of cell movement and intracellular trafficking, which are important for our body physiology such as skeletal muscle performance. Emphasis will be placed on understanding the cellular and molecular mechanisms that lend themselves to experimental manipulation and for future therapeutic intervention.
LSM4234	Mechanobiology	Yes - BMS	LSM2233 and LSM3220	2	Biological Sciences	Assoc Prof Yusuke Toyama dbsty@nus.edu.sg	This course introduces students to mechanobiology, an emerging field of life sciences that explores mechanical regulation and implications underlying numerous biological events from prokaryotes to higher organisms. It covers regulation of cell functions by cytoskeletal networks, mechanics of movement of tissue/cell/sub-cellular organelle, cellular/molecular force-sensing, mechanical modulation of biochemical signaling, physical landscapes of peri-/trans-/intra-nuclear events including transcription, and mechanical control of multicellular living organization. It also refers to physical and engineering aspects of physiological or pathological backgrounds of human health and diseases. In addition, students learn cutting-edge technologies to dissect mechanical/physical aspects of cellular/molecular functions.
LSM4236	Human Microscopic Anatomy	Yes - BMS	LSM2105 or LSM2106	2	Anatomy	Prof Ong Wei Yi antongwy@nus.edu.sg	This course develops the foundations of human microscopic anatomy essential for research or clinical applications. It covers the visualization of biomolecules in tissues of the body. Interpretation of images occurs in the context of knowledge about the normal microscopic anatomy of different tissues and organs of the human body. Suitable clinical problems will be introduced throughout the course to show the application of scientific knowledge.

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LSM4241	Functional Genomics	Yes - BMS	LSM3231 or LSM3241	2	Biochemistry	Assoc Prof Maxey Chung bchcm@nus.edu.sg	This course aims to introduce selected topics on functional genomics. Areas covered include: the assignment of functions to novel genes following from the genome-sequencing projects of human and other organisms; the principles underlying enabling technologies: DNA microarrays, proteomics, protein chips, structural genomics, yeast two-hybrid system, transgenics, and aspects of bioinformatics and its applications; and to understand the impact of functional genomics on the study of diseases such as cancer, drug discovery, pharmacogenetics and healthcare.
LSM4242	Protein Engineering	Yes - BMS	LSM3220 or LSM3231	1	Biological Sciences	Assoc Prof Pan Shen Quan dbspansq@nus.edu.sg	This course will familiarize students with the technologies that can be used to produce and engineer various proteins for basic biological research and biotechnology applications. The fundamental principles for manipulating protein production as desired and the common expression systems will be presented. The emphasis will be on the experimental strategies and approaches to improve protein properties and to create novel enzymatic activities. The topics include gene expression and protein production systems, uses of gene fusions for protein production and purification, directed molecular evolution and DNA shuffling, and engineering of proteins and enzymes for improved or novel properties.

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LSM4243	Tumour Biology	Yes - BMS	LSM2233	1 and 2	Physiology	Dr Derrick Ong phsostd@nus.edu.sg (Sem 1); Prof Reshma Taneja phsrt@nus.edu.sg (Sem 2)	This course deals with the understanding of processes that regulate cell growth and proliferation, and the intricate mechanism(s) that result in abnormal proliferation and oncogenesis. Molecular basis of immortalization and the acquisition of the neoplastic phenotype, namely oncogene activation, immune evasion, potential for local and distant spread, and resistance to cell death etc. will be discussed. Role of DNA damage/repair, telomere/telomerase in genome instability and tumourigenesis will be examined. A brief session on target therapies including gene therapy approaches will also be included. Tumour immunology role of inflammation in tumours will be discussed.
LSM4245	Advanced Epigenetics and Chromatin Biology	Yes - BMS	LSM3235	2	Biochemistry	Assoc Prof Chen Ee Sin bchces@nus.edu.sg	The aim of this course is to introduce concepts and molecular mechanism of epigenetics. Students will learn the historic discoveries of epigenetic research, DNA methylation, post-translational histone modifications, noncoding RNA, chromatin remodelling and epigenetic reprogramming. The course will focus on the role of epigenetic modifications in biological functions. The clinical applications of epigenetics will also be discussed.
LSM4251	Plant Growth and Development	Yes - EEB	LSM2254 or LSM3233 or LSM3258	1	Biological Sciences	Prof Yu Hao dbsyuhao@nus.edu.sg	Growth and development of higher vascular plants through their life cycles. Discussion in this course include selected topics in gamete development, fertilization, embryo development, seed germination, development of various plant organs and flowering, the role of plant growth regulators, and the cellular, physiological and molecular basis of plant morphogenesis. The molecular basis of various stages of plant development will be discussed using developmental mutant analyses.

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LSM4252	Reproductive Biology	Yes - BMS	LSM2233	2	Biological Sciences	Assoc Prof Christoph Winkler dbswcw@nus.edu.sg	This course covers the events and mechanisms leading to the development and differentiation of gonads and sexes in animals and humans, and eventually to the reproduction and propagation of a new generation. It describes the use of invertebrate (<i>Drosophila</i> , <i>C. elegans</i>) and vertebrate models (fish, mouse) in reproduction research, and discusses selected topics to highlight the current trends in animal and human reproduction. This includes new trends in hormonal control of human reproduction (endocrinology), cellular mechanisms and genetic control underlying gonad differentiation, and diseases of the reproductive system.
LSM4254	Principles of Taxonomy and Systematics	Yes - EEB	LSM3241 or LSM3252	Not offered until further notice	Biological Sciences -		This course introduces students to taxonomy and systematics, i.e., the science of grouping biodiversity into species, describing the species, and classifying this diversity into higher-level taxa that reflect evolutionary history. The course has two main goals: (1) It introduces the main concepts and goals of taxonomy and systematics. (2) It teaches the qualitative and quantitative techniques that are today used to describe/identify species and higher-level taxa based on the analysis of morphological and DNA sequence evidence. The aim is to equip environmental as well as other biologists with a thorough understanding of taxonomic/systematic units and the tools needed for evaluating and quantifying diversity in samples of plant and animal specimens.

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LSM4255	Methods in Mathematical Biology	Yes - EEB	LSM3257	1	Biological Sciences	Assoc Prof Chisholm, Ryan Alistair dbscra@nus.edu.sg	The use of mathematics has a long history in the life sciences, allowing scientists to clearly articulate their assumptions, rigorously test their ideas about how biological systems work, and make predictions. In this course, students will explore both current and classical questions in mathematical biology, such as: What factors constrain and contribute to the species diversity of an ecosystem? Under what conditions can we expect the stable coexistence of predator and prey populations, or competitors in an ecosystem? What proportion of a human population do we have to vaccinate to prevent an epidemic?
LSM4256	Evolution of Development	Yes - EEB	LSM3233 or LSM3252	1	Biological Sciences	Prof Antonia Monteiro antonia.monteiro@nus.edu.sg	The objective of this course is to integrate two disciplines, Evolutionary Biology and Developmental Biology into a common framework. The course explores the evolution of animal bodies, e.g., legs, segments, eyes, wings, etc., by focusing on changes at the molecular and developmental levels. This course will introduce important concepts such as hox genes, selector genes, homology, serial homology, modularity, gene regulatory networks, genetic architecture, developmental basis of sexual dimorphism, and phenotypic plasticity, and give a broad organismic-centred perspective on the evolution of novel traits.

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LSM4257	Aquatic Vertebrate Diversity	Yes - EEB	LSM2252	1	Biological Sciences	Dr Zeehan Jaafar jaafarz@nus.edu.sg	Aquatic vertebrates are essential components of freshwater and marine ecosystems, often occupying higher trophic/food web levels with wider ecological influence. As relatively sizeable and abundant elements of aquatic ecosystems, these organisms are also central to the ecosystem goods and services provided. Besides fishes, the most speciose extant vertebrate group, the remaining four vertebrate classes all include aquatic lineages. This course offers a firm foundation in the global diversity of aquatic vertebrates in the context of their biology, ecology, and conservation. Emphasis on Southeast Asian aquatic vertebrate biota provides a framework that informs management of regional imperiled freshwater and marine ecosystems.
LSM4259	Evolutionary Genetics of Reproduction	Yes - EEB	LSM2105 and LSM2107	1	Biological Sciences	Dr Nalini Puniamoorthy nalini@nus.edu.sg	Why do some species invest all their resources in securing a mate to reproduce with whilst others avoid sex altogether by cloning themselves? This course takes an integrative approach to understanding the mechanisms of inheritance and reproduction from an evolutionary perspective across plants and animals. We will adopt evidence-based learning, review both classic and current primary literature, as well as offer hands-on practicals on analysing datasets (e.g.: selection experiments, population genome data etc.). Topics covered include the evolution of sex, operation of sexual selection, the genetics of reproduction and the rapid evolution of immune function and reproduction.

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LSM4260	Plankton Ecology	Yes - EEB	LSM3254 or LSM3257	1	Biological Sciences	Dr Maxine Mowe dbsmadm@nus.edu.sg	Phytoplankton and zooplankton are a vital part of aquatic ecosystems and form the basis of aquatic food webs. Understanding the role of plankton in aquatic ecosystems will help in advancing the solutions to problems facing today's water resources (harmful algal blooms, eutrophication and pollution). This course focuses on the biodiversity and ecology of phytoplankton and zooplankton, the roles they play in marine and freshwater ecosystems, their potential uses as biofuel and in aquaculture. The course will consist of lectures, practicals and a hands-on application of modelling on phytoplankton datasets.
LSM4261	Marine Biology	Yes - EEB	LSM3254	2	Biological Sciences	Assoc Prof Huang Danwei huangdanwei@nus.edu.sg	Main focus on the understanding and appreciation of marine environment, the diversity of marine life, and the constant interaction between man and the sea. Marine biology as the scientific study of marine animals and the marine environment. Fundamentals of oceanography. The range of marine environments and variety of organisms inhabiting them. Benefits of the marine environment and its resources to humans. The impact of exploitation and human activities on the oceans.
LSM4262	Tropical Conservation Biology	Yes - EEB	LSM2251 and either LSM3272 or ENV1101	1	Biological Sciences	Dr Ian Chan ianchan@nus.edu.sg	Conservation and the loss of biodiversity and natural ecosystems are currently regarded as one of the most pressing problems facing mankind. The course will highlight the impact of habitat loss on biodiversity and the basis for formulation of effective conservation management strategies. The course will also introduce students to the theory of current conservation biology as illustrated by applications in tropical areas, species conservation issues, ecological challenges, role of zoological gardens, legal challenges etc. Conservation of tropical biota, management of local and regional environmental problems, appreciation and consideration of the socio-economic issues will also be treated.

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LSM4263	Field Studies in Biodiversity	Yes - EEB	LSM2251 and LSM2252	4	Biological Sciences	Dr Tan Yen Yi yenyi.tan@nus.edu.sg	This course introduces students to field biology - the basic techniques involved, sampling design and basic data gathering and data management. Through field study sessions, students will experience and encounter tropical environs and habitats, namely coastal, mangrove, primary and secondary forests. This is to gain an understanding of the various field methods in biodiversity research, and to achieve an appreciation and a broader perspective on the types or sub-fields of biodiversity research and what they entail. A week-long field project is incorporated and will be conducted in Pulau Tioman, Malaysia.
LSM4264	Freshwater Biology	Yes - EEB	LSM3254	2	Biological Sciences	Dr Maxine Mowe dbsmadm@nus.edu.sg	Freshwater is essential to life, yet constitutes less than 3% of Earth's total water. With many freshwater ecosystems under threat, understanding the biology of freshwaters is fundamentally important to their management, conservation and restoration. This course introduces the study of inland waters, with emphasis on aquatic ecology, structure and function, and aquatic conservation. Topics discussed will include diversity and ecology of freshwater habitats and aquatic organisms, and aquatic conservation issues including policies, regulation and management of freshwater resources in local and international contexts.

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LSM4266	Aquatic Invertebrate Diversity	Yes - EEB	LSM2252	2	Biological Sciences	Dr Theresa Su theresas@nus.edu.sg	Invertebrate biodiversity is an important component of aquatic environments and ecosystems. Its study is essential for conservation and management of such environments. This course aims to enhance students' knowledge of tropical aquatic biodiversity through directed studies in freshwater and marine invertebrates. Biota in Singapore will be highlighted. Emphasis is on organismal diversity, taxonomy and classification. Other topics such as structure and function, ecology, conservation, and economic importance will be covered within the context of selected organismal groups. Appreciation of the importance of aquatic biodiversity as well as knowledge, familiarity, and understanding of selected groups of aquatic biodiversity are the learning outcomes.
LSM4267	Light & Vision in Animal Communication	Yes - EEB	LSM3267	1	Biological Sciences	Dr Lim Lek Min, Matthew matlim@nus.edu.sg	Animals rely on various sensory systems to detect environmental information; a common mode involves light detection. Many rely on visual stimuli for numerous behavioural activities; humans often fail to understand these light signals. This course will introduce: (i) the fundamentals of light detection, (ii) the instrumentation and software involved in accurate detection, quantification/characterisation of animal/plant light signals, (iii) the formulation of hypotheses in animal-animal and animal-plant visual communication from interdisciplinary sciences (e.g., behaviour, conservation, optics), and (iv) relevant industrial applications. This course will also visit some other systems beyond the visible light spectrum, for example: infrared reception and thermoreception.

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LSM4268	Environmental Bioacoustics	Yes - EEB	LSM3267 or LSM3272	1	Biological Sciences	Dr Lim Lek Min, Matthew matlim@nus.edu.sg	Although animals sense their physical and biotic environments via various modalities, how they sense the environment acoustically is still poorly understood. From low frequency minute vibrations to infrasonic and ultrasonic frequencies, from waterborne to air-transmitted sounds, this course will introduce what sound is (i.e. fundamentals of sound, how sound travels etc.), how and why it matters to animals (i.e. mechanisms and adaptive functions of sound production and reception) in both terrestrial and marine habitats, bioacoustic instrumentation and software, industrial applications, and how environmental issues involving sounds such as terrestrial and ocean noise pollution are affecting animals and humans.
LSM4351	Vegetation and Plant Diversity of Southeast Asia	No <i>[For Minor in Botany]</i>	LSM3258	2	Biological Sciences	Dr Amy Choong dbscmf@nus.edu.sg	The vegetation types and plant diversity of Southeast Asia, including Singapore, will be introduced from ecological, evolutionary and biogeographical perspectives. Plant classification and major evolutionary lineages will be discussed, along with the fundamental importance of exploration, herbarium and living reference collections and taxonomic research. Plant identification, an indispensable tool in resource and conservation assessment, and for supporting management approaches including in urban landscapes, will be highlighted through practical sessions and fieldwork. The significance of plants for human societies, against a background of deforestation, agriculture, climate change, diseases and new medicines, will be underscored.

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LSM4352	Sustainable Urban Food Production for Food Security	No <i>[For Minor in Env Sustainability]</i>	GCE 'A' Level or H2 Biology or equivalent or LSM1301, and GCE 'A' Level or H2 Chemistry or equivalent or CM1417/CM1417 X	2	Biological Sciences	Dr Jiang Junhui jhjiang@nus.edu.sg	This course highlights the key food security considerations and research trends relating to sustainable urban food production. It covers the scientific and technological innovations in agriculture and aquaculture, with topics including genetics, nutrition and health involved in the production of fish and plants, and scientific considerations for a robust food safety system such as Hazard Analysis Critical Control Point (HACCP)-based risk assessment and testing of different food safety hazards relating to different food innovations. The course aims to develop an appreciation of the emerging risks in urban food production against the current backdrop of accelerating food production innovations and climate change.