Genetics

Genetics is fundamental to all biological sciences and, therefore, any student specialising in a biological science discipline should consider taking some genetics subjects.

Subjects in genetics aim to provide students with an understanding of the applications of a genetic approach to fundamental biological problems. The nature and analysis of genetic variation in organisms ranging from microbes to humans, and implications for modern evolutionary theories, are considered. Particular emphasis is placed on the combined use of classical and molecular genetic methodology to analyse biological phenomena at both the cellular and population levels. Subjects include studies relevant to biomedical applications of genetics and to biotechnology.

Students who wish to specialise in genetics are encouraged to do a genetics major as detailed on page 13. Completion of a genetics major will provide the student with an understanding of the fundamental aspects of genetics at 200-level, progressing at 300-level to advanced aspects of molecular genetics, ecological genetics, molecular evolution, genomics, practical genetic analysis, and a choice of additional studies in developmental, human and experimental genetics.

For BSc, BASc or BSc combined degree students, completion of a genetics major is a prerequisite for entry into honours in genetics. Students who completed their studies prior to 1999 and wish to be eligible for entry into honours in genetics are also required to complete a genetics major. Exceptions to this prerequisite may be allowed by the Head of Department on a case-by-case basis.

BBiomedSc students wishing to enter the genetics honours program need to have completed 652-214 Principles of Genetics, 652-216 Molecular & General Genetics Practical and at least 25 points of 300-level genetics subjects.

At 200-level it is recommended that all BSc, BASc or BSc combined degree students undertaking a genetics major also take biochemistry and molecular biology 521-211 and 521-212.

Students taking a genetics major may consider a second major depending upon their interests. For those with an interest in molecular genetics, the following are recommended: majors in biochemistry and molecular biology, biotechnology, cell biology, immunology, microbiology, neuroscience and plant sciences. For those with an interest in population and evolutionary genetics, the following are recommended: majors in animal behaviour and evolution, conservation and Australian wildlife, ecology, plant science, marine biology, mathematics and statistics; or a co-major in environmental science.

Students not wishing to undertake a second major in addition to a genetics major, should consider an appropriate selection of subjects from biochemistry and molecular biology (recommended), chemistry, botany, zoology, microbiology, psychology, mathematics and statistics, and physiology.

Students wishing to take some genetics subjects without completing a genetics major should take 652-214 and 652-215 and a selection from 652-301, 652-302, 652-303 and 652-305 depending upon their interests.

Bachelor of Science (Degree with Honours)

For information about the faculty and departmental entry requirements for honours, please refer to *Bachelor of Science (Degree with Honours) and Bachelor of Information Systems (Degree with Honours) (p.1)*. These requirements should be considered when planning your course.

Further information

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Subject descriptions

200-level subjects

652-214 Principles of Genetics

Note: This subject can be taken by itself, but is designed to be part of a two-semester sequence with 652-215.

Both 652-214 and 652-215 (or 652-214, 521-213 and 536-250) are prerequisites for 300-level genetics subjects.

Credit points: 12.5

Coordinator: Dr A Andrianopoulos; Dr B Appleton (Sum)

Prerequisites: Biology 650-142 or 650-132 (prior to 2004: 600-142 or 600-132). Biology 650-141 or 650-131 (prior to 2004: 600-141 or 600-131) is recommended.

Contact: 48 hours of lectures, problem classes and computer exercises *(Semester 1, repeat Summer)*.

Description: This subject provides a coverage of genetics from the DNA molecule and inheritance to the factors which modulate allele frequencies in natural populations; the genetic and molecular basis of phenotypic variation; genetic analysis in eukaryotes, viruses and bacteria; the nature of the genetic material; gene structure and function; quantitative inheritance; and genes at the population level.

Completion of this subject is expected to enhance a student's ability to understand the fundamental principles of genetics and to describe the experiments used to establish them. Students will develop skills to apply these principles to solve genetic problems and demonstrate how genetic analysis can be used to investigate aspects of biology.

Completion of this subject is expected to enhance the generic skills of a student in the application of fundamental scientific principles to solve new problems; in the application of scientific method through the development of hypotheses based on observations; and in planning efffective work schedules to meet deadlines for assessable work.

Assessment: Summer Semester: four online tests during semester (40% in total); a 2-hour written examination at the end of semester (60%). Semester 1: one written class test and two online tests during semester (30% in total); a 2-hour written examination in the examination period (70%). The intra-semester tests are of equal value both for the summer semester and semester 1.

Prescribed texts: RJ Brooker, *Genetics, Analysis and Principles*, 2nd Ed. McGraw-Hill.

652-215 Genes and Genomes

Note: Not available to students enrolled in the BBiomedSc.

Credit points: 12.5

Coordinator: Assoc Prof M Davis

Prerequisites: Biology 650-141 and 650-142; or biology 650-131 and 650-132 (prior to 2004: 600-141 and 600-142; or biology 600-131 and 600-132).

Contact: 48 lectures and problem classes (four per week) *(Semester 2)*.

Description: Upon completion of this subject, students should have:

- an understanding of the molecular basis of gene structure, expression and regulation in prokaryotes and eukaryotes;
- an understanding of DNA replication, recombination and mutagenesis;
- an appreciation of the organisation of genomes in a variety of organisms and the nature of molecular evolution; and
- the skills to solve problems and analyse data using a genetic approach.

The subject provides an introduction to the molecular basis of gene structure and expression in prokaryotes and eukaryotes; the processes of DNA replication, mutation and recombination; the molecular tools of gene isolation and analysis; and molecular evolution.

Assessment: A written class test held mid-semester (10%); two online tests during the semester (15% in total); a 2-hour written examination in the examination period (75%)

Prescribed texts: RJ Brooker, *Genetics, Analysis and Principles*, 2nd Ed. McGraw-Hill.

652-216 Molecular & General Genetics Practical

Note: This subject may be done in either Semester 1 or Semester 2.

Special requirements: laboratory coat.

Credit points: 12.5

Coordinator: Mr S Hardy

Prerequisites: Biology 650-141 and 650-142; or biology 650-131 and 650-132 (prior to 2004: 600-141 and 600-142; or biology 600-131 and 600-132).

Pre or Corequisites: Genetics 652-214 or 652-215.

Contact: 12 lectures (one per week), 36 hours of practical work (three hours per week) and 12 hours of computer-assisted learning (average of one hour per week) *(Semester 1, repeat 2)*.

Description: Upon completion of this subject, students should have:

- competence in the experimental methods used in genetics;
- an understanding of the application of genetic principles to experimental strategies;
- the ability to analyse data generated from their own experiments;
- experience in writing scientific reports; and
- experience in using computers for genetic exercises.

The subject provides coverage of the techniques and experimental designs used in genetic, cytogenetic and molecular genetic analysis of microorganisms and higher organisms.

Assessment: A written class test held mid-semester (10%); experimental reports not exceeding 30 pages due during the semester (30%); two reports, based on computer exercises, not exceeding five pages due during the semester (10%); a 2-hour written examination in the examination period (50%).

Prescribed texts: RJ Brooker, *Genetics, Analysis and Principles*, 2nd Ed. McGraw-Hill.

300-level subjects

652-301 Genomes and Evolution

Note: This subject replaces 652-301 Ecological and Evolutionary Genetics (prior to 2001).

Credit points: 12.5

Coordinator: Dr C Robin

Prerequisites: Genetics 652-214 and 652-215.

BBiomedSc students: Genetics 652-214, 521-213 and 536-250.

Contact: 36 lectures (three hours per week) *(Semester 2).*

Description: Upon completion of this subject, students should have:

- acquired an up-to-date understanding of whole-genome mapping and sequencing projects;
- developed a capacity to critically review the written literature and to access web-based databases of genomic information;
- understood how genes, gene pools, and genomes change through evolutionary time;
- developed a critical appreciation for the methods used to detect and quantify the major evolutionary forces;
- comprehended the logic used in inferring evolutionary processes from patterns of genetic variation in space and time; and
- appreciated the connections between molecular evolution and conservation biology and phylogenetics.

The emphasis of this subject is on the use of molecular markers in genome mapping, in understanding how evolutionary forces shape the gene pool, in dissecting polygenic traits by mapping quantitative trait loci, and in other applications such as phylogenetics and conservation biology.

The topics covered will be classical population genetics, the measurement of selection, processes of speciation, conservation genetics, molecular evolution of single-copy and multi-copy genes, phylogenetic reconstruction, development of saturated linkage maps, physical mapping of genomes, whole-genome sequencing projects, mapping quantitative trait loci, comparative genomics, functional genomics, and high-throughput methods for scoring genetic polymorphisms.

Assessment: A written class test during semester (20%); three tutorial assignments of not more than 500 words each due during the semester (30% in total); a 2-hour written examination in the examination period (50%).

652-302 Molecular Genetics

Credit points: 12.5

Coordinator: Dr R Todd

Prerequisites: Genetics 652-214 and 652-215.

BBiomedSc students: Genetics 652-214, 521-213 and 536-250.

Contact: 36 lectures (three per week) *(Semester 1).*

Description: Upon completion of this subject students should have:

- developed a general understanding of the molecular structure of genes and the molecular basis of genetic processes, including the various mechanisms that regulate the expression of genes, in both prokaryotes and eukaryotes;
- an appreciation of recently discovered molecular mechanisms for generating the diversity of gene products and controlling their expression;
- an understanding of the basic techniques involved in recombinant DNA analysis and genomics, and application of these tools to solve specific biological problems and determine gene function using gene manipulation, gene inactivation and/or transfer of genes between organisms;
- an ability to interpret data generated using standard molecular methods and an appreciation for, and understanding of, the way in which information in this field is obtained and presented through the study of primary research papers and review articles; and
- acquired the basic concepts and knowledge to enable them to critically appraise newly reported findings in molecular genetics and do more advanced courses in a wide range of areas of cellular and molecular biology.

This subject focuses on gene structure, function and regulation, which form the molecular basis of many important biological phenomena such as short-term organismal and cellular responses to rapid changes in environmental conditions and long-term controls of development and pathologies such as heritable diseases and cancer. The molecular mechanisms underlying these phenomena are frequently exploited in biotechnology, medical and agricultural applications. The techniques used to study these processes often make use of endogenous mechanisms for gene disruption and gene transfer.

The topics to be covered in this subject include prokaryotic gene structure, action and regulation; genomic and recombinant DNA methodology; eukaryotic gene structure, action and regulation; genetic manipulation of microorganisms, plants and animals and genetic engineering; genome structure; prokaryotic and eukaryotic mobile DNA elements and their uses; and genetic control of the cell cycle.

Assessment: One multiple-choice class test held mid-semester (10%); two online assignments/problem-solving tasks due during the semester (15%); a 3-hour written examination in the examination period (75%).

652-303 Developmental and Cellular Genetics

Credit points: 12.5

Coordinator: Assoc Prof L Kelly

Prerequisites: Genetics 652-214 and 652-215.

BBiomedSc students: Genetics 652-214, 521-213 and 536-250.

Genetics 652-302 is recommended.

Contact: 36 lectures (three per week) *(Semester 2).*

Description: Upon completion of the subject, students should have:

- become familiar with the techniques and concepts involved in the genetic investigation as applied to the developmental process and cell biology of various eukaryotic organisms;
- understood the usefulness of genetic analysis as a means to dissect biological systems; and
- gained a knowledge and understanding of some current biological problems, and of the application of genetic analysis to these problems.

The subject will cover developmental genetics in plants, animals and microorganisms; chromatin structure and its implication for gene regulation and development; neurogenetics; genome plasticity; oncogenetics; immunogenetics; and somatic cell genetics.

Assessment: Two assignments/problem-solving tasks of up to 1000 words each due during the semester (30%); a 3-hour written examination in the examination period (70%).

652-304 Genetic Analysis

Credit points: 12.5

Coordinator: Assoc Prof P Batterham

Prerequisites: Genetics 652-214, 652-216 and 652-215.

BBiomedSc students: Genetics 652-214, 652-216 and 521-213 and 536-250.

Corequisites: Genetics 652-302.

BBiomedSc students: 521-308.

Contact: 12 lectures (one per week) and 36 hours of practical work (three hours per week) *(Semester 1).*

Description: Upon completion of the subject, students should have:

- understood the application of genetic principles and different experimental designs in classical, molecular and population genetic analysis;
- appreciated the advantages and disadvantages of these different designs;
- developed a detailed understanding of the techniques employed in experimental designs;
- experienced the use of particular laboratory techniques and analytical approaches in each of these areas of genetics;
- become proficient in the analysis and interpretation of data derived from their own experimentation and that of others;
- gained experience in the written presentation of scientific data; and
- developed an ability to combine their understanding of genetic principles, experimental design and specific techniques to the investigation of new problems in biology.

The subject involves lectures and practical exercises which demonstrate the principles and techniques of genetic analysis from classical and population genetics to modern biochemical and molecular technology.

Assessment: Assignments/problem-solving tasks due during the semester (25%); four written practical reports due during the semester (25%); a 2-hour written examination in the examination period (50%).

652-305 Human Genetics

Credit points: 12.5

Coordinator: Prof J Camakaris

Prerequisites: Genetics 652-214 and 652-215.

BBiomedSc students: Genetics 652-214, 521-213 and 536-250.

Contact: 36 lectures (three per week) *(Semester 1).*

Description: Upon completion of the subject, students should have:

- appreciated the importance of genes in influencing human health, disease and evolution;
- recognised ways in which environmental factors may modify the effects of genes;
- appreciated the ethical issues raised by the 'New Genetics';
- understood the basic techniques and concepts of molecular genetics and human genomics which permit findings at the DNA level to be related to phenotype; and
- developed skills in use and application of methods of gene mapping and linkage in humans.

This subject focuses on several key areas in contemporary human genetics: mutation in humans and its molecular basis; polymorphisms; selection and its consequences; gene mapping; strategies for identifying genes which cause human disease; the molecular basis of genetic diseases; genetics of cancer and aging; the Human Genome Project and its applications; screening for genetic diseases; genetic counselling, human cytogenetics; and gene-environment interactions. Ethical issues will be discussed in context in various sections of the course.

Assessment: Three problem sets/assignments each less than 1000 words due during the semester (5%); a written class test during semester (10%); a 3-hour written examination in the examination period (85%).

652-306 Experimental Genetics

Availability: This subject is likely to be quota-restricted this year, see *Quota subjects (p.9)*.

Credit points: 12.5

Coordinator: Prof M Hynes

Prerequisites: Genetics 652-302 and 652-304.

Contact: 24 hours of lectures (an average of two per week) and 36 hours of laboratory practical/project work (an average of three per week) *(Semester 2).*

Description: Upon completion of the subject, students should have:

- understood the way in which experiments in genetics are designed, communicated and interpreted;
- developed experience in the planning and execution of experiments;
- extended their abilities in oral and written scientific communication; and
- gained the ability to read and assimilate specific research papers and to see how the research reported relates to the broad field of genetics.

The subject involves lectures and lecture/discussions on research papers in genetics, practical exercises and a project in one area of genetics.

Assessment: Three written assignments relating to lecture/tutorial and bioinformatics exercises totalling up to 2500 words due during the semester (50%); a 20-minute oral presentation during the semester (10%) and a project report up to 2000 words due at the end of semester (40%).

600-312 Research Project B

See full subject details on page 1.