Molecular Genetics is a discipline that underlies the majority of modern biological research. Much of modern Genetics is concerned with the molecular mechanisms by which genes are expressed and regulated, and the ways in which they control the properties and development of cells and organisms. The Honours course in year 4 combines coverage of both basic and advanced principles and the approaches involved in a broad range of both molecular genetic studies. Students in years 1-3 have a wide variety of course choices as the Biological Sciences degree programme provides a set of overlapping courses leading to different final Honours schools (see Courses and Progression).

Molecular Genetics is a degree programme run within the School of Biological sciences, a large School with 6 internationally renowned research Institutes: the Institute of Cell Biology, the Institute of Structural and Molecular Biology, the Institute of Evolutionary Biology, the Institute of Molecular Plant Sciences, the Institute of Immunology and Infection Research, the Institute for Stem Cell Research, and a number of interdisciplinary centres.

The degree programme in Molecular Genetics is designed to produce graduates able to pursue successful careers in a range of professional areas. Graduates with good Molecular Genetics degrees are frequently accepted for postgraduate research in other departments, including departments of molecular, cell or developmental biology and biochemistry. Geneticists are employed in medical and agricultural research establishments, by pharmaceutical companies, and by the health service, for example in Genetic Counselling roles. The graduate attributes are applicable in a wider context and help graduates find employment in other sectors.

**Educational aims of programme:** The degree programme aims to produce a graduate trained in Molecular Genetics, capable of independent thinking and analysis and able to communicate clearly both with fellow scientists and with the wider community.

The programme aims to develop:
- Knowledge and understanding in the core modules of Molecular Genetics and in specialised electives.
- Research skills in both laboratory and library
- Awareness of emerging issues and unsolved questions in Genetics
- Graduate attributes including a wide range of generic transferable skills
- An awareness of the contribution of Edinburgh to the development of the biological sciences

The programme aims to provide a set of learning skills, sound scientific knowledge and an understanding of underlying principles that enables each student to develop both as a scientist and as an individual. Molecular Genetics is a broad ranging discipline and students can choose a set of courses to suit both their academic interests and career aspirations within a wide choice of possible directions. Teaching provides both generic and specialist training. Students are taught experimental methods used to investigate areas of biology; how to perform and document experiments in a
laboratory; how to draw quantitative conclusions from experimental data and how to present results and theoretical knowledge. Specific courses develop particular skills within a sub-discipline. All students will develop the level of understanding that will allow engagement in debates on current topics in a broader context that may extend to

- health care and genetic counselling
- science technology and biotechnology
- environmental issues
- biodiversity
- sustainability
- management of biological data

11) Programme outcomes:

11a) Knowledge and understanding
Molecular Genetics, in common with other courses in the Biological Sciences, uses the pre-honours years to lay the necessary foundations of knowledge. In early years students are also learning how to study effectively, learning different modes of studying and are starting to develop skills in comprehension of scientific literature, analysis of data, writing and communication skills. The academic foundations are based on an understanding of chemistry, mathematics and physics, which are taught in a biological context in courses in the first year. Courses in second year develop understanding and background in relevant subjects; these are usually genetics, molecular biology, biochemistry and microbiology. Work in laboratories develops understanding of experimental research methods. In the third year students take 6 courses of which molecular genetics, molecular cell biology, evolution and ecological genetics, genomes and genomics, developmental biology, molecular microbiology, and biotechnology are most frequently taken. The third year (level 9) covers the genetics and genomics of a range of organisms along with topics such as cells and their interactions, properties of DNA and proteins, evolution and developmental biology. This together with problem exercises, research for an essay and further practical sessions increases the knowledge and understanding of students in preparation for 4th year. In 4th year students study core courses in Genetic Approaches, and gene expression including epigenetics. Together these courses develop a deep understanding of both classical and state of the art techniques and approaches for genetic studies. Optional courses and electives in specialised areas allow students to study topics including molecular evolutionary genetics and cell cycle regulation in depth and to interact with staff researching at the forefront of their fields. Understanding is enhanced by literature research and dissertation writing, paper analysis and presentation, problem solving, tutorials, and individual analysis.

This allows Molecular Genetics students to:
- critically analyse current research literature,
- appreciate the experimental approaches, methods and limitations in their field
- analyse and solve biological questions

11b) Graduate attributes: Skills and abilities in Research and Enquiry
Through a combination of laboratory practicals, research projects and group work, students learn current skills and approaches in biological research. An understanding of scientific method, allied to the ability to construct alternative arguments and hypotheses leads our students to develop an ability to explore and evaluate evidence for and against particular points of view. Our students will have developed numerical competence. They will learn to report research data and conclusions through written reports and competent oral presentations, drawing on the outcomes of their skills in research and enquiry.

Through participation in a combination of different teaching and laboratory experiences, graduates acquire the ability to:
- carry out scientific research within a research group or team (4th year research project)
- develop critical thinking, including the critical analysis of current literature (e.g. synoptic sessions, tutorials and 4th year dissertation)
- discuss and evaluate scientific arguments (within essays, dissertation and project reports)
- exchange ideas with scientific colleagues, including carrying out scientific research within a research group/team (4th year research project)
- analyse and solve biological questions (synoptic, data-interpretation sessions)
- analyse and summarise data, drawing on numerical and statistical analysis skills as appropriate
- build on existing knowledge to suggest new directions for investigation
- an appreciation of the experimental approaches, methods and limitations in their field (particularly in 4th year research project, 4th year core courses and electives)
- formulate scientific questions and programmes of research, drawing on expertise in the design and rationale of scientific experiments.

11c) Graduate Attributes: Skills and abilities in Personal and Intellectual Autonomy
The development of critical thinking and the capacity for independent is an important facet within the Molecular Genetics degree programme. Students develop an increasing competence to deal with intellectual concepts and scientific discussion and to evaluate arguments through preparation for tutorials, essay and dissertation writing, analysing research papers and through laboratory research. This is clearest in the final research project when independent thinking is essential for effective research in design, execution, analysis and communication of results.

Within the different course activities over the 4 years students progressively develop graduate skills in **Personal and Intellectual Autonomy** and are able to:

- summarise and interpret the work of others in the context of previous work and likely developments
- evaluate the strength and weaknesses of scientific evidence, thereby being able to arrive at independent conclusions
- analyse graphs, figures and tables
- apply logical thinking in the analysis of new material (synoptic analysis)
- formulate, investigate and discuss questions
- learn and work independently, analysing their own strengths and weaknesses, drawing on written and oral feedback
- learn analytical methods and to apply them to problem solving
- engage and draw on an understanding of scientific investigations
- build on existing knowledge to suggest new directions for investigation
- understand the relevance and importance of explaining scientific ideas and the impact of science to the wider community

11d) **Graduate Attributes: Skills and abilities in Communication**

The development of communication skills occurs throughout the degree programme and is staged so that the students’ development is matched to the SQCF level. Communication skills are important: to communicate scientific knowledge to other scientists, to inform and communicate science to the wider community and to demonstrate graduate attributes to employers. Skills comprise:

- oral and written communication that is logical and coherent (e.g. 3rd year talks, 4th year paper presentations and research project seminars)
- using computer, graphical and numerical skills (e.g. in elective and project reports)
- using communication to work effectively in groups (e.g. in e-learning exercises in 2nd and 3rd year)
- writing essays and laboratory reports (e.g. 2nd year laboratory reports, 3rd year essays and 4th year dissertation)
- working in groups for presentations (in debates and paper presentations)
- communicating concepts and ideas with the wider public, demonstrating an understanding of the relevance and importance of explaining scientific ideas and the impact of science to the wider community (topical debates in fourth year)

11e) **Graduate Attributes: Skills and abilities in Personal Effectiveness**

Student personal development is achieved through a number of interconnected learning processes over the successive SQCF levels. Personal effectiveness is acquired both through independent activities and through interactive activities with other students, staff and Directors of Studies.

Independent activities include:

- organising individual learning, managing the workload and working to a timetable
- learning to plan effectively
- working independently on the creation of essays and reports.

Collaborative activities include

- working in groups on projects, group talks or laboratory work
- building confidence from completion of assignments and from successful work experiences in laboratory, projects, presentations, dissertation and essay writing.
- utilising advice gained from discussions with Director of Studies, Course Organisers and Honours Programme organisers
- presenting scholarly work that demonstrates an understanding of the aims, methods and considerations in this subject area

11f) **Technical/practical skills**

Technical/practical skills are acquired in the first three years mainly through laboratory practicals within individual courses (e.g. Genes and Gene Action 2, Molecular Genetics 3) and in the final year through an 8 week Honours lab project. Quantitative and statistical skills are taught at all levels (e.g. Quantitation in the Life Sciences 1) and all courses include evaluation and problem solving components related to biological techniques. Many of the communication and analytical skills learnt from such technical work are integral to the graduate attributes listed in the sections on intellectual autonomy, communication and personal effectiveness. Work in laboratories is usually in pairs or
larger groups requiring cooperation and joint input. Over the degree programme students gain the following skills/experience:

- use of bioinformatic and other software tools (e.g. in Genomes and Genomics 3)
- use of graphics and data analysis software (e.g. 1st year Quantitation in the Life Sciences 1)
- competence in generic laboratory skills (e.g. Genes and Gene Action 2, Molecular Genetics 3, Evolution and Ecological Genetics 3, Molecular Cell Biology 3, Molecular Microbiology 3)
- appreciate the specificity, the accuracy and the limitations of particular techniques (e.g. Scientific Enquiry in Biology and Practical Skills in the Biomedical Sciences)
- Genetic and molecular techniques including DNA isolation, gel electrophoresis (e.g. Molecular Genetics 3)
- growth and metabolic activities of microorganisms (e.g. Microorganisms, Cells and Immunity 2, Molecular Microbiology 3)
- library skills - learning to read and analyse research and review papers, understanding the main concepts and identifying unresolved questions (particularly in level 9 and 10 courses)

In the Molecular Genetics with Management degree programme technical skills are concentrated most in the areas of genetics, molecular and cell biology but will depend on the courses taken by each individual student. At level 10 students learn specific practical skills related to their choice of Honours project. For example: “Genotype-phenotype correlations in the β-catenin oncogene” or “Epigenetic Modifications in Human Embryonic Stem Cells”. Molecular work might involve DNA isolation, amplification, cloning, sequencing and expression; whereas a biochemistry-based project might involve protein purification, enzyme assay and mass spectrometry techniques. However all biology students should receive training such that their technical skills are exportable and useful in a wide range of modern laboratories.

12 Programme structure and features
This programme fits within the general structure of the University's Curriculum Framework.

This programme is described at:
http://www.ed.ac.uk/studying/undergraduate/degrees?id=0,1&cw_xml=subject.php
which also gives a link to the entry criteria:
http://www.ed.ac.uk/studying/undergraduate/degrees?id=C100&cw_xml=degree.php

Courses and Progression
Students take courses totalling 120 credit points in each year of the programme. The programme is full time for 4 years, except where direct entry into 2nd year has been permitted. The choice of courses is very wide so the courses listed as “other” are the ones taken most frequently by students.

The degree regulations and programme of study, along with the degree programme table can be found at:
- programme of study and degree programme table (URL http://www.drps.ed.ac.uk/index.php)

1st year
Compulsory courses (Level 8):
Origin and Diversity of Life 1 (20 points)
Molecules, Genes and Cells 1 (20 points)
Business Studies 1 (40 points)
Students are required to take a further 40 points of courses. Other courses useful for the Molecular Genetics degree programme are:
Quantification in the Life Sciences (20 points)
Biological Chemistry 1A (20 points)

2nd year
Students must take at least three courses totalling 60 credit points from a selection of Biological and Biomedical Sciences level 8 courses as listed in the degree programme table. Frequently taken courses are:
Genes and Gene Action 2 (required) (20 points)
Dynamic Cell 2 (required) (20 points)
Other relevant courses taken are:
Evolution in Action 2 (20 points)
Microorganisms, Cells and Immunity 2 (20 points)
Chemistry for Life Sciences 2 (20 points)

Students must take 40 credits from business studies courses such as:
Business Economics (20 points)
### 3rd year (Junior Honours)

Students must take at least four courses totalling 80 credit points from a selection of Biological and Biomedical Sciences level 9 courses as listed in the degree programme table.

- **Molecular Genetics 3** (required) (20 points)
- **Genomes and Genomics 3** (required) (20 points)
- **either Evolution and Ecological Genetics 3** (20 points)
- **or Molecular Cell Biology 3** (20 points)

Other relevant courses:
- **Structure and Function of Proteins 3** (20 points)
- **Developmental Biology 3** (20 points)
- **Biotechnology 3** (20 points)
- **Molecular Microbiology 3** (20 points)

Students must also take 20 credits from business studies courses such as:
- **Entrepreneurship and new venture creation** (20 points)

### 4th Year (Senior Honours)

The courses offered in the senior honours year are level 10/11. The courses taken depend on the component courses chosen by the student. In the programmes there are 90 credit points of compulsory courses including a Research Project course (40 points) and core courses each worth 10 or 20 credit points. Elective courses (10 points) are also available.

- **Genetic Approaches** (core) (10 points)
- **Gene Expression** (core) (10 points)
- **Molecular Biology of Disease** (10 points)
- **or Host Parasite Interactions** (one usually taken) (10 points)
- **Molecular Genetics with Management project** (core) (40 points)
- **Molecular Genetics Synoptic Examination** (core) (20 points)
- **Dissertation** (core) (10 points)

Students must also take one Business studies course such as:
- **Green and Sustainable Entrepreneurship** (20 points)

### Exit Qualifications

The criteria for exit awards of Undergraduate Certificate of Higher Education, Undergraduate Diploma of Higher Education, BSc General and BSc Ordinary in a Designated Discipline are listed at [http://student.biology.ed.ac.uk/undergraduate/courses/](http://student.biology.ed.ac.uk/undergraduate/courses/)

If not provided earlier in the programme specification, information needs to be included on relevant factors from the University's Strategic Plan, e.g. embedding in the curriculum factors of:
- social responsibility
- sustainability
- equality and diversity.

### 13 Teaching and Learning Methods and Strategies

Teaching and Learning strategies employed at the University of Edinburgh consist of a variety of different methods appropriate to the programme aims. The graduate attributes listed above are met through a teaching and learning framework (detailed below) which is appropriate to the level and content of the course.

#### Teaching and Learning Activities

*In Year 1:*
- Lectures
- Workshops
- Laboratories
- Field Work
- Tutorials
- Discussion Groups/Project Groups
- Problem based learning activities

Example: as part of the Origin and Diversity of Life 1 course, students learn how to record and present practical procedures and outcomes, and how to analyse results.
One to one meetings with personal tutors

**In Year 2:**
- Lectures
- Laboratories
- Workshops
- Tutorials
- Seminars
- Problem based learning activities
Example: as part of The Dynamic Cell course students attend problem based tutorial sessions.

One to one meetings with personal tutors

**In Year 3**
- Lectures
- Laboratories
- Workshops
- Tutorials
- Seminars
- Presentations
- Problem based learning activities
Example: as part of the Molecular Cell Biology course students review academic papers, write abstracts and give a presentation.

One to one meetings with personal tutors

**In Year 4**
- Lectures
- Seminars
- Presentations
- Problem based learning activities
Project work in a research laboratory; students carry out their own research at the frontier of knowledge and can make a genuine contribution to the progress of original research. This also involves reviewing relevant papers, analysing data, writing a report and giving a presentation.

**Innovative Learning Week**
The University of Edinburgh Innovative Learning Week is scheduled in Week 6 of Semester 2. During this week 'normal' teaching is suspended which provides space outwith the curriculum for staff and students to explore new learning activities. Some examples of the types of activities held in Biological Sciences were workshops, peer assisted learning activities, public engagement activities, careers events.

**Assessment Methods and Strategies**
Courses are be assessed by a diverse range of methods and often takes the form of formative work which provides the student with on-going feedback as well as summative assessment which is submitted for credit.

**In Year 1**
- Laboratory Reports; formative feedback is provided early in the first semester followed by summative feedback contributing to course results.
- Essays; students are provided with written feedback
- Assessed Problems; students are provided with written feedback
- On-line Tests; on-line feedback with explanations
- Written Degree Examinations; students are invited to feedback sessions with course organisers to view their examination scripts.
Example: as part of the Origins and Diversity of Life 1 course students are provided with on-line feedback for their essay, including video feedback.

**In Year 2**
- Laboratory Reports
- Essays; students are provided with written feedback
- Class Tests
- Multiple Choice Tests
- Peer Marking (eg. in GGA2 the in course problem is marked by peers, during a tutorial session run by an experienced marker)
- Assessed Problems; students are provided with written feedback
- Written Degree Examinations; students are invited to feedback sessions with course organisers to view their examination scripts.

**In Year 3**
Laboratory Reports
Essays; students are provided with written feedback
Class Tests
Assessed Problems
Oral Presentations; feedback is provided by peers and staff
Written Degree Examinations; students are invited to feedback sessions with course organisers to view their examination scripts.

In Year 4
Project Reports and Presentations
Essays; students are provided with written feedback
Oral Presentations; feedback is provided by peers and staff
Written Degree Examinations; students are invited to feedback sessions with course organisers to view their examination scripts.

15 Career Opportunities

Graduates in Biological & Biomedical Sciences are highly valued. The broad analytical and scientific skills you gain equip you for a variety of careers. Previous graduates have been employed in the food, environmental and healthcare industries, or have moved into non-science sectors, including teaching, marketing, accountancy and policy research. Some of our graduates also choose further study before entering successful academic or industry–based research careers.

16 Other Items
Each student is assigned a Director of Studies who provides both academic and pastoral guidance. Throughout a student's time at the university the Director of Studies guides the student in choice of courses and provides general support.
Courses are administered and run through Teaching Organisations. These produce detailed course guides for new students and for continuing students. These guides provide details of courses and also advise students on assessment and general university policy and regulations.