

Biomedical Science

Subject benchmark statements

Subject benchmark statements provide a means for the academic community to describe the nature and characteristics of programmes in a specific subject. They also represent general expectations about the standards for the award of qualifications at a given level and articulate the attributes and capabilities that those possessing such qualifications should be able to demonstrate.

This *Subject benchmark statement*, together with the others published concurrently, refers to the bachelors degree with honours.

Subject benchmark statements are used for a variety of purposes. Primarily, they are an important external source of reference for higher education institutions when new programmes are being designed and developed in a subject area. They provide general guidance for articulating the learning outcomes associated with the programme but are not a specification of a detailed curriculum in the subject. Benchmark statements provide for variety and flexibility in the design of programmes and encourage innovation within an agreed overall framework.

Subject benchmark statements also provide support to institutions in pursuit of internal quality assurance. They enable the learning outcomes specified for a particular programme to be reviewed and evaluated against agreed general expectations about standards.

Finally, *Subject benchmark statements* may be one of a number of external reference points that are drawn upon for the purposes of external review. Reviewers do not use *Subject benchmark statements* as a crude checklist for these purposes however. Rather, they are used in conjunction with the relevant programme specifications, the institution's own internal evaluation documentation, in order to enable reviewers to come to a rounded judgement based on a broad range of evidence.

The benchmarking of academic standards for this subject area has been undertaken by a group of subject specialists drawn from and acting on behalf of the subject community. The group's work was facilitated by the Quality Assurance Agency for Higher Education, which publishes and distributes this *statement* and other *statements* developed by similar subject-specific groups.

In due course, but not before July 2005, the *statement* will be revised to reflect developments in the subject and the experiences of institutions and others who are working with it. The Agency will initiate revision and, in collaboration with the subject community, will make arrangements for any necessary modifications to the *statement*.

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Academic standards - Biomedical science

1 Introduction

This *Subject benchmark statement (statement)* defines the subject area of biomedical science (BMS) relating to BSc Honours degrees, incorporating this title, offered by UK Universities. Because of the fast moving nature of BMS, encompassing subjects such as molecular biology, immunology and neuroscience, this *statement* is not a 'tablet of stone', but a 'photograph' taken at the time immediately preceding the date of publication of the document. The *statement* is intended to be valuable to potential students, their parents and guardians, employers, professional and regulatory bodies, universities, colleges and schools.

The *statement* is not a syllabus and no form of prescription is intended in the amount of time devoted to each component, the order in which the material is presented, or the titles of subject areas which comprise BMS. It is expected, therefore, that providers of BSc Honours programmes will combine, teach and assess the subject matter in different ways. Such creativity and diversity is encouraged. The *statement* will provide, however, an inventory of content, delivery method and assessment of programmes, thus enabling identification of vital components of BMS Honours degrees in whichever form they are presented by universities and colleges in the UK.

Honours graduates in BMS are readily employable in a wide range of areas in the public and private sectors due to their education at the interface between biological science in its broadest sense and medical science.

2 Defining principles

An Honours degree programme in BMS is designed to give graduates an understanding of scientific investigation of human health and disease. An Honours graduate will have the qualities needed for employment in situations requiring the exercise of professionalism, independent thought, personal responsibility and decision making in complex and unpredictable circumstances.

BMS is concerned with the integration of a wide range of subjects to understand the biology of disease. Biology, in this sense, means predominantly anatomy, physiology, biochemistry, genetics, immunology, microbiology, pharmacology and molecular biology related to human disease. More specific knowledge of disease processes comes from the study of specialised biology, viz cellular pathology, clinical biochemistry, clinical immunology, haematology, transfusion science and medical microbiology. This enables a biomedical scientist to understand the science of causes, diagnosis and treatment of disease.

Most of the component subjects of BMS are at the forefront of modern science and therefore attract leading-edge research activity. This means that BMS is a rapidly evolving subject and highly relevant to investigating and understanding current controversies, concerns and dilemmas of modern life such as the use of genetically engineered products in healthcare and major health problems of international importance such as food safety, Creutzfeld-Jacob's disease, malaria, human immunodeficiency virus infection, drug resistance of bacteria and cell cloning. In view of this BMS plays a pivotal and essential role in healthcare.

Graduates in BMS enter a very buoyant employment market and are sought by a wide range of employers. Major employment areas include:

- research laboratories in universities;
- government or charity funded research laboratories;
- National Health Service (NHS) laboratories;
- Public Health Laboratory Service (PHLS)/microbiology laboratories;
- private pathology laboratories;
- veterinary and agricultural laboratories;
- forensic laboratories;
- clinical genetics laboratories;
- research and development for the pharmaceutical, diagnostics, medical devices and laboratory instrumentation industries;
- commerce (sales and marketing) related to healthcare products;
- education: university, college and school teaching.

Many BMS graduates achieve further qualifications (eg. MSc/PhD) before and/or after taking up employment.

If a BMS graduate wishes to undertake professional duties as a biomedical scientist in a Health Service laboratory, it is necessary for the graduate to become state registered. To qualify for state registration the graduate needs to hold a degree approved by the UK statutory regulatory body, the Health Professions Council. Not all providers of BMS degrees seek such approval. The regulatory body also requires the graduate to undertake a period of approved professional practice.

BMS graduates enter a rapidly changing environment in which lifelong learning plays an essential role.

There are many scientific/professional bodies which BMS graduates join. The Institute of Biomedical Science is a professional and learned body for biomedical scientists which accredits appropriate BSc Honours degrees and provides a wide range of professional and scientific activities. BMS graduates may, equally, become members of organisations such as the Institute of Biology, the Biochemical Society, The British Society for Immunology.

3 Nature and extent of subject/discipline

BMS involves a multidisciplinary approach to the study of human disease. Graduates must have knowledge of how diseases develop and how they affect the normal function of the human body. They will have awareness of the development of new methods for diagnosis, treatment and prevention of disease and their relevance in a research or diagnostic environment.

The complex multidisciplinary nature of BMS requires a sound, research led, scientific education. Graduates need to have knowledge of key subject areas. BMS students are encouraged to integrate the knowledge base of various key disciplines to further their understanding of research, diagnosis and management of a clinical disorder. A pathophysiology or biology of, disease component to the programme may be used to integrate the knowledge base of the key disciplines.

Students will be aware of the role of epidemiology in the identification of risk and protective factors associated with disease development and of the latest major advances in the scientific understanding of human health and disease. The education of a BMS Honours student should involve a study of pharmacology and toxicology and methods for the treatment/management of human diseases.

Advances in BMS as a result of research and development efforts make a major impact on the health and well-being of society. A knowledge of research design and the appropriate use of statistical techniques to enable a valid interpretation of experimental results is required.

Students are required to undertake appropriate practical education throughout their programme which is progressive in nature and designed to supplement other academic learning. Final year students will be equipped with the skills necessary to enable them to plan and perform a research project and be aware of the need for good laboratory practice, health and safety and ethical considerations.

The work of biomedical scientists is fundamental in ensuring the effective operation of the healthcare system. It is important that graduates are aware of aspects of the work undertaken by all health professionals.

4 Subject knowledge and understanding

BMS graduates acquire knowledge in the subject areas indicated below. The sub-headings are not intended to imply module titles and the subject matter is not intended to constrain module content.

Core knowledge

These are subjects studied by all students.

Human anatomy and physiology

Human anatomy and physiology is the study of the structure, function and control of the human body, its component parts and major systems.

Biochemistry

Biochemistry is the study of chemical processes which support life. It includes the structure, function and metabolism, including its control, of carbohydrates, lipids, nucleic acids and proteins.

Molecular genetics

Molecular genetics is the study of structure, function and control of genes; techniques used in such study and the causes and consequences of alterations of genetic material.

Immunology

Immunology is the study of the immune response in health and disease.

Microbiology

Microbiology is the study of the structure, physiology, biochemistry, classification and control of micro-organisms.

Biomedical science key subjects

'Key subjects' are described in more detail than that given for 'core knowledge'. This does not imply that an Honours degree programme will devote a greater period of time to key subjects as opposed to core knowledge or that key subjects are necessarily taught separately from core knowledge. Some providers of BMS Honours degrees teach key subjects integrated within core knowledge.

All key subjects are not necessarily taught to the same level and programme specifications will indicate this.

Cellular pathology

Cellular pathology is the microscopic examination of cells (cytology) and tissues (histology) for indicators of disease. A BMS graduate will have a knowledge of the role of cellular pathology in the diagnosis and treatment of disease and of:

- the preparation of tissue and cells for microscopic examination;
- microscopy and its application;
- the histology and ultra structure of normal and abnormal tissues and cells;
- immunocytochemistry and histochemistry.

Clinical biochemistry

Clinical biochemistry is the qualitative and quantitative evaluation of analytes to aid the diagnosis, screening and monitoring of health and disease. A BMS graduate will have knowledge of:

- the principles of methods used in clinical biochemistry;
- the investigation, management and consequences of function and dysfunction of organs and systems;
- the principles of biochemical investigations used in the diagnosis, treatment and management of hereditary malignant disease;
- therapeutic drug monitoring and investigation of substance abuse.

Clinical immunology

Clinical immunology is the study of immunological diseases or disorders. A BMS graduate will have a knowledge of:

- the principles of the measurement of effectors of the immune response;
- the principles of organ transplantation;
- prophylaxis and immunotherapy;
- detection and monitoring of treatment of neoplasia.

Haematology

Haematology is the study and investigation of the different elements that constitute blood in normal and diseased states. A BMS graduate will have a knowledge of:

- the structure and function of bone marrow;
- the role, structure and function of red and white cells;
- the nature and diagnosis of anaemias;
- haemoglobinopathies and thalassaemias;
- haematological malignancy;
- haemostasis and thrombosis.

Immunohaematology and transfusion science

Immunohaematology is the identification of blood group antigens and antibodies. Transfusion science ensures a safe supply of blood and blood components. A BMS graduate will have knowledge of:

- the genetics, inheritance, structure and role of red cell antigens;
- the preparation, storage and use of blood components;
- the selection of appropriate blood components for transfusion and possible adverse effects;
- immune mediated destruction of blood cells;
- the role of histocompatibility antigens in transplantation.

Medical microbiology

Medical microbiology is the study of pathogenic micro-organisms. A BMS graduate will have knowledge of:

- classification, structure and function of bacteria, fungi, helminths, parasites and viruses;
- the role of 'normal flora';
- the epidemiology of infectious diseases;
- food, water and environmental microbiology;
- anti-microbial and anti-viral therapy;
- vaccination and immunisation;
- the laboratory investigation of infectious disease.

Integrated Studies

Biology of disease

Biology of disease is the integrated study of a range of human disorders and disease processes together with their investigation. The effects of treatment must also be considered.

5 Subject and other skills

There is a range of skills which a BMS graduate will have acquired during the programme of study:

- key/transferable skills (communication, IT, numeracy, data analysis);
- research skills;
- skills associated with biomedical laboratory practice.

A BMS graduate will be aware of the need for compliance with health and safety policies, good laboratory practice, risk and COSHH assessments and the importance of quality control and quality assurance.

6 Teaching, learning and assessment

The primary aim of teaching, learning and assessment strategies is to equip students with the necessary subject knowledge skills to make a contribution within BMS following graduation. Cross-referencing of topics from one section to another is essential to ensure effective teaching. These strategies are designed to be enriching, stimulating, challenging, effective and enjoyable.

Teaching, learning and assessment are progressive throughout programmes to encourage the transition from dependent to independent learning so that the students become increasingly responsible for their own learning as the programmes advance.

This is supported by clear, detailed and accurate documentation. The documentation is available to students and must specify the overall rationale of the programme and individual modules. Syllabus details, learning outcomes, assessment regulations and scheduling are also included.

Teaching is conducted by appropriately qualified professionals who undertake pertinent and ongoing staff development relevant to the educational aspects of subject discipline(s) for which they are responsible. All student learning is appropriately underpinned by research, scholarship and professional practice of teaching staff.

Motivation and challenge of the student requires a skilled and balanced selection of teaching and learning techniques. Student learning is encouraged and developed through a combination of methodologies such as:

- lectures (traditional, interactive and virtual);
- tutorials;
- seminars;
- laboratory sessions;
- self-directed study;
- computer-aided learning;
- case studies and problem-based learning;
- demonstrations;
- project work.

The above list is not intended to be prescriptive or exhaustive.

Assessment strategies are integral to teaching and learning. The instruments of assessment must accord with the stated learning outcomes and be appropriate to the level of study.

A large number of assessment methods have been developed to measure the knowledge, competence, understanding and ability of students within specified criteria. Assessment methods may include:

- unseen examinations;
- open book examinations;
- essays;
- laboratory reports;
- project reports;
- analytical exercises;
- poster presentations;
- oral presentations;
- learning logs, diaries and personal development plans;
- abstract writing and journal article reviews.

The above list is not intended to be prescriptive or exhaustive.

7 Standards

It is recognised that BMS programme designers will achieve the goals set for standards in various ways.

The achievement of the knowledge and skills described in this statement is monitored by such measures as anonymous and double marking of assessment. Central to this process is the involvement of external examiners with responsibility for ensuring that standards in any particular institution are comparable with others.

Periodic subject area review and appraisal by the Quality Assurance Agency for Higher Education results in published data which help in judging standards achieved. Information relating to the quality and nature of research is made available by institutions providing Biomedical Science Honours degrees. This helps in indicating the level of relevant research which both leads and informs teaching in any particular HE institution.

Interactions between the course teachers and Learned/Professional societies provide an indication of staff development activities related to achieving standards.

Student attainment

Student attainment is the achievement, graded from the minimum acceptable knowledge and skill level in the areas specified in this statement (threshold performance), to an excellent performance where graduates have demonstrated: a comprehensive in-depth knowledge and understanding of BMS; an ability to apply their knowledge to analyse, interpret and evaluate biomedical data.

The essential areas of achievement include knowledge and understanding of BMS, the factors and processes which contribute to human health and disease, application of scientific knowledge, handling of biomedical data and key skills. Graduates must be able to demonstrate laboratory skills and knowledge of instrumentation ranging from a satisfactory performance (threshold performance) to a deep understanding of principles, advantages and limitations of those skills and equipment.

Graduates must have executed, successfully, an independent research project centred on data generation and confirmed their accomplishments within a range of abilities from a basic completion to the demonstration of critical analysis and application of results.

Appendix 1

Membership of the benchmark group

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