

## Research Methods – Module Details

The Research Methods module covers an introduction to statistical methods and tools and their practical applications for student projects. Below the elements and goals are outlined.

Additionally we introduce a series of detailed lectures on the scientific basis of science research methods and allied skills.

### Statistics teaching:

#### Stats 1 Lecture: Introduction to Data Analysis

<b>Aim:</b>	The aims of this session are first to show the relevance and importance of statistics by removing the misconceptions students might have and then to demonstrate a systematic knowledge of the descriptive statistics and finally to demonstrate a systematic understanding of confidence intervals and p-values.
<b>Objectives:</b>	At the end of this lecture, students should be able to <ol style="list-style-type: none"><li>1. Understand the role of statistics in research;</li><li>2. Understand different study designs;</li><li>3. Interpret descriptive statistics;</li><li>4. Understand when to use different statistics;</li><li>5. Apply appropriate knowledge and skills to interpret sample estimates, confidence intervals and p-values.</li></ol>

#### Stats 2 Practical: Distributions, summary statistics and confidence intervals

<b>Aim:</b>	The aim of this practical session is to reinforce the understanding of the concept of distributions, mean, standard deviation, standard error and confidence intervals through the use of Computer Assisted Learning (CAL)
<b>Objectives:</b>	At the end of this practical session, students should be able to <ol style="list-style-type: none"><li>1. Understand distributions</li><li>2. Understand the normal distribution</li><li>3. Be able to explain the difference between standard deviation and standard error</li><li>4. Be able to interpret a confidence interval</li><li>5. Understand how to use a confidence interval to say something about a p-value</li></ol>

### Stats 3 Practical: Descriptive Statistics using R notebooks

<b>Aim:</b>	The aim of this practical session is to introduce the statistical software package R and to provide experience of calculating descriptive statistics and producing graphs using R.
<b>Objectives:</b>	At the end of this practical session, students should be able to <ol style="list-style-type: none"><li>1. Familiarize themselves with the software package R;</li><li>2. Understand the principle of a data analysis notebook, and how to access and use azure R notebooks;</li><li>3. Load data into R;</li><li>4. Produce common summary statistics for continuous data and frequency tables for categorical data;</li><li>5. Produce simple plots and interpret them.</li></ol>

### Stats 4 Lecture. Statistical analysis for research workers

<b>Aim:</b>	The aim of this session is to introduce a number of fundamental analysis methods that are commonly used by research workers
<b>Objectives:</b>	At the end of this session, students should be able to: <ol style="list-style-type: none"><li>1. Compare two samples, in order to determine how they may differ</li><li>2. Assess correlation between paired data, visually and numerically</li><li>3. Assess independence between paired observations, visually and numerically</li><li>4. Summarise data using tables</li></ol>

### Stats 5 Lecture: Regression models

<b>Aim:</b>	The aim of this session is to introduce a number of statistical methods that are often used to analyse data generated by research workers
<b>Objectives:</b>	At the end of this session, students should be able to: <ol style="list-style-type: none"><li>1. Be able to interpret results from a linear regression</li><li>2. Be able to interpret results from a logistic regression</li><li>3. Understand the concepts of confounding and adjustment</li><li>4. Understand the importance of adjustment for multiple comparisons in certain settings</li></ol>

## Stats 6 Lecture: Sample Size

<b>Aim:</b>	The aim of this session is to demonstrate a critical understanding of the principles of sample size calculations and relate to the ethical implications of study size.
<b>Objectives:</b>	At the end of this session, students should be able to: <ol style="list-style-type: none"><li>1. Understand the ethical requirement for sample size calculations;</li><li>2. Discuss the parameter specification involved in a sample size calculation;</li><li>3. Discuss appropriate sources of information for use in supporting parameter values in a sample size calculation.</li></ol>

## Other Research Methods:

### Lecture: Scientific Report Writing

<b>Aim:</b>	To learn how to write your laboratory practical reports to maximize your mark
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Understand the structure of a research paper</li><li>2. Understand what is relevant information in the various components of a scientific report</li><li>3. Understand the importance of correct annotation and labeling of figures</li><li>4. To appreciate why reading, and correctly citing, relevant scientific literature is essential in producing a good report</li><li>5. How plagiarism will be identified and punished</li></ol>

### Lecture: Reading Research Papers

<b>Aim:</b>	The aim of this session is to develop students ability to identify and interpret cancer research papers
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. To identify different approaches for finding good research papers.</li><li>2. To develop strategies for reading a research paper.</li><li>3. To have insight into key facts and critical interpretation of research</li></ol>

## Antibodies and Principles of Immunochemistry

<b>Aim:</b>	To appreciate the techniques for detecting specific molecules in cells and tissues using antibodies
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. To understand the difference between monoclonal and polyclonal antibodies</li><li>2. To appreciate pros and cons of monoclonal and polyclonal antibodies</li><li>3. To review the methods for detecting bound primary antibodies (direct versus indirect labeling methods)</li><li>4. To appreciate the importance of immunochemistry in routine pathology and research</li></ol>

## Lecture: Poster presentation outline

<b>Aim:</b>	<p>The aim of this practical session is to explain to the students the format, assessment and groups for their Research Skills Poster presentation.</p> <p>Students are assigned to a research paper group. Each student in a group then produces (over a period of several weeks) a small poster on a different method described in the paper. Explaining how the method is used, the data generated, the conclusions reached and any strengths/weakness in the method or paper.</p>
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Understand the assignment assessment and Poster theme “How did they do that?”</li><li>2. Account for Scientific Poster design and principles of poster presentation</li><li>3. Form and organise research paper groups. Identify methods in designated research paper and agree topics for poster presentation</li></ol>

## Lecture: Basic Tissue Culture

<b>Aim:</b>	To learn the history and current practice of tissue culture
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. To learn who was the pioneer of tissue culture</li><li>2. To discuss the principles of tissue culture: adherent versus non-adherent cells</li><li>3. To understand the importance and essential components of growth media</li><li>4. To understand how and why we use trypsin and EDTA</li><li>5. To understand how a haemocytometer works</li></ol>

## Lecture: Principles of Protein Analysis

<b>Aim:</b>	To understand how to analyse proteins in cells and tissues
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. To understand the principles of SDS-PAGE (sodium dodecyl polyacrylamide gel electrophoresis)</li><li>2. To understand the principles of Western Blotting</li><li>3. To understand how to probe a Western blot with antibodies using Enhance Chemilumnescence (ECL)</li><li>4. To understand the importance and probing for a house-keeping protein</li></ol>

## Lecture: DNA sequencing

<b>Aim:</b>	The aim of this session is to gain a historical view of DNA sequencing technology and its application as a research and diagnostic tool
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Understand principles of Sanger Sequencing</li><li>2. Understand principles of Next Generation Sequencing</li><li>3. Overview of the application of Next Generation Sequencing</li></ol>

## Practical: Reading DNA Sequences/Bioinformatics

<b>Aim:</b>	The aim of this practical session is to gain some insight in the possibilities of the online data resources available to the genomics community, using the Genome Browser from the University of California Santa Cruz
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Understand an over view of the genomic content available online</li><li>2. Be able to retrieve genome sequences</li><li>3. Derive the homologous sequence human to rat</li><li>4. Be able to identify which tissue a gene is expressed in</li></ol>

## Lecture: Legislation and Practise

<b>Aim:</b>	To understand how the law affects scientists and clinicians in their research
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Be aware that there are laws in the UK that govern the use of clinical material</li><li>2. Obtaining ethical approval to conduct studies or use clinical material</li><li>3. What are the rights of patients with respect to providing their tissues and enrolling on clinical trials</li></ol>

## Lecture: Flow cytometry

<b>Aim:</b>	To understand the principles of how a flow cytometer works and when and why it is used
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. To understand how flow cytometers work and what they can be used to measure.</li><li>2. To understand how to prepare samples and acquire them onto a flow cytometer.</li><li>3. To understand the principles of optics, fluorochromes and fluorescence emission and excitation in cytometry</li><li>4. To understand how to analyse data that has been acquired onto a flow cytometer.</li></ol>

## Lecture: Human tissue usage

<b>Aim:</b>	Understand the use of human tissues in research
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Understand role of routine Path lab</li><li>2. Role of pathology in research</li><li>3. Different ways tissue may be collected</li><li>4. Advantages and disadvantages of each method of tissue collection</li></ol>

## Lecture: Chromatography and Mass Spectrometry

<b>Aim:</b>	To understand how chromatography and mass spectrometry can be applied to cancer research
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Introduce the subject of chromatography and mass spectrometry and providing an overview for these two technologies.</li><li>2. Stimulate thinking about the possible application of these technologies in the area of cancer pharmacology and cancer research in general.</li><li>3. Facilitate understanding of the theoretical basis of quantification of drugs and small molecules using liquid chromatographic and mass spectrometry systems.</li><li>4. Arouse interest in this field and motivating further inquiry and discussion</li></ol>

## Lecture: Genetic animal models: theory and practice

<b>Aim:</b>	To provide information on how animal models are used in genetics
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Explain the technical details of how to generate, knockout, transgenic and knock-in mutant mice.</li><li>2. Describe their utilisation</li><li>3. Give examples of using knockout mice for medical research</li></ol>

## Lecture: Gene Expression Analysis

<b>Aim:</b>	Understand the utilities of gene expression arrays in the context of other methodologies for gene expression analysis
<b>Objectives:</b>	<ol style="list-style-type: none"><li>1. Understand the principles of gene expression arrays</li><li>2. Understand the methods involved in gene expression arrays</li><li>3. Compare expression arrays to Next Generation Sequencing approaches and to qPCR.</li></ol>