SCHOOL OF MEDICINE

SAN RAFFAELE INTERNATIONAL MD PROGRAM

Academic Year 2010/2011

Semester 1
• Medical Humanities
• Statistics and Bioinformatics
• Chemistry and Biochemistry
• Basic Life Support

Semester 2
• Medical Physics
• Genetics & Developmental Biology
• Cell & Molecular Biology
MEDICAL HUMANITIES

Course Chair:  Michael John  michael.john@unisr.it
Credits:  1st Semester 2010-11  Total credits: 9  Total hours: 110

Aim: To help students understand that patients are people, and not just a mass of molecules, who have not only an illness, but are also suffering fear and anguish. Doctors must therefore strive to empathize with individuals and not simply distribute medication and drugs to faceless and nameless numbers.

Scientific sector – discipline code: L/LIN-12, M-FIL/03, MED/02
Total number of credits: 9
Number of lecture and seminar hours: 110
Number of hours for tutorials: 12

Discussion and active student participation will be paramount to the overall success of the course.
Course objectives:
In today’s frenetic, high-tech world, where medicine is evidence based and focuses on specialties of all possible kinds, doctors generally have little time to ponder the multifaceted problems of their patients. Indeed, there are innumerable horror stories told by sick people that stem from the uncaring attitudes and the lack of sensitivity shown by many health professionals. Yet medicine should be seen as a caring profession that requires doctors not only to provide valid clinical assistance but, above all, to empathize with patients and their families when they are at their most vulnerable and in need of understanding.
Nowadays, medical school students are encouraged to interact with patients virtually from the beginning of their training and an increasing amount of emphasis is being placed on the teaching of social sciences, ethics and communication skills to help create a new kind of doctor. One way of doing this is by introducing the study of the Medical Humanities (literature, music, visual arts, psychology, sociology, philosophy, ethics, history, language, religion etc.) into the medical curriculum. These subjects require imagination, close observation and understanding, which are all fundamental characteristics of a successful and caring doctor.
How otherwise might a 20-year-old medical or nursing student learn about the complexities of the human condition? How would they be able to understand the reactions and feelings of someone with a terminal illness or a crippling disability, let alone a parent who has just lost a child? They certainly will not learn these skills from standard clinical textbooks, where the words fear and anguish do not appear in the index. Yet fear and anguish are at the very center of how a patient faces up to and lives with an illness.
At the end of this course, students will have a greater understanding of:

- empathy and patient-centered communication
- team work and the ability to interact with colleagues and other health professionals
- linguistics and use of language
- truth-telling and the delivery of bad news
- withdrawal of treatment
- euthanasia and assisted suicide
- treatment of violence and abuse
- ethical and legal problems linked to medical errors
- ethics committees
- conflict of interest and relationship with industries
- chronic illness
- old age, death and bereavement
- cross-cultural conflicts
- alternative and complementary health practices
- religion and spirituality
- ethical problems linked to stem cells, organ donation and transplantation
- re-pro ethics and new reproductive technologies
- history of medicine and medical education

Prof Michael John – course coordinator
Prof. William Cooke
Prof. Roberta De Monticelli
Prof. Roberto Mordacci
Prof. Giuseppe Pantaleo
Prof. Andrea Sereni
Prof. Simon Tiberi

AREA 1: DOCTOR-PATIENT COMMUNICATION

MICHAEL JOHN - Coordinator (20 hours)

<table>
<thead>
<tr>
<th>Title: Doctors and patients in literature and at the movies</th>
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</thead>
<tbody>
<tr>
<td>1 Introduction to Doctor-Patient Communication</td>
</tr>
<tr>
<td>2 Movie: The Doctor (Director - Randa Haines)</td>
</tr>
<tr>
<td>3 Reading: The Diving Bell and the Butterfly (Jean Dominique Bauby)</td>
</tr>
<tr>
<td>4 Movie: The Diving Bell and the Butterfly (Director - Julian Schnabel)</td>
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<tr>
<td>in French with English subtitles</td>
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<tr>
<td>5 Reading: Awakenings (Oliver Sacks)</td>
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<tr>
<td>6 Movie: Awakenings (Director - Penny Marshall)</td>
</tr>
<tr>
<td>7 Reading: Gesundheit (Patch Adams with Maureen Mylander)</td>
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<tr>
<td>8 Movie: Patch Adams (Director - Tom Shadyac)</td>
</tr>
<tr>
<td>9 Reading: One Flew Over the Cuckoo’s Nest (Ken Kesey)</td>
</tr>
<tr>
<td>10 Movie: One Flew Over the Cuckoo’s Nest (Milos Forman)</td>
</tr>
</tbody>
</table>
SIMON TIBERI (20 hours)
This course will focus on three main areas:
1. Introduce concepts of visual literacy to the medical curriculum and its usefulness in clinical medicine.
2. Development of empathy, through role plays, creative writing and discussions.

<table>
<thead>
<tr>
<th>Title: Developing observation and empathy- the lost art of medicine</th>
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</thead>
<tbody>
<tr>
<td>1 Introduction to Medicine today, is it an art or science? What does it take to be a doctor. (Prof. G.Pozza)</td>
</tr>
<tr>
<td>2 Introduction to visual literacy - methods used in describing art</td>
</tr>
<tr>
<td>3 Example to deep looking - guided visit to an art gallery</td>
</tr>
<tr>
<td>4 Example to deep looking - focus on facial and body expressions</td>
</tr>
<tr>
<td>5 Example to deep looking - practical examples in groups</td>
</tr>
<tr>
<td>6 How to integrate visual literacy into clinical medicine</td>
</tr>
<tr>
<td>7 Developing empathy through poetry, short stories and creative writing</td>
</tr>
<tr>
<td>8 Final presentation</td>
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WILLIAM COOKE (10 hours)

<table>
<thead>
<tr>
<th>Title: Can the pen be mightier than the scalpel?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Why, How and What Doctors Write</td>
</tr>
<tr>
<td>2 Deductive Communication, from Roman Oratory to Quentin Tarantino</td>
</tr>
<tr>
<td>3 Mindset: (i) Writing is Writing, (ii) No Place for Narcissism, (iii) Content Expertise is not Enough</td>
</tr>
<tr>
<td>4 The Science of Science Writing: Five Golden Rules for Reader-Friendly prose</td>
</tr>
<tr>
<td>5 Clarity in the expression of Who (subject/actor) does What (verb/action). Practice and Peer Review</td>
</tr>
</tbody>
</table>

Materials consist in a pdf file + “The Science of Science Writing”, Gopen and Swan, American Scientist, Volume 78, 1990, a copy of which will be made available on intranet.
ROBERTA DE MONTICELLI  (10 hours)

Title: Outlines of a phenomenology of the doctor-patient relationship
1  Personal identity: theories of the self
2  The layers of the emotional life
3  The ways of empathy
4  Confidence and Suspicion
5  Dante’s Inferno: Phenomenology of a strange passion

References:

Suggested reading:
1. Gallagher-Zahavi 2008, chapters 7 (The embodied mind); 8 (Action and agency); 9 (How we know others)
2. Dante, Inferno, Canti VII-VIII. (any English translation, for ex. The Divine Comedy, transl., by Allen Mandelbaum, with an Introduction buy E.Montale, New York, Everyman’s Library, 199
GIUSEPPE PANTALEO  (10 hours)

Title: Psychological aspects of social interaction in health-related contexts
  1 Unique individuals or interchangeable group members? Social identification, self-categorization and the shape of social interaction
  2 The intensity of positive/negative emotions and motivations in health-related and broader societal contexts
  3 'Intensity' issues in compliance, health, and risky behaviors – the paradoxical role of deterrents
  4 Perspective-taking and (mis-)communication: Self-symbolizing and the neglect of others’ perspectives
  5 ‘Physical/biological orienting’ vs. ‘multiple psychological perspectives’
  6 Consistency needs in doctor-patient communication
  7 Static vs. dynamic thinking: Cognitive and motivational factors underlying doctor-patient communication
  8 From “empathic resonance” to “empathic perspective-taking”: The evolution of empathy
  9 “Multiple perspectives” and the complexities of the human condition: fear, anxiety, and anguish as instigators of the orienting response
  10 Beyond the Age of Empathy?

Articles and reading materials will be made available to the students at the beginning of each lesson.
AREA 2: BIOETHICS

MORDACCI ROBERTO (10 hours + 12 hours practicals)
Introductory course on Bioethics

Prof. Roberto Mordacci.
Tutors: Alex Grossini, Michele Loi

Mon 10/1, 11-13
Lecture I – *An Introduction to Bioethics*
- The meaning of the term
- The origins
- The main areas
- The main theories

Wed 12/1, 9-11
Tutorials: analytical reading and discussion of

Wed 26/1, 9-13
Tutorials: vision and discussion of a movie of bioethical interest (with tutors and teacher)
GATTACA, by Andrew Niccol, USA 1997

Mon 31/1, 9-11
Lecture II – *The Beginning of Life*
- The moral status of human embryos
- Medically assisted procreation
- The issue of abortion

Mon 31/1, 11-13
Tutorials: analytical reading and discussion of

Tue 1/2, 9-11
Lecture III – *The End of Life*
- The definition of death
- Euthanasia and assisted suicide
Tue 1/2, 11-13
Tutorials: analytical reading and discussion of

Wed 2/2 9-11
Lecture IV - *Research Ethics*
- The ethics of biomedical research
- Informed consent and ethics committees
- New frontiers: neuroethics

Wed 2/2 11-13
Tutorials: analytical reading and discussion of

Fri 4/2 9-11
Lecture V – *Genetics and Justice*
- The ethics of genetics
- Playing God, future persons and nature
- Enhancement and justice
- General conclusions

All the books are already available at San Raffaele Library
Useful Websites: http://moraliaontheweb.com
http://theimmoralist.wordpress.com
AREA 3: LOGIC OF DISCOVERY

ADNREA SERENI (20 hours)
Epistemology

This course aims to introduce selected fundamental issues in epistemology, theory of knowledge and philosophy of science. Topics are chosen on the basis of their historical and philosophical relevance, and all feature important connections with medical thinking.

Lecture I – Fundamental issues in epistemology
Wed. 10/11, 9-13 (4h.)
- Kinds and Sources of knowledge
- Knowing-how and knowing-that
- What is knowledge? Definitions and problems.
- What is justification? Theories of justification.
- Epistemology and science:
  - foundationalism, naturalized epistemology, experimental philosophy

Lecture II – Forms of reasoning
Wed. 17/11, 9-13 (4h.)
- deductive reasoning
- inductive reasoning
  - problem of induction
- abductive reasoning
  - inference to the best explanation
- critical thinking and decision making

Lecture III – Realism, anti-realism, and empiricism
Thur. 18/11, 11-13 (2h.)
- fundamental issues and differences
- reductionism vs anti-reductionism
- relation empirical evidence / theory
  - realistic mechanical model of body
  - realistic and anti-realistic conceptions of diseases

Lecture IV – Mind/body problem
Frid. 19/11, 11-13 (2h.)
- monism vs dualism
- reductionism and emergentism
- behaviourism
- functionalism
- biological vs phenomencal: the problems of qualia and consciousness
  - patient as a body and patient as a person

Lecture V – Explanation
Wed. 24/11, 9-11 (2h.)
- what is explanation?
- covering laws model (and problems)
- causal explanation
  - empiricism and causation
- medical causation

Lecture VI – Q&A
Wed. 25/11, 11-13 (2h.)
Questions on lectures I-V with class answers
Open question-time
Class exercises
Selection of topics for group-work

Lecture VII/VIII – Group-work
Thur. 9-12, 11-13 / 14-16
Group presentation with class discussion
Approximatel8 slots each group, 5 persons per group, 25 minutes each group (15 mins. presentation and 10 mins. discussion)

Readings
The course’s reading-list will consist of lecture-notes and book-chapters. Chapters will be selected among the following text-books:
Wulff H.R., Pedersen S. A., Rosenberg R., Philosophy of Medicine, Blackwell, 1990;
Additionally, many wepages from the Stanford encyclopedia of Philosophy might be of help: http://plato.stanford.edu.
COMPULSORY READING MATERIAL FOR MEDICAL HUMANITIES

Prof. Michael John
2. One Flew Over the Cuckoo's Nest  Ken Kesey
4. Gesundheit Patch Adams with Maureen

Prof. Roberta De Monticelli
Mylander Gallagher S. Zahavi D.

Prof. Andrea Sereni

Conditions and notes

Notes: Attendance of all lessons, seminars and tutorials is COMPULSORY and an electronic register will be kept. For unavoidable absences (e. g. illness) follow the procedure indicated on the Student Intranet on Attendance Requests.
STATISTICS AND BIOINFORMATICS

Course Chair: Clelia Di Serio diserio.clelia@hsr.it

Credits: 1st Semester 2010-11 Total credits: 6
Total hours: 112

Teacher: Prof. Clelia Di Serio

Teaching Assistant (TA): Chiara Brombin, Ph.D

Course Description

The course presents fundamental concepts in applied probability, exploratory data analysis, experimental design, statistical inference, focusing on probability and analysis of one and two samples. Fundamentals in informatics, data management and basic data analysis are also provided in the course. Topics are described in detail in the timetable.

Course Objectives

The goal of this course is to equip medical students with core applied statistical concepts and methods:

1) The course will refresh the mathematical, computational, statistical and probability background that students will need to take the course.

2) The course will introduce students to the display and communication of statistical data by means of descriptive statistics for univariate and bivariate variables.

3) Students will learn to recognize the experimental design to understand different types of studies arising in public health studies.

4) Students will learn to read epidemiological papers and interpret the statistical analyses.

5) Students will learn to understand basics in probabilities (Bayes theorem) to interpret screening tests and main topics in experimental design (e.g., studies type definition, sources of bias, etc..)

6) Students will learn to evaluate correlation, calculate regression coefficients and interpret confidence intervals for population means and proportions in order to build a hypothesis systems one and two tails;

7) Students will learn to perform a two-sample t-test and interpret the results; calculate a 95% confidence interval for the difference in population means and proportions

8) The course will also cover Analysis of Variance (ANOVA)
During the course lessons in information technology will be held in computer room. Excel and SPSS statistical software will be used for computer applications of theoretical issues.

**Readings**

Main material:

- Supplementary Online Material.

Additional material (one of the following):

- **SPSS Programming and Data Management, 4th Edition,** by Raynald Levesque; SPSS Inc.

**Homework**

Each lecture topic will be accompanied by a homework assignment. Homework completion will contribute to the final mark.

**Prerequisites**

Calculus and a moderate level of mathematical literacy are prerequisites for this class (set theory, concept of function, linear function, logarithm, exponential, concept of derivative and integral). Students are required to have good knowledge of Office package (Excel in particular). Upon entering the course, students are expected to have basic skills in Excel (e.g. reading in data, creating new variables, merging data sets, case selection, sub-setting, sorting, stratification, etc.).
CHEMISTRY AND BIOCHEMISTRY

Course Chair: Massimo Degano degano.massimo@hsr.it
Credits: 1st Semester 2010-11 Total credits: 12

Type of subject: Traditional medical discipline
Field: General discipline for the preparation of a doctor: Structure, function and metabolism of molecules of medical interest.
Scientific sector – discipline code: BIO/13- BIO/10
Total number of credits: 12
Number of lecture hours: 106
Number of hours for Seminars/Practicals: 12
Number of hours for Tests and exams: None
Number of hours for Individual study: 156

Course objectives:
The Chemistry and Basic Biochemistry course is one of fundamental importance, in which students are presented with the notions of the chemical and biochemical mechanisms necessary to understand the regulation of biological processes of the cell and of the organism.
This course covers classical molecular and cellular biochemistry, cellular physiology, and molecular genetics. Metabolic interrelationships as they occur in the individual will be stressed and related to disturbances in disease states.
The knowledge and understandings provided by the course constitute the foundations for the following semesters both for the molecular analysis of physiological processes and those of pathogenetic mechanisms in disease. The specific field of Chemistry and Basic Biochemistry will focus on the principles of general and organic chemistry with a description of the fundamental chemical reactions for the understanding of biological processes, the structure and function of organic molecules that constitute the building blocks of living matter, and the analysis and structure and function of principle biological polymers, with particular emphasis on the processes of catalytic enzymes.

At the conclusion of this course, students should be able to:

- Solve problems in diagnosis and treatment of human disease by application of biochemical principles.
- Use primary medical and scientific literature as a resource for learning and problem-solving.
- Define, describe and contrast functions of genes and macromolecules in normal and pathologic contexts.
- Define and describe systemic metabolic biochemistry in terms of genes and molecules.
- Deduce therapeutic mechanisms from established molecular mechanisms.
- Interpret new medical discoveries in terms of fundamental principles of biochemistry.
- Explain the molecular basis of diseases that affect cellular function or development.
The course is a prerequisite for:
Foundation for “Cellular and Molecular Biology” and “Genetics and developmental Biology”.
Prof. Massimo Degano (MD) – Coordinator - 40 hours
Prof. Mauro Freccero (MF) – 40 hours
Prof. Angelo Corti (AC) – 20 hours

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<thead>
<tr>
<th>No.</th>
<th>Theme</th>
<th>Lecturer</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction to the course. Chemistry and biochemistry in human physiology</td>
<td>MD</td>
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<tr>
<td>5</td>
<td>Chemical Kinetics. Reaction Rates and Factors that Influence them. Activation Energy and the Activated Complex. Catalysts and Mechanism of their Effect.</td>
<td>MF</td>
</tr>
<tr>
<td>8</td>
<td>Scope of Organic Chemistry. Formulas, Naming and Classification of Organic Compounds. Resonance, delocalization, conjugation, and aromaticity</td>
<td>MF</td>
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<tr>
<td>9</td>
<td>Hydrocarbons and their Derivatives. Alkanes, Alkenes, Alkynes, Cycloalkanes.</td>
<td>MF</td>
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<td>10</td>
<td>Alcohols</td>
<td>MF</td>
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<td>11</td>
<td>Ethers, epoxides, and sulfides</td>
<td>MF</td>
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<tr>
<td>12</td>
<td>Amines</td>
<td>MF</td>
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<td>13</td>
<td>Ketones and aldehydes</td>
<td>MF</td>
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<tr>
<td>14</td>
<td>Carboxylic acids, esters, amides</td>
<td>MF</td>
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<tr>
<td>15</td>
<td>Amino Acids and their Properties. Important Peptides.</td>
<td>AC</td>
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<td>16</td>
<td>Lactones, lactates and antibiotics</td>
<td>MF</td>
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<tr>
<td>17</td>
<td>Phosphoric acids, inorganic and organic phosphates</td>
<td>MF</td>
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<tr>
<td>18</td>
<td>Aromatic compounds</td>
<td>MF</td>
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<td>19</td>
<td>Alpha substitution and condensation of enols and enolate ions</td>
<td>MF</td>
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<tr>
<td>20</td>
<td>Synthetic reactions in bioorganic chemistry</td>
<td>MF</td>
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<tr>
<td>21</td>
<td>Proteins - Amino Acid Composition, Conformation of Proteins -</td>
<td>AC</td>
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<tr>
<td>23</td>
<td>Types of Bonds and Interactions. Physical and Chemical Properties. Classification of Proteins.</td>
<td>AC</td>
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<tr>
<td>24</td>
<td>Carbohydrates.</td>
<td>MF</td>
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</tbody>
</table>
25 Myoglobin and Hemoglobin
27 Enzymatic catalysis
28 Introduction to the cell, compartments and cellular biochemistry.
29 Cell membranes. Introduction to metabolism.
30 Enzyme regulation
31 Overview of Intermediary Metabolism. Biological Oxidation and Bioenergetics.
   The Respiratory Chain and its Components. The Mechanism of Oxidative
32 The Citric Acid Cycle and its Regulation. The Pyruvate Dehydrogenase Complex.
33 Protein folding
34 Metabolism of Carbohydrates - Metabolism of Glucose and its Regulation. The
   Pentose Phosphate Pathway. Other Pathways of Hexose Metabolism.
   Gluconeogenesis. Metabolism of Glycogen and its Regulation. Metabolism of
   Glycosaminoglycans.
35 Protein purification and characterization
36 Antibodies
37 Metabolism of Lipids and Steroids - Digestion, Resorption and Transport.
   Lipoproteins and their Metabolism. Biosynthesis and Degradation of Saturated and
   Unsaturated Fatty Acids. Ketogenesis. Eicosanoids. Metabolism of Acylglycerols
   and Sphingolipids. Metabolism of Cholesterol. Biosynthesis of Bile Acids and
   Steroid Hormones.
38 Metabolism of Proteins and Amino Acids - Digestion, Resorption and Transport.
   Transamination, Oxidative Deamination and Decarboxylation of Amino Acids.
   Catabolism of the Carbon Skeleton of Amino Acids. Ammonia Formation and its
39 Nucleosides, Nucleotides and Nucleic Acids. DNA and RNA structure and
   properties. DNA sequencing.
40 Metabolism of Pyrimidine and Purine Nucleotides.
41 Protein Synthesis.
42 Metabolism of Porphyrins and Bile Pigments. Biosynthesis of Heme and
   Hemoglobin and their Catabolism. Jaundice.
43 Components of the Blood. Water and Ions Metabolism. Acid-Base Balance. The
   Lungs and the Kidney in Acid-Base Balance. Disorders of Acid-Base Balance.
44 Metabolism of Erythrocytes. Haemostasis and Blood Clotting.
45 Contractile and Structural Proteins. Mechanism of Muscle Contraction and its
   Energy Supply.
46 Metabolism of Connective Tissue. Connective Tissue Proteins, Proteoglycans.
   Process of Mineralization.
47 Metabolism of Adipose Tissue.
48 Metabolism of Liver.
49 Receptors. Hormones.
50 Extracellular and Intracellular Communication. Second Messengers, Protein
   Kinases.
**Suggested textbooks** (choose 1 or 2 from this list)


MEDICAL PHYSICS

Course Coordinator:
Prof. Michele Arneodo: arneodo@to.infn.it
Collaborator
Prof. Monika Grothe: grothe@mail.cern.ch

SDS: FIS/07 – MED/36
Credits: 5
Lectures: 50 hours
Practicals: 10 hours

The course covers the basic principles of Physics, with emphasis on subjects useful for understanding biological phenomena and biomedical instrumentation. Problem sessions are foreseen.

Prerequisites
Basic mathematics. Knowledge of calculus is not required.

Course Syllabus

Mathematical review

Physics quantities and their measurement
Units. Statistical and systematic uncertainties.

Mechanics


Simple harmonic motion; pendulums and springs. Elastic forces, elastic potential energy. Damped and forced oscillations; resonance.

Motion of the centre of mass; Newton’s law for particle systems. Motion of rigid bodies: angular speed and acceleration. Moment of inertia. Angular momentum and its conservation.

Elasticity. Stress and strain. Young’s modulus; Poisson’s modulus; shear modulus; bending. Elastic limit, ultimate strength.

**Fluids**

Archimedes’ principle. Flow rate. Equation of continuity. Conservation of energy and Bernoulli’s equation. Viscosity; Hagen-Poiseuille’s law; flow resistance; Stokes’ law; sedimentation velocity; turbulent flow; Reynolds number.

Ideal gases; equation of state; kinetic theory. Real gases. Vapours and gases. Saturated vapour.

Diffusion, diffusion coefficient, Fick’s law. Surface tension; laws of Laplace and Jurin.

**Thermodynamics**

The first principle of thermodynamics. Specific heat capacity, heat capacity. Heat capacity of an ideal gas at constant pressure or constant volume. Metabolic rate. Second principle of thermodynamics; reversible and irreversible processes; entropy; thermodynamic cycles, Carnot’s cycle, efficiency.

**Electricity and Magnetism**

Electric charge, Coulomb’s law, electric field, electrostatic potential energy, potential; electron volt. Relation between field and potential difference. Electric dipole: field lines and behaviour in an electric field.


Direct and alternating current circuits.

Effects of current through the human body. Grounding.


Cathode ray tube. Linac, cyclotron, synchrotron.

Nuclear magnetic resonance.


Generation of X rays: Bremsstrahlung and characteristic lines.

**Sound Waves**

**Geometrical Optics**

**Modern Physics, Nuclear Physics**
The main concepts of special relativity. The main concepts of quantum mechanics (energy quantisation). Atomic structure; transitions between atomic orbitals.

Structure of the atomic nucleus. Stable and unstable nuclei. Alpha, beta and gamma decays. Activity; law of radioactive decay. The physics principles of PET.

**Interaction of radiation with matter**

**COURSEBOOKS:**

- **General Physics 2nd Edition,**
  Morton Sternheim, Joseph Kane
  ED. Wiley & Sons

- **Physics 3rd Edition,**
  Morton Sternheim, Joseph Kane
  ED. Wiley & Sons

- **Fundamentals of Physics Extended, 9th Edition** (or preceding editions),
  David Halliday, Robert Resnick, Jearl Walker
  ED. Wiley & Sons
CELL AND MOLECULAR BIOLOGY

Course Coordinator:
• Prof. Roberto Sitia RS: sitia.roberto@hsr.it
Collaborators:
• Prof. Marco Bianchi MEB bianchi.marco@hsr.it
• Prof. Fulvio Mavilio FM mavilio.fulvio@hsr.it
• Prof. Eelco Van Anken EVA vananken.eelco@hsr.it
• Prof. Simone Cenci SC cenci.simone@hsr.it
Tutors:
• Dr. Josè Garcia Manteiga garciamanteiga.josemanuel@hsr.it
• Dr. Isaline Rowe rowe.isaline@hsr.it
• Dr. Céline Schaeffer schaeffer.celine@hsr.it
• Dr. Emilie Venereau venereau.emilie@hsr.it

SDS: BIO/11, BIO/13, INF/01
Credits: 11
Lectures: 88 total hours
Practicals: 60 total hours

• RS 1 (Tuesday, 15/03/11 h. 9-11)

Introduction to the Course of Molecular and Cell Biology

Structure of the Course, a voyage between Systematic teaching and Problem Based Learning
-what are genes and how they work (MB)
-genetic and epigenetic mechanisms (MB)
-what are cells (RS, EvA)
-how cells divide (MB, SC)
-how cells die (SC)
-how cells know where they are and where to go (RS, EvA)
-how they interact with the environment (EvA, SC, MB, FB, RS)
-how cells differentiate (MB)
-molecular bases of disease (MB, EvA, RS)

What is life?
Where do we come from?

Introduction to our cells
Membranes, cytoskeleton, organelles.
• RS 2 with Tiziana Anelli  (Tuesday, 15/03/11 h. 14-16)  
  *Intracellular transport and cell movements*  
  
  Microtubules, microfilaments, molecular motors  
  Polarity  
  Axonal transport  
  Cytoskeleton  
  Muscular contraction  
  Cilia and flagella  
  Microvilli  

• RS 3 with Monica Fabbri  (Wednesday, 16/03/11 h. 9-11)  
  *Cytoskeleton and adhesion molecules*  
  
  Adhesion molecules  
  Integrins  
  Tissue organization  

RS 4 (Monday, 21/03/11 h. 9-11)  
*Evolution, Darwin and the adaptable cell structure*  

Prokaryotes, eukaryotes, multicellular organisms.  
The evolution of specialized tissues.  
Homeostasis.  

• RS 5 (Tuesday, 22/03/11 h. 9-11)  
  *Intracellular transport*  
  
  Three main mechanisms of macromolecular transport:  
  -To and from the nucleus  
  -Membrane translocation  
  -Vesicular transport  

  Exo, endo, pino, phagocytosis  
  Transcytosis  
  Mechanisms of cell polarity
• RS 6 (Wednesday, 23/03/11 h. 9-11)  
*Cell compartmentalization*

Specific signals target macromolecules to different organelles.

• RS 7 (Thursday, 24/03/11 h. 14-16)  
*Protein folding, the second genetic code*

Anfinsen’s demonstration of the central dogma  
Chaperones and protein evolution

• RS 8 (Monday, 28/03/11 h. 9-11)  
*Protein degradation*

Proteasomes, lysosomes and autophagy

• RS 9 (Tuesday, 29/03/11 h. 9-11)  
*Protein quality control and homeostasis*

Stress responses in development and disease

• RS 10 (Wednesday, 30/03/11 h. 9-11)  
*Proteostasis as a signal and pathogenetic mechanism.*  

Mechanisms of proteotoxicity.  
Molecular and cellular aging

• RS 11 (Thursday, 31/03/11 h. 14-16)  
*Conformational diseases*

Prions, Amyloidoses, Alzheimer & Parkinson.

• RS12 with Domenico Cianflone (Tuesday, 05/04/11 h. 14-16)  
*Where is biomedicine going?*

A DNA-driven world. Craig Venter’s lecture  
The mystery of non-coding DNA
• **MEB 1** (Tuesday, 29/03/11 h. 14-16)  
*Nuclear structure*

Nuclear membrane and lamins. Nuclear pores and transport

• **MEB 2** (Wednesday, 06/04/11 h. 9-11)  
*An example of transcriptional regulation.*

The NF-kB system

• **MEB 3** (Thursday, 07/04/11 h. 14-16)  
*Chromatin and gene expression 1*  
*Nucleosomes. Histones and histone variants. Histone post-translational modifications, and enzymes that effect them.*

• **MEB 4** (Monday, 11/04/11 h. 9-11)  
*Chromatin and gene expression 2*  

Heterochromatin an euchromatin. How nucleosome position and histone modifications affect gene expression

• **MEB 5** (Tuesday, 12/04/11 h. 9-11)  
*miRNA, siRNA, heterocromatin and centromeres*

• **FB 1** (Monday, 04/04/11 h. 9-11)  
*Transcriptional Regulation of gene expression*

Transcription factors, inducible and constitutive. Subnuclear structure and transcription factories. Does RNA polymerase goes to the gene or does the gene go to the polymerase?

• **FB 2** (Tuesday, 05/04/11 h. 9-11)  
*Regulation of transcription by signaling mechanisms*

• **FB 3** (Monday, 18/04/11 h. 9-11)  
*Stem cells*
• FB 4 (Tuesday, 19/04/11 h. 9-11)
  *Stem cells and cancer*

• FB 5 (Wednesday, 20/04/11 h. 9-11)
  *Regulating loops*

• EvA 1 (Tuesday, 22/03/11 h. 14-16)
  *Membrane Structure*
  Architecture, composition, membrane proteins.

• EvA 2 (Monday, 02/05/11 h. 9-11)
  *Energy conversion I*
  Mitochondria

• EvA 3 (Tuesday, 03/05/11 h. 9-11)
  *Energy conversion II*
  Chloroplasts, genetics of mitochondria & plastids, evolution of electron transport chains.

• EvA 4 (Tuesday, 03/05/11 h.14-16)
  *Cell signaling I*
  Principles of cell communication

• EvA 5 (Wednesday, 04/05/11 h. 9-11)
  *Cell signaling II*
  G protein coupled cell surface receptors.

• EvA 6 (Thursday, 06/05/11 h. 14-16)
  *Cell signaling III*
  Enzyme coupled cell surface receptors.

• EvA 7 (Monday, 09/05/11 h. 9-11)
  *Cell signaling IV*
  Unfolded Protein Response, determining cell shape.
• EvA 8 (Tuesday, 10/05/11 h. 9-11)  
**Manipulating proteins & DNA I**  
Cloning, cDNA libraries, tagging, PCR.

• EvA 9 (Tuesday, 10/05/11 h. 14-16)  
**Studying gene function & expression I**  
Function prediction, genetic screens, tagged libraries, reporter genes.

• EvA 10 (Wednesday, 11/05/11 h. 9-11)  
**Studying gene function & expression II**  
Reverse genetics, knock-out libraries, RNAi, complementation, epistasis & EMAP, microarray.

• EvA 11 (Thursday, 12/05/11 h. 14-16)  
**Visualizing cells I**  
Standard microscopy techniques.

• EvA 12 (Tuesday, 17/05/11 h. 9-11)  
**Visualizing cells II**  
Advanced microscopy techniques

• EvA 13 with Antonio Siccardi (Wednesday, 18/05/11 h. 9-11)  
**A historical perspective**  
The Luria-Delbruck experiment.

• SC 1 (Tuesday, 12/04/11 h. 14-16)  
**Cell cycle 1**  

• SC 02 (Wednesday, 13/04/11 h. 9-11)  
**Cell cycle 2**  
- **SC 03 (Thursday, 14/04/11 h. 14-16)**
  *Mitosis*

- **SC 04 (Tuesday, 19/04/11 h. 14-16)**
  *Apoptosis - I*

- **SC 05 (Tuesday, 17/05/11 h. 14-16)**
  *Apoptosis - II*

- **SC 06 (Monday, 23/05/11 h. 9-11)**
  *Apoptosis- III*

EvA 14 S1 Group 1 Tutor: Jose Garcia Manteiga
EvA 15 S2 Group 4 Tutor: TBN
RS 13 S3 Group 2 Tutor: Isaline Rowe
RS 14 S4 Group 3 Tutor: Celine Schaeffer
USMLE REQUIREMENTS

Biology of cells
- adaptive cell responses and cellular homeostasis
- intracellular accumulations
- mechanisms of injury and necrosis
- apoptosis
- mechanisms of dysregulation
  - cell biology of cancer, including genetics of cancer
  - general principles of invasion and metastasis, including cancer staging
- cell/tissue structure, regulation, and function, including cytoskeleton, organelles, glycolipids, channels, gap junctions, extracellular matrix, and receptors
  
Molecular biology
- gene expression: DNA structure, replication, exchange, and epigenetics
- gene expression: transcription
- gene expression: translation, post-translational processing, modifications, and disposition of proteins (degradation), including protein/glycoprotein synthesis, intra/extracellular sorting, and processes/functions related to Golgi complex and rough endoplasmic reticulum
- structure and function of proteins and enzymes
- energy metabolism

COURSEBOOKS:

- Molecular Biology of the Cell
  Bruce Alberts, Alexander Johnson
- Molecular Cell Biology
  Harvey Lodish, A. Berk, C. Kaiser....
- Essential cell biology
- Cells
  Lewin, Cassimeris et al.
- Cell Biology
  Thomas Pollard, William Earnshaw
  ED. Saunders W.B ISBN: 978-1416022558
- Cell Biology
  Gerald Karp,

The above books contain all the essential notions, differing primarily in the style of presentation.
Suggested readings

We encourage our students to read on science, medicine and society. Below are a few tips.

M. Perutz. *Is science necessary? and/or I wish I made you angry before.*
Two lovely series of essays on science and scientists.

J. Diamond. *Germs, guns and steel.*
A brief summary of the last 13000 years of humans… Why did some civilisations prevail?

J. Monod *Chance and necessity.*
A Nobel Prize winner in Medicine tackles fundamental philosophical issues

**J.D. Watson. The double helix.**
Watson tells the story of how the structure of DNA was solved, with the pace of a crime fiction novel.

P. Medawar. *Advice to a young scientist.*
A few useful tips, should you decide to become a physician scientist. A thoroughly enjoyable book..
GENETICS AND DEVELOPMENTAL BIOLOGY

Course Coordinator:
- Prof. Giorgio Casari: casari.giorgio@hsr.it

Collaborators:
- Prof. Giangiacomo Consalez: consalez.giangiacomo@hsr.it
- Prof. Luca Rampoldi: rampoldi.luca@hsr.it

SDS: BIO /13 MED /03
Credits: 12
Lectures: 96 hours

Topics covered by the course

Mendelian and non-Mendelian genetics

1. Course introduction_ The Human Genome Project.
5. Exceptions to Mendelian inheritance_Sex-related effects. Pleiotropy. Pedigree design._2
6. Chromosomes/mitosis/meiosis_Chromosome structure (telomeres, centromere) and segregation during mitosis and meiosis. Crossing-over.
8. Recombination/mapping (I)_Molecular basis of recombination.
12. Dynamic mutations (I)
13. Dynamic mutations (II)
14. Mitochondrial Inheritance
15. Chromosome mutations
16. Cytogenetics
17. CGH
18. DNA/RNA structure
20. Translation. Mechanisms of splicing
21. RNA interference_miRNA, siRNA, shRNA. Discovery and applications.
22. Point mutations and repair_Spontaneous and induced mutations. Repair of mutations and recombination.
23. Nonsense mediated decay
24. Complex mutations/polymorphisms/CNVs
25. Mutation detection techniques
26. Deep sequencing
28. Effect of mutations (ESE)
29. Genetic markers_DNA markers (microsatellites, SNPs). Genetic maps. Haplotype maps (the HaploMap project).
32. Probability_Bayes' theorem, application for risk calculation in human pedigrees.
33. Examples of linkage/positional cloning
34. Examples of functional cloning
35. Quantitative Trait Loci
36. Population genetics_1
37. Population genetics_2
38. Molecular Evolution (I)
39. Non-parametric linkage analysis/association studies
40. Jolly

Embryology and developmental biology

This part of the course will cover the essentials of normal human development and of its main aberrations, providing information on some recognizable patterns of human malformation.

Topics covered by the course

General Embryology
- Gametogenesis: Conversion of Germ Cells into Male and female gametes,
- First Week of Development: ovulation to implantation
- Second Week of Development: Bilaminar Germ Disc
- Third Week of Development: Trilaminar, Germ Disc
- Third to Eighth weeks: The Embryonic Period
- Third Month to Birth: The Fetus and Placenta
Systems-based Embryology

- Skeletal System
- Muscular System
- Body Cavities,
- Cardiovascular System
- Respiratory System
- Digestive System
- Urogenital System
- Head and Neck
- Central Nervous System
- Ear and eye development
- Tegumentary System

USMLE REQUIREMENTS

Human development and genetics
- principles of pedigree analysis
- inheritance patterns
- occurrence and recurrence risk determination
- population genetics: Hardy-Weinberg law, founder effects, mutation-selection equilibrium
- principles of gene therapy
- genetic testing and counselling
- genetic mechanisms

COURSEBOOKS:

- **Langman’s Medical Embryology / Edition11**, Thomas W. Sadler, ED. Lippincott Williams & Wilkins

- **Human Molecular Genetics 3rd Edition**, Tom Strachan, Andrew Read
MEDICAL HUMANITIES

Prof. Andrea Moro: andrea.moro@iusspavia.it
SDS: L-LIN/01
Credits: 1
Lectures: 10 total hours

Topics covered by the course

On the biological foundations of language: the linguistics perspective

1 &2. A short history of linguistics
3. The XX century: language(s), machines and children
4. The architecture of human language
5. Recursion or the specific differences with respect to other animals’ codes
6. Grammar like a crystal: the universals of language (syntax)
7. Grammar like a crystal: the universal of language (semantics)
8. The brain and the mystery of impossible languages
9. Does the structure of the world influence the structure of language (and viceversa)?
10. Language, genetics and evolution

Coursebooks:

- The Generative Enterprise Revisited, [selected parts]
  Noam Chompsky (2004),

- The Boundaries of Babel
  [chapter 1 and 2]