COURSE OVERVIEW

L O R O C H
communication & training
in life sciences

Swiss Biotech Association
PREFERRED SOLUTION PROVIDER

Introduction

Biotechnology and life sciences are of growing concern to many professionals that do not necessarily have any formal training in biology or an adequate personal knowledge base. Indeed, biotechnology is becoming more and more **transdisciplinary** in nature, owing to a rapid and massive emergence of new hybrid technologies that combine medicine, agriculture, environmental sciences, robotics, informatics, engineering, and modern biology. Without a basic, yet sound understanding of the latter, it is not impossible to fully comprehend these hybrid technologies, nor have any critical outlook on their practical consequences.

At the same time, currently, more than half of all professionals active in pharma, biotech, medtech and other industries that interface with life sciences are non-biologists. In many ways*, they already are biotechnologists, even though most lack any literacy skills in life sciences*.

The need for literacy in modern biology among non-scientists is particularly felt and recognized in the pharmaceutical sector where biologics have started playing an important role a long time ago and where increasingly sophisticated biomolecular constructs, gene, RNA and cell therapies, nanobiotechnologies, organ regeneration and synthetic biology will clearly occupy an important place in a not so distant future.

Recognizing the need for adequate training of non-biologists in molecular biology, Loroch CTLS has made it a priority to develop short, introductory courses that would help busy professionals bridge the gap between a state of “partial or non-existent understanding” of key concepts in modern biology to that of “literacy and competence to advance in self-learning”.

As a clear sign of the usefulness and quality of Loroch CTLS educational offerings, the Swiss Biotech Association (SBA) has promoted the course as part of its 10th year anniversary celebrations. Starting 2009, Loroch CTLS is offering its educational products as the SBA preferred solution provider and has started managing the newly created SBA educational sector. In the last three years, nearly 600 professionals of all venues have attended our courses, offering us invaluable insights as how to optimally format our trainings.

Course content as of 2011

An outline of the course content is presented in the following pages. Please note that depending on the profiles of the course participants, time and other constraints, not all topics may be covered and emphasis may shift from one subject to another. The listed contents thus represent the “maximum typical version” of the course.

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Day 1: The toolbox of Molecular Biology

The first day is essentially a historical account of the key experiments that shaped molecular biology over the last 60 years. At the end of the day, the participants understand how macromolecules act within biological systems and how the living cell is capable of coordinating its vital functions (gene expression and control of gene expression). This understanding translates into the creation of molecular views of a healthy cell vs. diseased cells. While necessarily simplistic, these views serve as a common base for further building of knowledge. In addition, the key properties of molecules used in diagnostics and therapeutics are also described. Day 1 covers the following topics:

A. Fundamentals

1. **Butterflies and Legos: the foundations of molecular biology.**
   A quick historical introduction to molecular biology: its precursors (Gregor Mendel, Friedrich Miescher), the importance of modern physics, chemistry and of the interest of physicists in biology in the 20-th century, leading to the central paradigm of molecular biology.

2. **The size and numbers of the objects that molecular biologists study**
   The impact of small sizes and big numbers in biology: size of molecules and impact on their behavior, biological datasets, the importance of selection, screening, labeling and statistics.

3. **Three archetypes of living organisms: bacteria, animals, viruses**
   A quick review of the essential structural and functional features of viruses, prokaryotes and eukaryotes and how these features impact on health and disease.

4. **What life is like if you are a macromolecule**
   The nature of chemical bonds (covalent, hydrogen, ionic), small molecules, macromolecules, phospholipids, biological membranes, trans-membrane proteins, signal transduction and drugability of targets.

5. **The three pillars of life sciences**
   Because science without scientists is an empty shell, it is essential to understand the logic used in biology. What kind of people work in life sciences? How do they think? How do they tackle the problems that stem from the very phenomenon of life? We will explore the three main sciences that are the main pillars of biotechnology:

   - **Genetics – how does life perpetuate itself?**

   From Mendel, the monk who invented genetics to Dolly, the sheep that proved him right, we will take a grand tour of one of the most fascinating aspects of living systems that is at the basis of sex, evolution and the quest for immortality.

   - **Molecular Biology – it's all about building blocks and a bit of molecular magic!**

   Living organisms are made of simple, small molecules like water and salt and complex, gigantic macromolecules, often referred to as living macromolecules. In this section we will explore the basic rules that hold living matter together and confer to it its most amazing property: to be alive.

   - **Biochemistry – the watchmaker's dream**

   A living cell is capable of carrying complex chemical reactions at a speed and with an ease that are unimaginable in a lifeless world. How is this possible? We will attempt to answer this question by exploring how enzymes, molecular machines essential to life, drive all of metabolism on earth, from photosynthesis to the functioning of the human brain.

Day 1: The toolbox of Molecular Biology (continued)

6. **BREAKING NEWS of April 9, 1952: the genetic material is made of DNA !**
   The Hershey-Chase T4-phage experiment as the archetypal experiment in molecular biology.

B. DNA knowledge and basic applications

7. **DNA: the primary reservoir of information**
   The essential features of individual nucleotides, oligonucleotides, single stranded and double-stranded DNAs, principles of DNA-based diagnostics, origin of replication, in vivo and in vitro DNA replication.

8. **The dawn of recombinant DNA technology: the glorious and sad history of antibiotics**.
   Discovery of penicillin, selection and resistance, multiples antibiotic resistances, plasmids, conjugation, horizontal gene transfer, homologous recombination, random insertion, introduction to the concept of gene therapy, insertional mutagenesis and recombinant DNA technology.

C. Gene expression

9. **RNA: the message that comes with its toolbox**
   The essential features of the RNA molecule, different classes of catalytic and inhibitory RNAs, transcription, promoters and terminators, transcription factors and transcriptional regulation, molecular definition of a gene.

10. **BREAKING NEWS of May 15, 1961: The genetic code is cracked!**
    The genetic code and translation.

11. **Artificial genes and universal recombinant DNA technology**

    In 1972, an unprecedented revolution took place in biology: it became possible to assemble new chimeric DNA molecule from preexisting DNAs isolated from different organisms. The ability to manipulate DNA at will in a test-tube and to introduce the modified version into an organism of choice completely changes how biologists can study life and how biotechnologists can produce novel substances with extraordinary properties.

    We will conclude Day 1 with an exploration of classic recombinant technology which includes the following topics: comparison of gene expression in prokaryotes and eukaryotes, introns, splicing, polyadenylation, retroviral life cycle, reverse transcription, cDNA for human gene expression in bacteria, cloning, cDNA libraries.

Day 2: Biotechnology for a Better World

The second day of the course is organized around case studies chosen according to the participants' interest and progress accomplished during day 1. Each case study includes short presentations, questions and a structured discussion. In addition, we will also review the material from day 1 by integrating earlier discoveries into today's, state-of-the-art technologies and new challenges. The following topics are covered:

1. **Review of Day 1 What tools does the toolbox contain?**
   A synthetic view of gene expression, leading to key features of different strategies in the production of bioactive molecules, ranging from chemistry to mammalian cell culture.

2. **Structural proteins and enzymes: at the heart of health and disease**
   After reviewing the basic features of structural proteins and enzymes, we will take a quick look at bioinformatics as a science that enables rational drug design and the engineering of biologics.

3. **DNA diagnostics to identify criminals: microorganisms or humans**
   Key techniques in diagnostics and characterization of DNA: restriction endonucleases electrophoresis, Southern hybridization, PCR and various PCR applications.

4. **Recombinant insulin: the making of the first recombinant drug in history**
   The making of a biologic from A to Z. Rapid introduction to diabetes and glucose metabolism. cDNA library construction, colony hybridization, sequencing, gene expression systems, protein engineering.

5. **Antibodies in diagnostics, purification and therapeutics**
   Quick introduction to immunology, diagnostic Mab-,s ELISA, Western, therapeutic Mab-s (murine, chimeric, humanized, human), Fab-s, recombinant antibodies, antibody-drug conjugates.

6. **Health, disease and drugs: a molecular view**
   Using the concepts acquired in the first day, we will build simple molecular models of different living cellular processes to gain a unified and simple representation of the following states of a living cell:
   - Healthy
   - Bacterial diseases
   - Viral diseases
   - Oncological diseases
   - Metabolic and endocrinological diseases
   - Neurological diseases
   - Autoimmune and inflammatory diseases

   Each representation will include current and future therapeutic strategies. This section presents the "big picture" of drug discovery and development.

7. **A biologist's view of cancer**
   Quick introduction to cancer biology, biomarkers and molecular prognosis, genome sequencing, MFISH, DNA micro arrays, regulatory cascades (kinases and phosphorylases), real-time PCR, SNPs and epigenetics, POC diagnostics.

8. **Emerging therapeutic technologies: what will tomorrow bring?**
   A quick but a no non-sense presentation of the following therapeutic strategies:
   - Therapeutic vaccinations (oncology)
   - Phage therapies (infectious diseases)
   - RNAi therapies (various diseases)
   - Gene therapies (various diseases)
   - Cell therapies (various diseases)

9. **Biology of Aging and the dream of immortality (or at least of healthy aging)**
   An introduction to the biology of aging and a molecular portrait of age-related diseases. This section will review all the key concepts at the heart of the curative therapeutics of the future (gene therapies, cell therapies, cellular engineering, synthetic biology, epigenetics) and will constitute the conclusion of the course.