Nucleic Acids & Carbohydrates (Biological Chemistry I)  
HS 2013

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## Syllabus

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<tr>
<th>Week</th>
<th>Date</th>
<th>Exercises</th>
<th>Lecture and Topic</th>
<th>Lecturer</th>
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<tr>
<td>1</td>
<td>17.09.13</td>
<td>No session</td>
<td>Overview and DNA/RNA structure - components/$2^{nd}$/3$^{rd}$/higher order</td>
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<tr>
<td>2</td>
<td>24.09.13</td>
<td>Intro to presentations / topic distribution</td>
<td>Genes and genomes - definition/regulation/genomics</td>
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<td>Exercise &quot;The Genetic Material&quot;</td>
<td>Presentations: (1) Traditional DNA sequencing; (2) Next-generation sequencing</td>
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<td>5</td>
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<td>DNA synthesis - chemical vs. enzymatic</td>
<td>SS</td>
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<td>6</td>
<td>22.10.13</td>
<td>Presentation: (3) Nucleoside drugs</td>
<td>DNA binding interactions - with DNA/proteins/small molecules</td>
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<td>7</td>
<td>29.10.13</td>
<td>Exercise &quot;Nucleic Acid Recognition &amp; Synthesis&quot;</td>
<td>DNA modification and processing - chemical modification/alkylation - enzymatic translesion synthesis/repair</td>
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<td>8</td>
<td>05.11.13</td>
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<td>Presentations: (4) Non-canonical bases in DNA; (5) PNA</td>
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<td>9</td>
<td>12.11.13</td>
<td>Presentation: (6) Chemical vs. enzymatic synthesis of RNA</td>
<td>RNA world: functional binding - aptamers/antisense/RNAi</td>
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<td>10</td>
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<td>Presentation: (7) Riboswitches</td>
<td>RNA world: catalysis/ribozymes - self-splicing/SELEX</td>
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<td>11</td>
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<td>Carbohydrates - structure</td>
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<td>12</td>
<td>03.12.13</td>
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<td>Carbohydrates - synthesis</td>
<td>HW</td>
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<td>13</td>
<td>10.12.13</td>
<td>Exercise &quot;Carbohydrates&quot;</td>
<td>Carbohydrates - applications</td>
<td>HW</td>
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<tr>
<td>14</td>
<td>17.12.13</td>
<td>Presentation: (8) Oligosaccharide synthesis</td>
<td>Presentations: (9) Oligosaccharide biosynthesis; (10) Carbohydrate vaccines</td>
<td>HW</td>
</tr>
</tbody>
</table>

**Lecturers:**
- **Peter Kast** (PK); e-mail: kast@org.chem.ethz.ch
- **Shana Sturla** (SS); e-mail: shana.sturla@hest.ethz.ch
- **Donald Hilvert** (DH); e-mail: hilvert@org.chem.ethz.ch
- **Helma Wennemers** (HW); e-mail: helma.wennemers@org.chem.ethz.ch
GENERAL INFORMATION

Course Goals:
To survey the chemistry and biology of nucleic acids and carbohydrates with respect to synthesis, structure and function in nature and in the laboratory.

What we expect from you / final exam:
The exercises are an integral part of this course, designed to complement and reinforce the material discussed in the lectures. It is thus highly recommended that you solve the problems independently ahead of the exercise sessions led by the assistants. Furthermore, we expect each participant to prepare and give a presentation of research papers and/or reviews from the distributed list of "Papers for Presentations", which contains topics that are integral parts of this lecture series. The final exam (both written and oral) will cover the lecture material, including the student presentations and literature specifically assigned for each lecture. The exercises, which are taken in part from previous exams, give a good sense of the kinds of questions that will be asked and the level of understanding that students are expected to master in the course of the semester.

Bibliography of Useful Texts:

While the content of this course does not fully overlap with the lectures previously given by Prof. Peter H. Seeberger, his script provides a good overview of the topics covered and can be downloaded at https://www.protein.ethz.ch/lecture/docs.html (enter with your NETHZ login and password).

Original Literature:
Citations and illustrations from the original literature relevant to the individual lectures will be provided weekly (as handouts for download) and are part of the material covered in the final exam.
Papers for Presentations:

(1) Traditional DNA Sequencing (October 8, 2013)

- Introduction, background, sequencing strategies, summary:
  - find text books and reviews on classical DNA sequencing.

- Chemical method:

- Enzymatic method:

- Fluorescent approaches:

(2) Next-Generation DNA Sequencing (October 8, 2013)

- Introduction, background, rationale, overview, perspectives, e.g.:

- The 454 pyrosequencing strategy:

- Single-molecule sequencing:

- Applied to individual genomes:
(3) Nucleoside Drugs (October 22, 2013)

- Nucleosides as antiviral therapeutics: general mode of action and a focus on the basis of selective toxicity to the virus over the host:

- Nucleosides as antiviral therapeutics: The importance of kinase-mediated activation in drug activity:

- Nucleosides as anticancer therapeutics:

- Problems with nucleoside drugs: Mechanisms of drug resistance, e.g.:

(4) Non-Canonical Bases in DNA (November 5, 2013)

- Overview of general concepts, strategies, and applications involving synthetic base surrogates in DNA:

- Influence of base modification and replacement on thermodynamic properties of DNA:

- Application of synthetic nucleotide as a mechanistic probe of DNA-interacting enzymes: An example of polymerase-mediated lesion bypass DNA synthesis:

- Application of synthetic nucleotides as a basis in new biotechnologies: PCR of synthetic DNA:
(5) Peptide Nucleic Acids (November 5, 2013)

- Introduction, background, rationale, summary, e.g.:

- Targeting double-stranded DNA:

- Correction of defective genes:

- Regulating mammalian gene expression:

(6) Chemical Versus Enzymatic Synthesis of RNA (November 12, 2013)

- Chemical synthesis:

- Enzymatic synthesis:
  - Text books on general mechanism of transcription and the similarities and differences to replication and chemical synthesis.

- Structural basis of transcription:

(7) Riboswitches (November 19, 2013)

- Introduction, background, rationale, summary:

- Thiamine pyrophosphate riboswitch:

- Structural studies:

- Engineering:
(8) Automation/Combinatorial and Parallel Synthesis of Oligosaccharides (December 17, 2013)

- Reviews on oligosaccharide synthesis: background, rationale, perspectives, such as:

- Automation:

- Libraries:

(9) Oligosaccharide Biosynthesis (December 17, 2013)

- Text books or reviews on oligosaccharide biosynthesis, e.g.:

- Engineering bacterial cells for N-linked glycosylation:

- Oligosaccharyltransferase structure:

- Cell surface engineering:

(10) Carbohydrate Vaccines (December 17, 2013)

- Introduction, background, rationale, summary:

- Affinity Versus Avidity:

- Cancer vaccines:

- Malaria vaccines:
General guidelines on how to give a good presentation

* Read the paper(s) carefully and discuss anything you do not understand with your group or the teaching assistants or the lecturers

* Gather and read appropriate papers that provide the relevant background for your articles

* Decide which part(s) of a paper (or of an ensemble of papers) you actually want to present in the allotted time period to tell a compelling story

* Provide your presentation with a clear structure such as the one outlined below

1) **Background/Introduction**
   What are the larger goals to which this paper contributes? What is the relevance of the paper in terms of technological development, drug design or basic aspects of the life sciences? Can you make a connection between the paper and the material covered in class?

2) **Goals of the study**
   What is the specific hypothesis that the authors address? What are the goals of the study? What approach is taken to address the hypothesis/achieve the goals?

3) **Results**
   Discuss the results of the experiments conducted. Show figures of gels etc. – the quality of the data determines the quality of the paper.

4) **Discussion**
   What do the authors conclude from the experimental results? Are these conclusions justified based on the data? What is the importance of the work – where does it go beyond the “state of the art”? What are the possible next steps toward the larger goal of this work?

* Prepare clear presentation materials

* Speak up and articulate clearly

Special requirements for the team presentations

1) Be aware of the amount of time needed (≥ 2 weekends) to prepare the lecture.

2) No PowerPoint/computer/beamer presentations: chalk talks supported by transparencies are mandatory.

3) Meet with the other team members to ensure a coherent presentation. Ensure smooth transitions between the individual presentations, such that the whole lecture flows well.

4) Prepare handouts (pdf files) for the other students in the course (1 page per team member).

5) Work as a team and help each other. However, everyone in the team has to present his/her own part.

6) Practice your talk in front of your team members (use a blackboard and your transparencies) and get feedback from the group.