

Learning modules

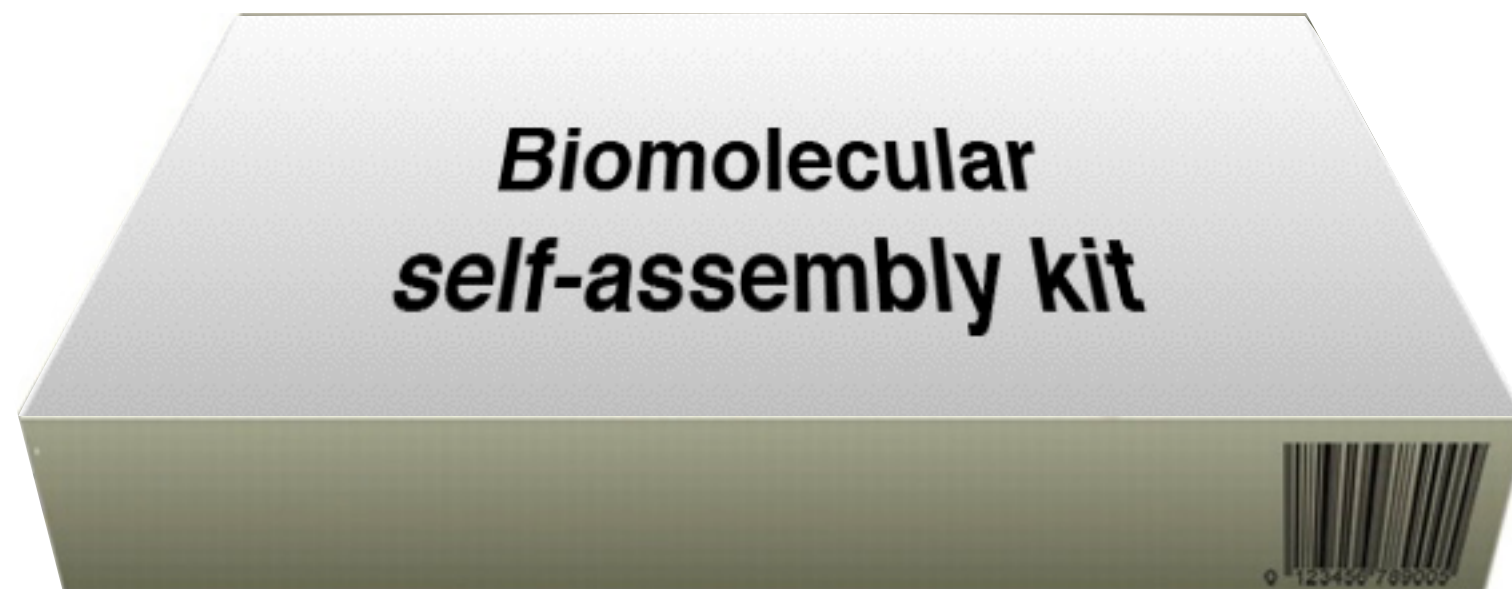
as used in the Bionanotechnology MSc course



Ebbe Sloth Andersen
Interdisciplinary Nanoscience Center
Aarhus University

MSc course on

BIONANO TECHNOLOGY





5 ECTS = 125-150 hours

[TIMETABLE]

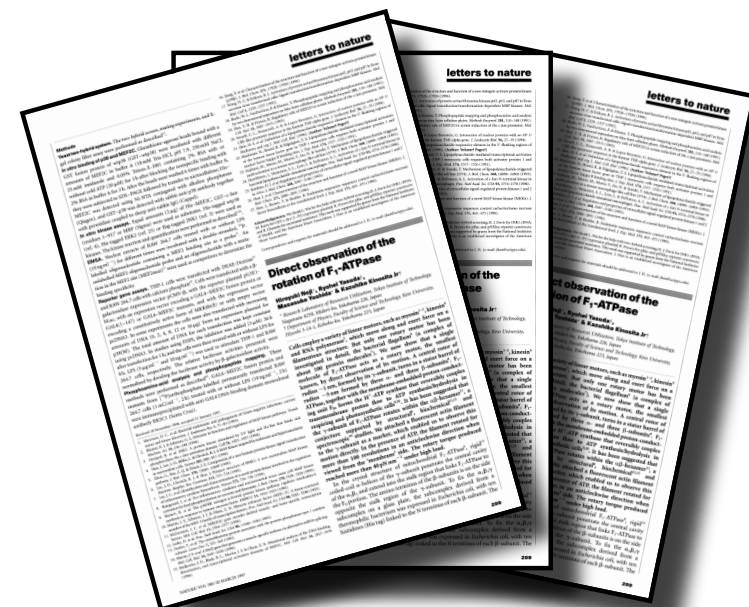
Date: _____

Learning Centre
FB061
Otago Polytechnic
Learningcentre@otago.ac.nz



| | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY | SATURDAY | SUNDAY |
|------|--------|---------|-----------|----------|--------|----------|--------|
| AM 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| PM 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |




Lectures
Exercises
Journal clubs



My use of learning modules



E15Q2 –
Bionanoteknologi
[260112U002]



Home Page

Information

Announcements

Course Description

Roster

Teaching

Course plan

Introduction

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Exam


Discussion forum

Wiki pages









COURSE MANAGEMENT

Control Panel

Week 2



RNA nanotechnology and RNA synthetic biology

Attached Files:  [P3-Geary-2014.pdf](#) (2.708 MB)
 [P4-Win-2007.pdf](#) (1.978 MB)
 [R3-Jaeger-2006.pdf](#) (955.292 KB)
 [R4-Isaacs-2006.pdf](#) (453.701 KB)
 [L3-Andersen-RNA-structure.pdf](#) (10.503 MB)
 [L4-Andersen-RNA-synbio.pdf](#) (14.193 MB)
 [P4-Win-2007-presentation.pdf](#) (632.381 KB)
 [P3-Geary-2014-presentation.pdf](#) (7.49 MB)

Dear all,


The first lecture this week is on the topic of "structural RNA nanotechnology". This topic covers the use of RNA helices and other structural motifs to create well-defined RNA nanostructures. In preparation for the lecture please read R3-Jaeger-2006. The lecture slides are available for download. The exercise after the lecture can be found below.

The Tuesday lecture will be on "RNA synthetic biology". This topic deals with the use of rationally designed RNA elements in cells. Please read the Isaacs-2006 review in preparation. The exercise will use the online game [Eterna](#) to design an RNA switch.


The Friday journal club will be run by Steffen. Group 1 and 7 should prepare a presentation of paper P3-Geary-2014 and P4-Win-2007, respectively. Please prepare presentations of the two papers.

Best regards,

Ebbe



Exercise 1: Design RNA nanostructure



Exercise 2: Design RNA switch

What is a learning module?

A Learning Module is a collection of Content Items focused on a specific subject that students can navigate at their own pace. Instructors can create a structured path for progressing through the items.






- Learning path is displayed in the Table of Contents, which can be used to navigate through the Learning Module.
- Can force students to progress through the content in the order that is set.
- Learning Modules can be set to open in a new browser window.
- Tracking Statistics for the Learning Module
- Instructors can customise the hierarchical view of the Learning Module.

The screenshot displays a web interface for a learning module. On the left, a 'Table of Contents' sidebar lists five items: 'Introduction' (highlighted), 'Topic discussion', 'RNA 3D design', 'RNA sequence design', and 'Presentation of results'. The main content area is titled 'Introduction' and shows 'Page 1 of 5'. It contains a list of four tasks for a group exercise, each with a time allocation: 1. Discuss a topic internally in group and contribute to discussion forum (10 min), 2. Each group design the blueprint of an RNA nanostructure (15 min), 3. The blueprint is used for designing a sequence using online tools (10 min), and 4. Present your results and discuss in plenum (10 min). A note at the bottom says 'Click the activities to the left to start.'

Example

Table of Contents

Page 1 of 5

-  **Introduction**
-  Topic discussion
-  RNA 3D design
-  RNA sequence design
-  Presentation of results

Introduction

In this exercise each group should work together to do the following tasks:

1. Discuss a topic internally in group and contribute to discussion forum (10 min).
2. Each group design the blueprint of an RNA nanostructure (15 min).
3. The blueprint is used for designing a sequence using online tools (10 min).
4. Present your results and discuss in plenum (10 min).

Click the activities to the left to start.

Example

Table of Contents

Page 2 of 5

- Introduction
- Topic discussion**
- RNA 3D design
- RNA sequence design
- Presentation of results

Topic discussion

Time for this activity: 10 min

First use 5 min in the group to discuss a topic from the lecture in more detail.

The topics are distributed among the work groups as follows:

- Group 1: What are the structural benefits of using RNA for constructing nanostructures?
- Group 2: What are the functional benefits of using RNA for constructing nanostructures?
- Group 3: What structural modules are used in RNA architectonics and how do they differ from DNA?
- Group 4: Describe the design principle of tensegrity. What physical properties are used and how are they implemented?
- Group 5: How does the RNA tectonics method work? What method is used for sequence design?
- Group 6: What are the pros and cons of the different self-assembly strategies?
- Group 7: How can RNA nanostructures be functionalized?

After your group discussion you should contribute your answer to the discussion forum. Write the answer to the question "How can RNA nanostructures be functionalized?". Now write your answer to the question that you have chosen for your group. You can also give feedback to the other groups to give them feedback on the quality of their answer (be kind :-).

[Click to launch Discussion Forum](#)

Example

Table of Contents

Page 3 of 5

- Introduction
- Topic discussion
- RNA 3D design**
- RNA sequence design
- Presentation of results

RNA 3D design

Time for this activity: 15 min

In this activity you should consider the 3D design of your RNA nanostructure (see graphics below, a print-out will be handed c

- Group 1-4 should design a 2H-AE tile.
- Group 5-7 should design a 2H-AO tile.

Work in the groups to discuss the following features of your design:

- What is the base-pair distance between crossovers on each of the two helices?
- Where would you place the 5' and 3' ends?
- Choose internal KL sequences (blue box)
- Choose external KL sequences to form hexagonal lattice (red boxes)
- Choose immobile RNA junctions (see helper graphics below)
- Insert GU wobbles to avoid >8 bp stems (for efficient synthesis)
- Add GGAA to 5' end to make a good start site for T7 RNA polymerase
- Now write out the sequence and dot bracket notation (use the templates below) (Hint: Use a text editor with monospace)

Information:

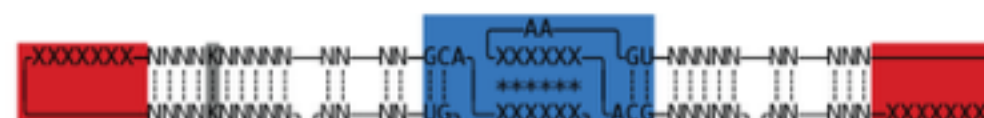
2H-AO

[illegible]

2H-AE

[illegible]

2H-AE



these are not
allowed to pair

3' 5'

Example

Table of Contents

Page 4 of 5

- Introduction
- Topic discussion
- RNA 3D design
- RNA sequence design**
- Presentation of results

RNA sequence design

Time for this activity: 10 min

Now that you have designed your RNA nanostructure you need to design a sequence.

First you will need to construct an input file for the online sequence design software NUPACK.

You will need the structure and sequence that you designed in former activity.

Use NUPACK to design your sequence by inputting your structure and sequence constraints. The input should be:

- material = RNA
- temperature[C] = 37.0
- trials = 4
- sodium[M] = 1.0
- dangles = some
- allowmismatch = true
- structure RNA_seq = [INPUT YOUR STRUCTURE HERE, REMEMBER TO REMOVE SQUARE BRACKETS]
- domain a = [INPUT YOUR SEQUENCE CONSTRAINTS HERE]
- RNA_seq.seq = a
- prevent = AAAA, CCCC, GGGG, UUUU, KKKKKK, MMMMMM, RRRRRR, SSSSSS, WWWWWW, YYYYYY






If your input was returned with an error then submit this input instead:

- material = RNA
- temperature[C] = 37.0
- trials = 4
- sodium[M] = 1.0
- dangles = some
- allowmismatch = true

Example

Table of Contents

Page 5 of 5

-  Introduction
-  Topic discussion
-  RNA 3D design
-  RNA sequence design
-  **Presentation of results**

Presentation of results

Time for this activity: 10 min

The last activity is to present your result.

Report your sequence design result on the wiki pages. Include the "ensemble defect"

Also describe shortly your design choices. Why your design is better? How it feels to create

[Launch wiki pages](#)

Finally present your final design for the class.

How to construct a learning module

The screenshot shows a web interface for a learning management system. At the top, there is a dark green header with the text "Week 2" and a dropdown arrow. Below this is a navigation bar with four main sections: "Build Content", "Assessments", "Tools", and "Partner Content", each with a dropdown arrow. To the right of these is a sort icon (up and down arrows). The "Build Content" dropdown menu is open, showing a list of options. A red arrow points to the "Learning Module" option, which is highlighted with a white background. The menu is organized into two columns: "Create" on the left and "New Page" on the right. The "Create" column includes "Item", "File", "Audio", "Image", "Video", "Web Link", "Learning Module", "Lesson Plan", "Syllabus", and "Course Link". The "New Page" column includes "Content Folder", "Module Page", "Blank Page", "Mashups", "Flickr Photo", "SlideShare Presentation", "YouTube Video", and "Kaltura Media". In the background, there is a list of items under the heading "biology". Some items are partially visible, showing file sizes like "(10.503 MB)", "(14.193 MB)", "(632.381 KB)", and "(7.49 MB)". Below the list, there is a paragraph of text: "atural RNA nanotechnology". This topic covers the use of RNA helices and other structures. In preparation for the lecture please read R3-Jaeger-2006. The cise after the lecture can be found below." Another paragraph follows: "logy". This topic deals with the use of rationally designed RNA elements in cells. . The exercise will use the online game [Eterna](#) to design an RNA switch.

The Friday journal club will be run by Steffen. Group 1 and 7 should prepare a presentation of paper P3-Geary-2014 and P4-Win-2007, respectively. Please prepare presentations of the two papers.

Best regards,

Ebbe

Create a module

Create Learning Module

A Learning Module is a collection of Content Items focused on a specific subject that students can navigate at their own pace. For example, a Learning Module about the solar system can include lecture notes, links to websites with pictures of all the planets and assignments. Instructors can create a structured path for progressing through the items. The path can be set so that students must view content sequentially or set to permit users to view the content in any order. [More Help](#)

* Indicates a required field.

Cancel

Submit

1. Learning Module Information

* Name

Colour of Name

Black

Text

B **I** **I** Arial 3 (12pt) **T**

Path: p

Words:0

Create a module

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2. Learning Module Options

Select **Yes** to force users to progress through the content in the order that is set by the number next to each Content Item. Users are unable to advance to a page within the Learning Module without viewing the previous page.

Enforce Sequential
Viewing of the Learning
Module?

☐ Yes ☒ No

Open in New Window

☐ Yes ☒ No

3. Standard Options

Permit Users to View this
Content

☒ Yes ☐ No


Track Number of Views

☐ Yes ☒ No

Select Date and Time
Restrictions

☐ Display After  

Enter dates as dd/mm/yyyy. Time may be entered in any increment.

☐ Display Until  

Enter dates as dd/mm/yyyy. Time may be entered in any increment.

Create a module

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4. Table of Contents

Select **Yes** to show a structured view of the Learning Module. Users can choose to display the Table of Contents on the bottom or on the side of the Learning Module.

Show Table of Contents to Users ☒ Yes ☐ No

Hierarchy Display

5. Submit

Click **Submit** to proceed. Click **Cancel** to go back.

Cancel

Submit

Create a module

Table of Contents

Introduction

Topic discussion

RNA 3D design

RNA sequence design

Presentation of results

Exercise 1: Design RNA nanostructure

Build Content

Assessments

Tools

Partner Content

Create

New Page

Item

Content Folder

File

Module Page

Blank Page

Audio

Image

Mashups

Video

Flickr Photo

Web Link

SlideShare Presentation

Lesson Plan

YouTube Video

Syllabus

Kaltura Media

Course Link

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• Group 6: What are the pros and cons of the different self-assembly strategies?

• Group 7: How can RNA nanostructures be functionalized?

After your group discussion you should contribute your answer to the discussion forum. Write the question from above as the topic of your thread e.g. "Group 7 agreed on. Finally, comment on the answers of at least two other groups to give them feedback on the quality of their answer (be kind :-).

[Click to launch Discussion Forum](#)

RNA 3D design

Time for this activity: 15 min

In this activity you should consider the 3D design of your RNA nanostructure (see graphics below, a print-out will be handed out: [Geary-tiles.pdf](#))