
DTU

DTU Health Technology
Bioinformatics

Metagenomics and Microbiome Analysis: Introduction to course

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Menu

- Who are we?
- What is this course about?
- Course timeline
- Exam and evaluation
- Project
- Pre-test

Course responsible

Gisle Vestergaard

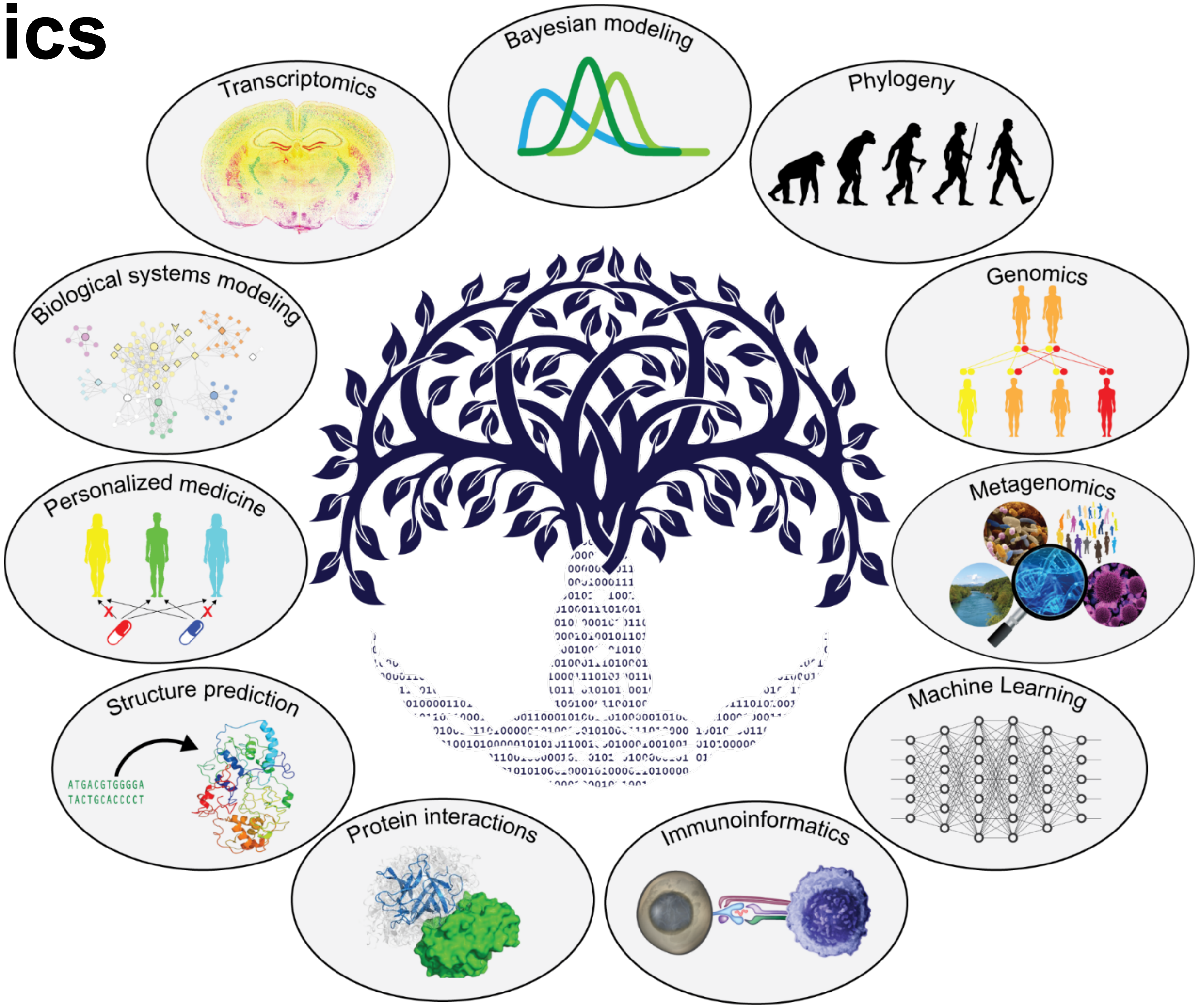
Associate Professor, Section of Bioinformatics

Marlene Danner Dalgaard

Senior researcher, Head of DTU Multi-AssayCore (DMAC)

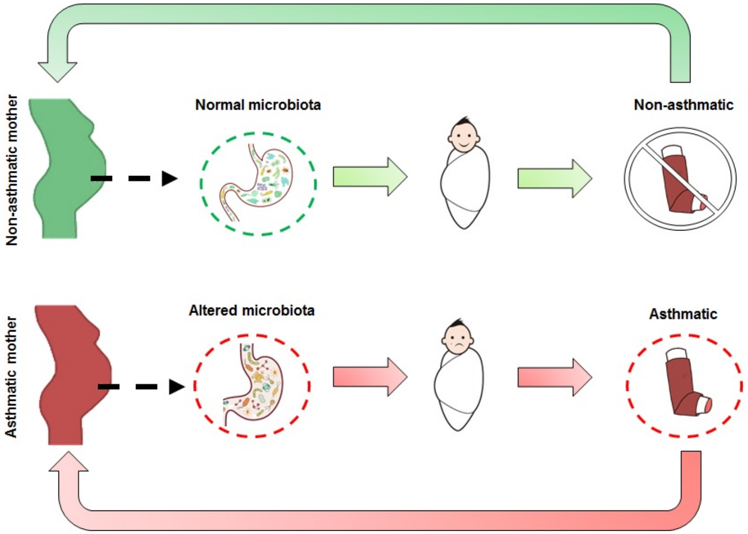
Section of Bioinformatics

Solving biological problems using a wide variety of state-of-the-art informatics solutions



Who am I?

- PhD in Biochemistry from Copenhagen University
- Postdoc at Helmholtz Zentrum München on a Humboldt Research Fellowship
- Assistant Professor at Copenhagen University in 2018
- Associate Professor at DTU in 2019
- Taught NGS in München and at Copenhagen University
- Head of studies for the MSc degree in Bioinformatics and Systems Biology



Science & Environment

Atacama's lessons about life on Mars

By Jonathan Amos
BBC Science Correspondent

27 February 2018

The Atacama has been in a hyperarid state for millions of years

Even in the driest places on Earth there is life eking out an existence, it seems.

Scientists have examined the soils in those parts of the Atacama desert that may not see any rains for decades.

Who are we?

- MSc in Molecular Biology and Chemistry
- PhD in Human Biology: Testicular Cancer
- Senior Researcher, Head of DMAC: Multiassay Core Facility
- 6th year course responsible

Who are you?

- 30 Participants
- Master students
  - Bioinformatics and Systems Biology
  - Biotechnology
  - Quantitative biology
  - Mathematical Modelling and Computation
- Quite a lot of externals

Feedback

- Sixth time course is running
- Second time I am course responsible
- We are still improving
- Please give us feedback !
  - Please do the evaluation at DTU Inside

Learning objectives

- Explain the concept of metagenomics and its applications opposed to single genomics
- Discuss a possible metagenomics experimental design; from sampling to sequencing
- Explain basic metagenomic data generation
- Explain the advantages and limitations of microbiome data
- Perform basic metagenomics analysis
- Explain the basic principles of microbiome ecology
- Explain the basic principles of quantitative count based data analysis
- Perform basic quantitative count based data analysis
- Perform calculations of basic ecological measures
- Present project work orally and on a poster

Course material

- No text book required
- Material will be distributed during the course on DTU Inside and the homepage
- You will also find recommended reading and supplementary information on the homepage

Online learning, recommended reading and supplementary information

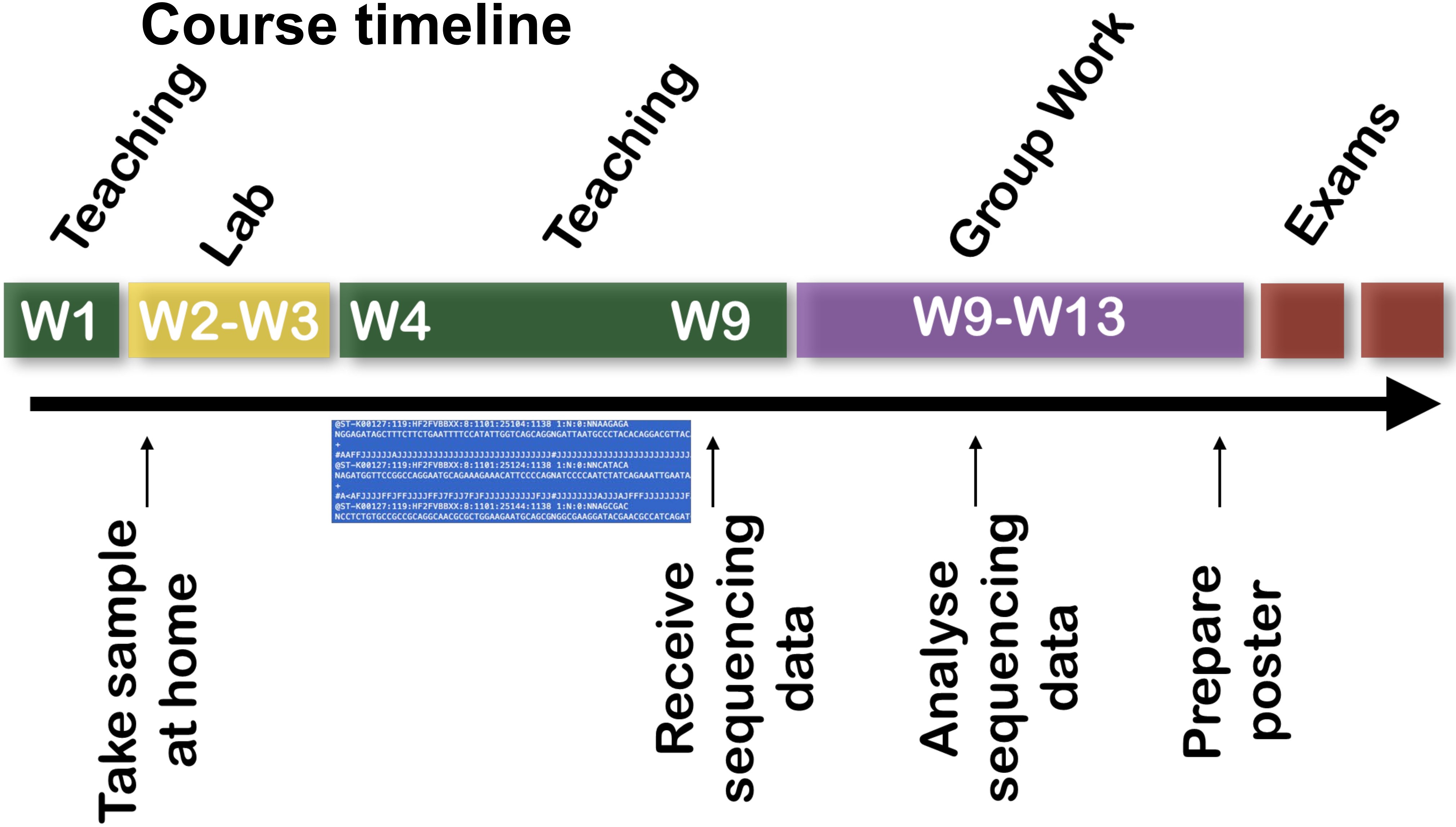
Will NOT be part of the curriculum

Great recent overview paper: ”Best practices for analysing microbiomes”
https://www.nature.com/articles/s41579-018-0029-9.pdf

Coursera course: ”Gut Check: Exploring Your Microbiome”
https://www.coursera.org/learn/microbiome

- Videos, reading and quizzes

Course timeline



Teaching

Lab

Teaching

Group Work

Exams

W1

W2-W3

W4

W9

W9-W13

Take sample at home

```
@ST-K00127:119:HF2FVBBXX:8:1101:25104:1138 1:N:0:NNAAGAGA
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```

Receive sequencing data

Analyse sequencing data

Prepare poster

YOUR microbial metagenomic study

- Today design this years microbial metagenomic study
- Limitations have to be considered: time limitation, effect, cohort size, feasibility
- Collect samples until next weeks laboratory exercise
- Previous years this has always been a students stool used for an intervention study EXCEPT last year!

Wet lab exercise

- 2 days of laboratory work at Room 006 in Building 208 and Laboratory Room 001 also in Building 208
- Sampling, purification and extraction of DNA, QC
- Library preparation and sequencing
- Don’t worry if you lack wet-lab experience!!

Exams & grading

- Group work with individual exams
  - Each group of 3-4 people will present their poster for about 15 minutes
  - Each member of the group will be examined individually about course objectives and the project for 5-15 minutes
- 2 hour written exam without aids

Oral exam / Group work

- Group work with individual exams
  - Each group of 3-4 people will present their poster for about 15 minutes
  - Each member of the group will be examined individually about course objectives and the project for 5-15 minutes
- You will have the chance to assign the groups of 3-4 people
- Questions?

≈50%

Written exam

- 2 hours written exam without help
- Questions?

≈50%

Deliverables

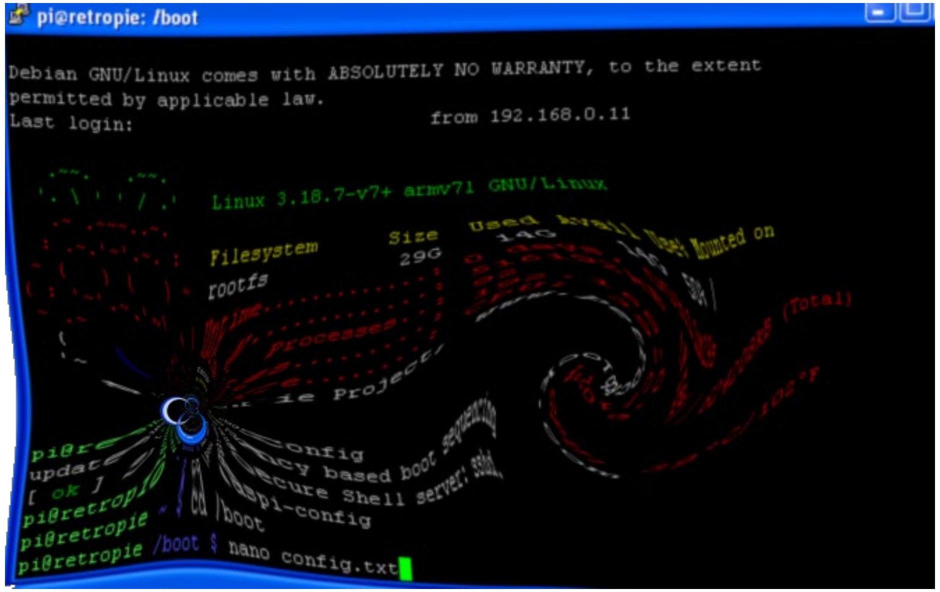
- See program webpage for overview and dates
- Quizzes and assignments are not graded but important when planning recap sessions
- Questions?

Deliverable	Date	Description
I	02/09-2020	Class Room presentation in groups: Intervention study
II	09/09-2020	Hand-in: Lab protocol Powersoil Kit
III	16/09-2020	Hand-in: Lab protocol Nextflex DNAseq kit
IV	28/09-2020	Hand-in: Sequencing technology report
V	30/09-2020	Class Room Quiz: NGS I
VI	28/10-2020	Class Room Quiz: NGS I+II & Quantitative metagenomics I+II

Cloud computing

- The course has moved to the Cloud!
- Danish National Supercomputer for Life Science (Computerome) located at DTU Risø
- 16048 cores, 92 Tb RAM an 3Pb storage
- We have 2 nodes via virtual machines
  - Each has +20 cores and 128 Gb RAM

Why shell terminal?



```
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login:                               from 192.168.0.11

                  Linux 3.18.7-v7+ armv7l GNU/Linux

pi@retropie /boot $ nano config.txt
```

- The command-line is not as dangerous as it looks…trust us!
- Almost all tools for NGS analysis are command line only
- Generally more efficient/flexible, you can play around with the tools/data
- They can be pipelined, ie. analyzing 100 files in windowed mode is a pain ...
- Alternative approaches: Galaxy, CLC-workbench, Geneious

Course essentials

- Course homepage:
  - https://teaching.healthtech.dtu.dk/22136/index.php/22136:Course_plan_autumn_2020
- Teaching Wednesdays in Room 162, Building 210, EXCEPT:
  - Week 2 & 3 wet lab exercises at Room 162 in Building 210 and Laboratory Room 001 in Building 208
- Form groups for project work to begin 21.10.2020
- Poster exam 02.12.2020
- Written exam 18.12.2020

Course advice

- Use the cloud servers on other days than Wednesday
- Learn principles of how to analyse metagenomics data
- Use principles for your project
  - This includes formulating a project that can be answered with the time, tools and data you have available
- Use the cloud servers for group analysis and coordinate data heavy analysis across all groups (no need for all groups to perform assembly of the same data)
- Form groups with people from other backgrounds…diversity IS an advantage
- Use the cloud servers on other days than Wednesday
- …and again please feel free to answer questions and give us feedback!!

Course breakdown – Week 1

- Course introduction
- Pre-test
- General introduction to metagenomics
- Introduction to course study design
- Agreement on course study…YOUR study!

Course breakdown – Week 2 & 3

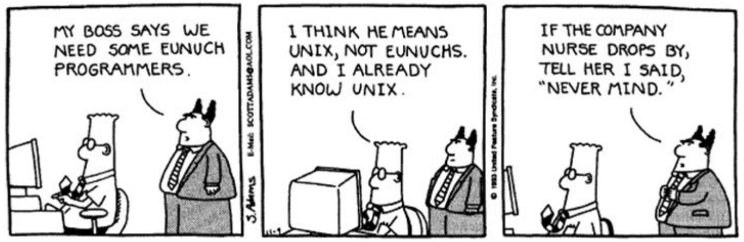
W1 | W2-W3 | W4 W9 | W9-W13

- Sample purification
- DNA isolation
- Quality control
- Fragmentation
- Create sequencing library

Course breakdown – Week 4

W1 W2-W3 W4 W9 W9-W13

- Introduction to UNIX
- Log on to Computerome
- Introduction to Next-Generation Sequencing
- Next-Generation Sequencing basics



Course breakdown – Week 5-9

- R
- 16s rRNA analysis
- Quantitative metagenomics
- De novo assembly & Binning
- Human gut microbiome
- Association studies
- Group formation and project formulation

Course breakdown – Week 9-13

- Group work on projects

Course breakdown – Exams

- Oral presentation of project posters
  - Group work, 3-4 per group, and present results on a poster
  - Try to form diverse groups in terms of skills
  - Analyse your own data!
  - Supplement with existing data (e.g. MetaHIT, SRA…)
  - Don’t run too large datasets (computational and time restrictions)

Pre-test

- 10 min individually
- Discuss in plenum and summarize
- Not used for grading, it will give us an idea of your level