Evolution and biology of lateral gene transfer mechanisms in prokaryotes / biol-254 (060773) & (060768)

Prokaryotes possess the unique ability to acquire DNA from the environment, or their neighbors, and to incorporate this horizontally transmitted DNA into their genome in a process called lateral gene transfer (LGT). Accumulating evidence shows that LGT plays a major role in prokaryote genome evolution, affecting virtually all genes, with only few genes that are resistant to it. Lateral gene transfer is crucial to our understanding of microbial evolution; furthermore, as a source of natural variation it facilitates the emergence of novel infectious diseases through the spread of virulence mechanisms. The known mechanisms for LGT include transformation, conjugation (via plasmids), transduction (via phages), and gene transfer agents. In this module we will focus mainly on plasmids, which are genetic elements that promote transfer of DNA within genomes or between bacterial cells. Many plasmids share a history of co-evolution with their host, while others appear as promiscuous elements with a broad host-range.

The module comprises an introduction to the diversity of lateral gene transfer mechanisms found in prokaryotes. In the practical part, which comprises three experiments (see below), we will investigate three different aspects in the biology of plasmids.

Important note: This module requires active participation in the planning, the execution of experiments, and data evaluation. Basic knowledge in bacteriology and genetics is plus. The lab work requires basic lab skills and at least some experience in good microbiological practices.

EXP 1.
In the first part we will dissect the concept of biological fitness and determine if and how plasmid carriage can affect host cell fitness.

EXP 2.
In the second part we will take a close look at the process of plasmid mediated conjugation and follow the transfer of DNA from a donor to a recipient cell.

EXP 3.
In the third part of the module we investigate the molecular mechanisms and outcome of homologous recombination between plasmids in the course of natural transformation and conjugation. In order to investigate this process we will plan an unique experiment that allows us to follow the molecular outcomes of recombination. For this, we will design and construct a plasmid in vitro using the state-of-the-art Gibson assembly technique for molecular cloning.

MNF biol-254 - Evolution and biology of lateral gene transfer mechanisms in prokaryotes

Coordinators: Prof. Tal Dagan (IFAM), Dr. Nils Hülter (IFAM)

SS 2020 (04-15.05.2020)

	Date	Lecturer	Topic
1 Mo	04.05.20	Hülter	Mobile elements in evolution
2 Di	05.05.20	Hülter	LGT mechanism: Natural Transformation
3 Mi	06.05.20	Hülter	LGT mechanism: Natural Transformation
4 Do	07.05.20	Hülter	LGT mechanism: Conjugation
5 Fr	08.05.20	Hülter	LGT mechanism: Conjugation
6 Mo	11.05.20	Hülter	Plasmid F
7 Di	12.05.20	Hülter	Homologous recombination
8 Mi	13.05.20	Hülter	Plasmid replication and partitioning
9 Do	14.05.20	Hülter / tba	Plasmid evolution
10 Fr	15.05.20	-	-

Daily routine
9:00-9:45 Lecture
10:00-17:00 Project work

Outcome: Protocol (graded). The protocol is expected to be in the format of research report (in English).

Lab assignment: Coordinator: Dr. Nils Hülter (IFAM), members of the AG Dagan (tba)

	Date	Tasks (tasks include additional lecturing and discussions)
1 Mo	04.05.20	Introduction to EXPs 1 and 3, preparations for Gibson assembly (PCR etc).
2 Di	05.05.20	Start of Plasmid fitness experiment (EXP. 1), Gibson assembly (EXP. 3)
3 Mi	06.05.20	HFR mating experiment (EXP. 2), End of EXP. 1
4 Do	07.05.20	Evaluation of EXP 1
5 Fr	08.05.20	Evaluation of EXP 2
6 Mo	11.05.20	Work on EXP. 3 (Main experimental day)
7 Di	12.05.20	Work on EXP 3
8 Mi	13.05.20	Work on EXP 3 (Molecular analysis of recombination events)
9 Do	14.05.20	Work on EXP 3 (Molecular analysis of recombination events)
10 Fr	15.05.20	Evaluation of the results and final discussion