Bio-Strike

A strategy to overcome the Antibiotics Crisis
Antibiotics Crisis

MRSA = methicillin-resistant *Staphylococcus aureus*; VRE = Vancomycin-resistant *enterococci*; FQRP = Fluoroquinolone-resistant *Pseudomonas aeruginosa*

Source: Center for Disease Control
**Ampicillin Resistenz**

- **Plasmid With Ampicillin Resistance gene**
- **Bakteria With cell wall (grampositiv)**
- **Ampicillin** (blocks D-Alanin-Transpeptidase)
- **beta-lactamase** (destorys Ampicillin)
Antibiotics Crisis

Market failure
1990
- 18 companies,
- 10 new antibiotics
2011
- 4 companies,
- 2 new antibiotics
<table>
<thead>
<tr>
<th>Drug / Billion US Dollar</th>
<th>Source</th>
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<tbody>
<tr>
<td>Antibiotics Crisis</td>
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Antibiotics Crisis

overuse of antibiotics

spread of antibiotics in environment

development of resistant bacteria by mutation

resistance genes render antibiotics useless

spread of resistance genes by Horizontal Gene Transfer
Solutions

• Reduce antibiotic consumption
  – Regulation
  – Management
  – Education
• Research new antibiotics
• Find entirely new cures
Scenario I

Scenario II

Scenario III
Digital biology

Nanopore Sequencing

Microfluidics

Synthesis

Analog Biology

Digital Biology

AGTC
Analog Biosphere
Digital biosphere
Phage Therapy

- Well known since 100 years
- They are everywhere!
- Programmable
- Highly specific
- Safe
In a not too distant future...

Citizens / NGOs / Academics

Biostrike

Wetware

Hardware

Software

Personalized Phages
Nachweis von Ampicillinresistenz in der Umwelt (Bodenproben)

1) Vorbereiten der Bodenproben
2) Vorbereiten von Ampicillin Nährböden
3) Ausbringen der Bodenprobe auf Nährboden
4) Kultivierung in Inkubator über Nacht
5) Vernichtung der Bakterienkulturen in Autoklav
Biostrike: Hack your way out of the antibiotic crisis

An overuse of the available antibiotics and subsequent evolutionary pressure has led to the development of multi-resistant bacteria. By now, the situation is becoming urgent, as very few effective drugs are left to treat infections. Antibiotic resistance development is a natural process. Bacteria are under selective pressure and evolve mechanisms to avoid the antimicrobial effects of the antibiotics. Once developed, the genes for the resistance then rapidly spread even cross over between different species - a process called horizontal gene transfer.

It is therefore necessary to continuously develop new antibiotics to keep up pace with resistant bacteria. However, in 1990 there were 18 companies developing new antibiotics, by 2011 there were only 4. In 1990 10 new antibiotics were licensed, in 2011 only 2. The reason for a worsening of the antibiotics problem into an antibiotics crisis is a classical market failure in the pharmaceutical branch. Due to the high costs and the risky nature of drug development, there is a tendency to push for even higher shareholder revenue from a newly developed drug. Thus, there is a lack of financial incentives for the pharmaceutical industry to involve themselves in the development of drugs like antibiotics with a small profit margin.

This workshop is part of the global ‘biostrike’ project. Citizens will explore the biological mechanisms of antibiotics resistance development and discuss its socio-economic causes and consequences. Experiments will be done to detect resistant microbes from the environment and to unravel the environmental highways for horizontal gene transfer such as human influence, animals, rivers and even the weather. Only by developing a
Soil sample and dilution

• Often there are so many microbes in the soil, that they would simply overgrow your plates. Therefore, we need to dilute the samples a few times.

• **Materials:**
  • 3 test tubes or other container
  • 1 tea spoon
  • 1 pipette
  • 1 cup of sterile water (boil it in a pressure cooker for 25 min)
  • Marker pen
  • Soil samples from farmland (e.g. apple plantation)

• What you need to do is:
  • If you don’t have pipettes, simply take a bit of the solution out of the sample container and dilute it by adding more water.
  • Otherwise do the following:
    • Label each small tubes with one the following: “10x”, “100x” and “1000x”
    • Fill the sample container with 10 mL (two tea spoons) sterile water, shake until all the soil is mixed with water
    • Pipet 1 mL of sterile water into each labelled tube
    • Use the pipette to put 4 drops of the soil sample from the tube into the small tube labeled with “10x”.
    • Pipette the liquid up and down 3 times.
    • Transfer 4 drops of liquid from the “10x” tube to the “100x” tube.
    • Pipette the liquid up and down 3 times
    • Transfer 4 drops of liquid from the “100x” tube to the “1000x” tube.
    • Pipette the liquid up and down 3 times
Agar plates Material

• starch 3 g/L
• bullion (beef stock) 12,5 g/L
• milk powder 10 g/L
• Agar-agar 20 g/L
• Ampicillin 100mg/L

• In 1L destilled water
Agar plates Procedure

• Measure ingredients into marmelade jars, remember to write down exactly what you add to them.
• Boil at 25 min in the preaassure coocker - and let the pressure cooker cool.
• Add antibiotics to some of the jars in appropriate amount. NOTE: some antibiotics will degrade when boiled and must be added at cooler temperature
• pour the agar mix into the plates (using good sterile techniques )
• Let them cool down

• **Plating**
  • Apply samples and dilution (se below ) on prepared plates
  • add tape on the plates.
  • Innoculate plates at 23 or 37 C depending on what you are looking for. at least innoculate some at 37 C as plates inocculated at 23-25 degrees don’t usually shows colonies before after 2-3 days.