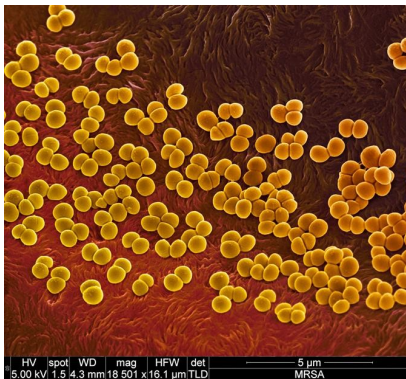


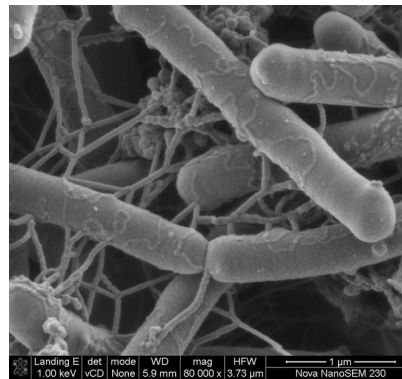
Bacteria, antibiotics and synthetic biology

Bacteria

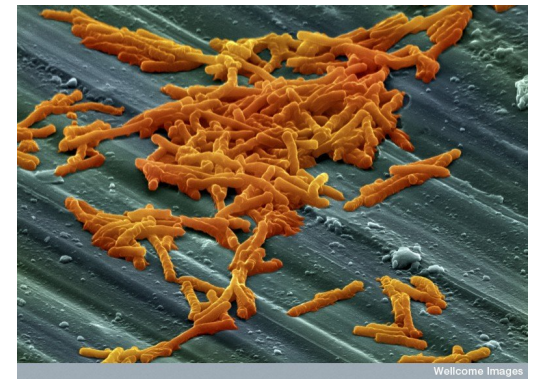
- “Prokaryotes” – single cells without a nucleus, mitochondria and chloroplasts
- A single circular piece of DNA, attached to the cell membrane
- Reproduction by binary fission
- The main forms are: cocci, bacilli, spirillae, and vibrios
- Cause such diseases as: tetanus, diphtheria, tuberculosis, pneumonia, meningitis



Staphylococcus aureus, CIL:40593



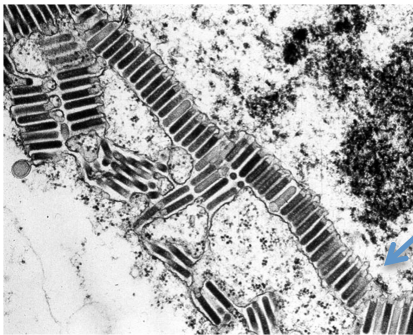
Salmonella, CIL:40592



Clostridium difficile, CIL:38815

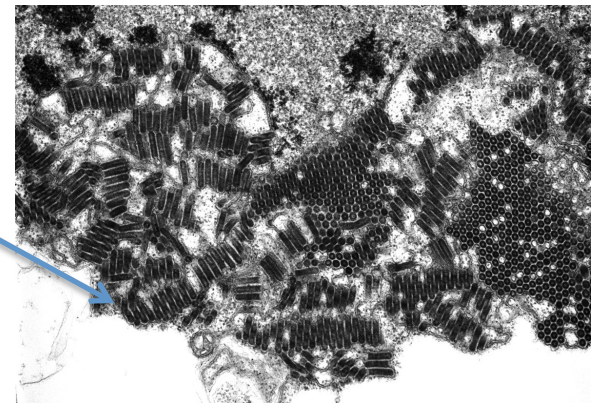
Viruses

- Consist of one strand of DNA or RNA in a protein capsid
- Able to replicate only in a living cell
- Cause such diseases as: influenza, herpes, AIDS, croup, mumps, colds, running nose
- The protein capsid can have different forms: isometric, helical etc.



CIL:12415

Maize mosaic virus particles
in a cell



CIL:12416

Bacteria vs. Viruses

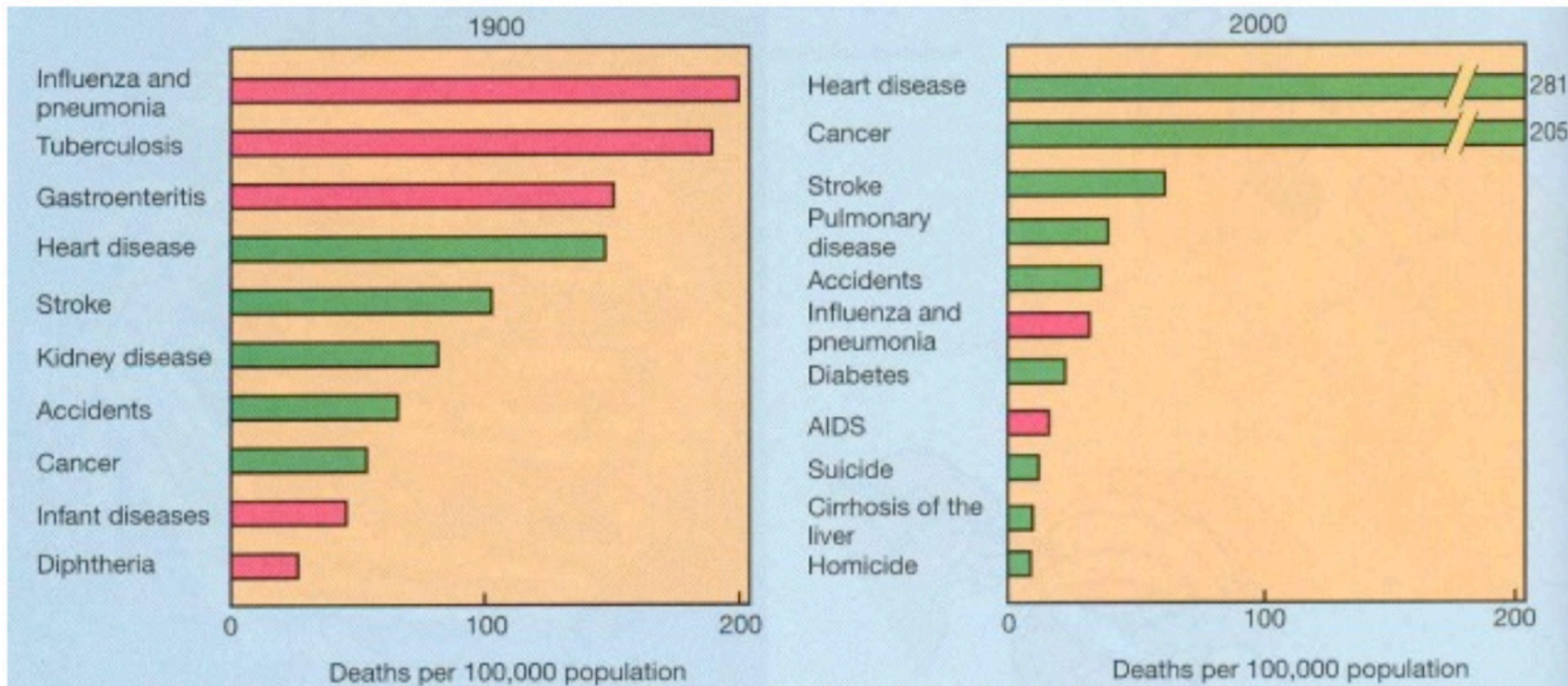
| | Bacteria | Viruses |
|-------------------|--|--|
| Size (Nanometers) | 1000-5000 | 20-300 |
| Living organisms | Yes | No |
| Structure | one cell with organells, cytoplasm, genetic material and a cell wall | only genetic material in a protein capsid |
| Reproduction | binary fission | need a living host cell |
| Disease induction | by means of toxins | directly kill cells or cause an immune response, which makes immune cells destroy infected cells |
| Treatment | Antibiotics | Virostatics |

Antibiotics...

...stop replication or kill bacteria

- Alexander FLEMING discovered Penicillin (in 1928)
- Classification of antibiotics:
 - Types (broad and narrow spectrum antibiotics),
 - Activity (bacteriostatic and bactericidal),
 - Chemical structure, site of activity, mechanism etc.
- Only partly- or completely synthetic substances with antibiotic activity are used now as medicaments.
- Possible side effects that might appear during a long-term or incorrect antibiotics intake: allergies, microflora disorders, fungal infections, antibiotic resistance etc.

How would the world without antibiotics look like?

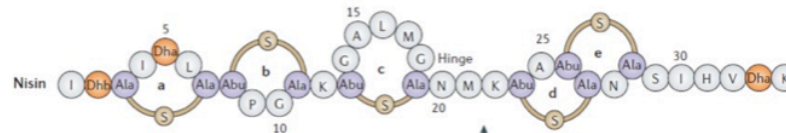
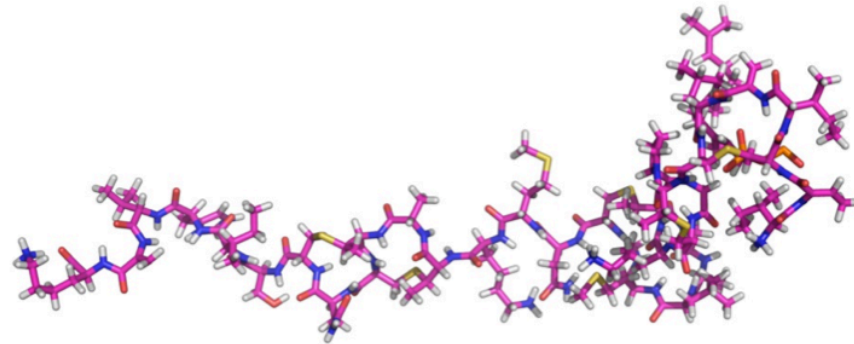


100 years ago the 3 main causes of death were of bacterial nature. Nowadays people live longer, and a death caused by a bacterial infection is very rare.

Lantibiotics...

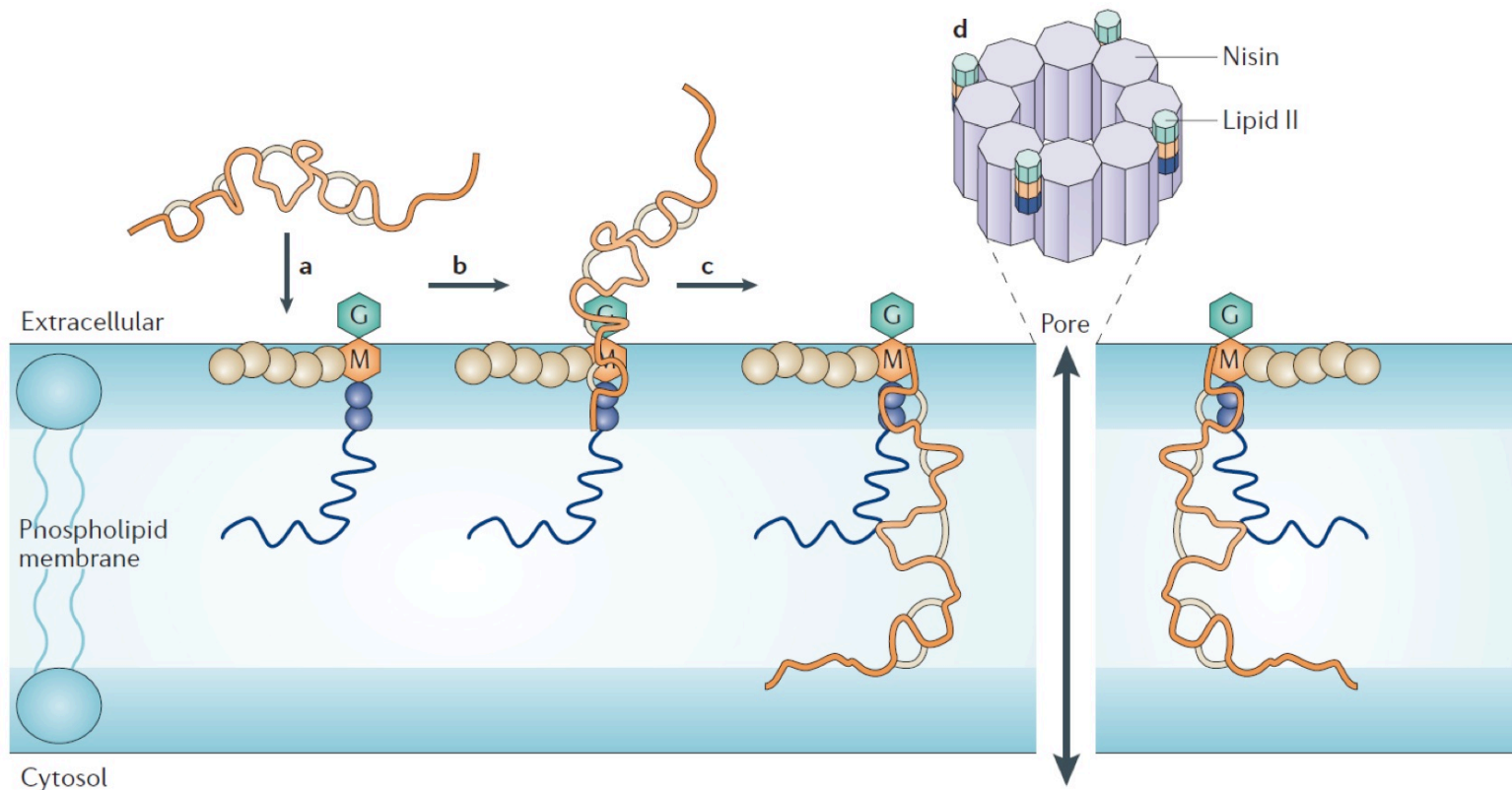
... are peptide antibiotics built of amino acids and containing a lanthionine bond, f.e. Nisin

Nisin – an (L) antibiotic



Lantibiotics...

...form holes in bacterial membrane and cause the leakage of the cell content. They can also inhibit the synthesis of cell membranes.



Amino acids...

... are organic acids, composed of carbon atoms and amino groups.

- ♦ there are more than 700 amino acids
- ♦ 20 - 22 of them build proteins:
 - 20 amino acids are encoded within the genetic material - Alanine, Arginine, Asparagine, Aspartic acid, Cysteine, Glutamine, Glutamic acid, Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tryptophane, Tyrosine, and Valine
 - some living beings have 2 additional amino acids – Selenocysteine and Pyrrolysine

Essential and non-essential amino acids

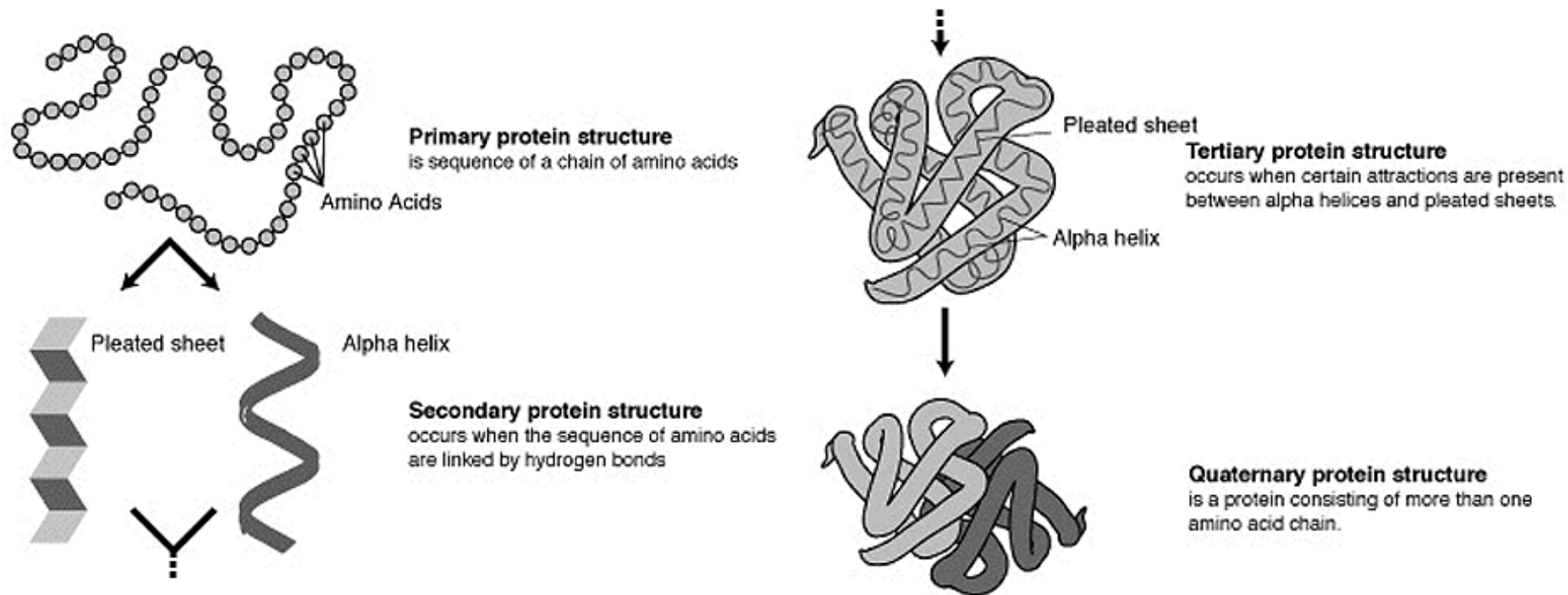
- 8 essential amino acids you can get only from food sources

Valine, Tryptophane, Threonine, Phenylalanine, Methionine, Lysine, Leucine and Isoleucine

- 14 non-essential amino acids are synthesized in the body

Alanine, Arginine, Asparagine, Aspartic acid, Cysteine, Glutamine, Glutamic acid, Glycine, Histidine, Proline, Serine and Tyrosine

Structure of proteins



Amino acids labeling

In order to label the amino acids, scientists use 1- and 3-letter codes:

Alanin – A and Ala,

Glutamin – Q and Gln,

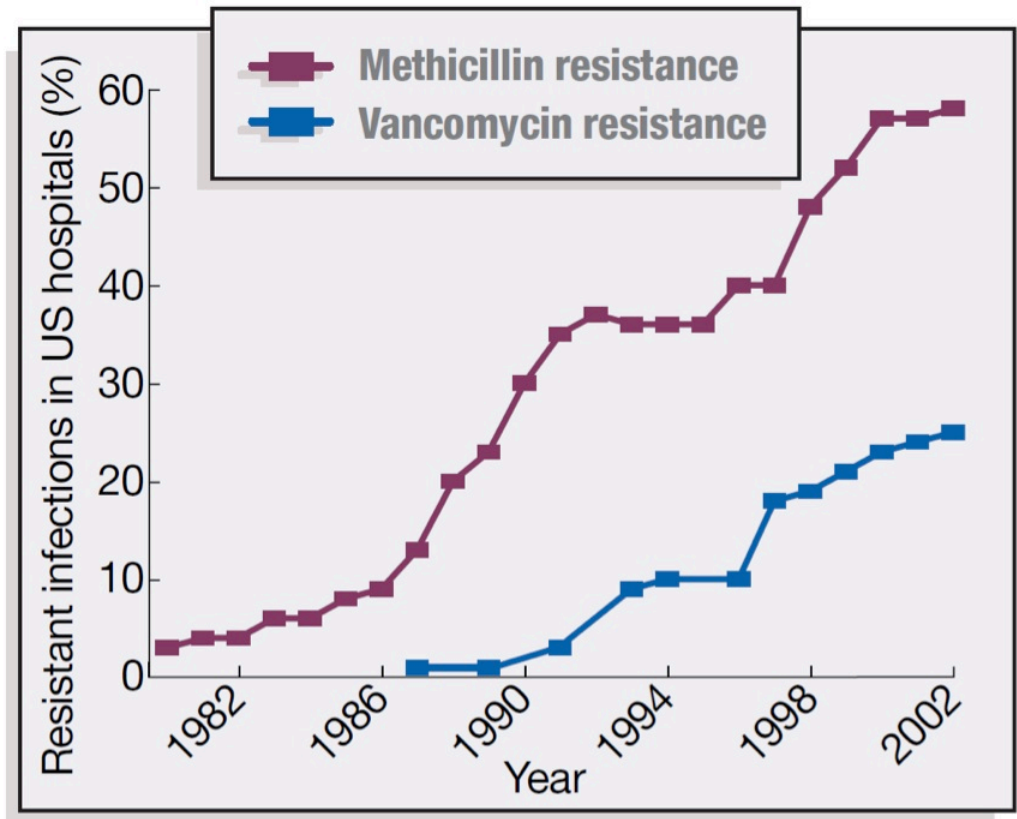
Lysin – K and Lys

etc.

Antibiotic resistance

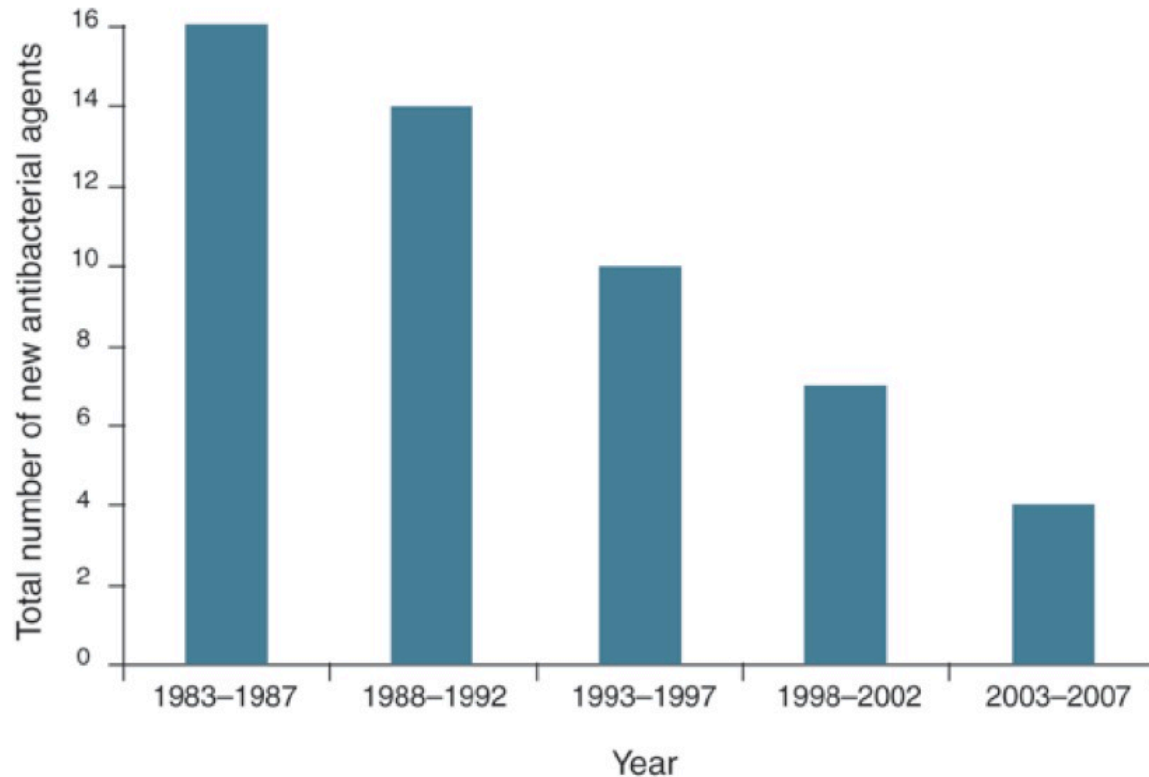
- More and more antibiotics lose their activity (they are being prescribed too often or patients do not intake them correctly)
- Bacteria develop resistance, f.e.:

- Methicillin-resistant *Staphylococcus aureus*,
- Vancomycin-resistant Enterococci,
- Penicillin-resistant *Streptococcus pneumonia*



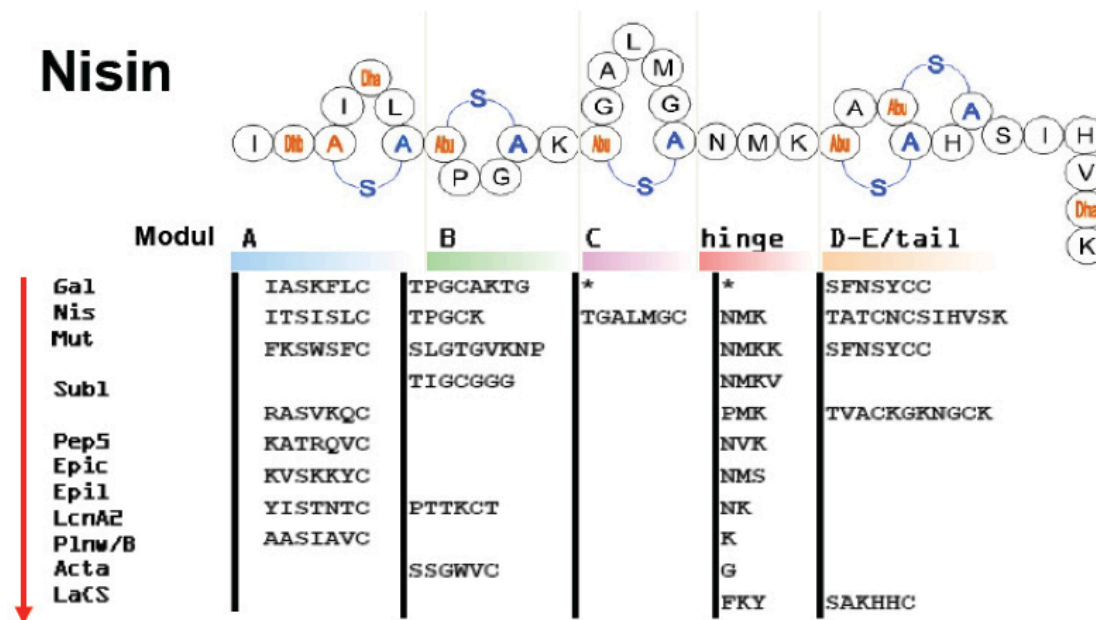
Lack of natural antibiotics

The number of newly developed antibiotics decreases



SYNPEPTIDE Project

The aim of the project is to design and produce novel antibiotics by means of synthetic biology*. As a result, natural peptide modules are recombined to create ca. 5000 new lantibiotics.

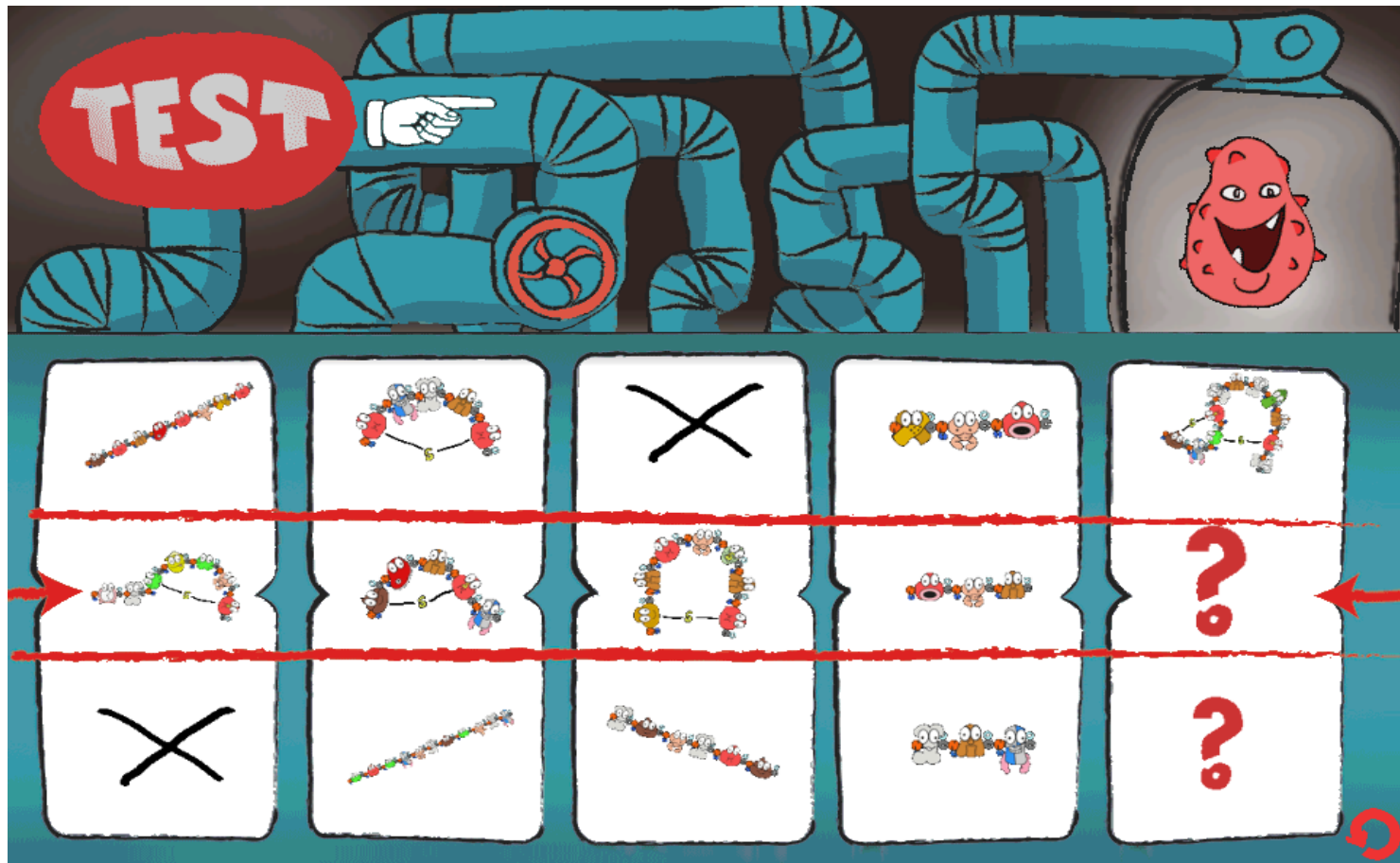


* **Synthetic biology:** Application of engineering principles to biology (f.e. standardization, modular principle, design, etc.)

<http://www.biofaction.com/project/synpeptide/>

SYNMOD game

www.biofaction.com/synmod



From amino acids to peptide modules



Questions

- What are bacteria, and what are viruses?
- What diseases can cause bacteria?
- What are amino acids?
- How could you kill bacteria?
- What problems are there with antibiotics?
- How could new antibiotics be created?