

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

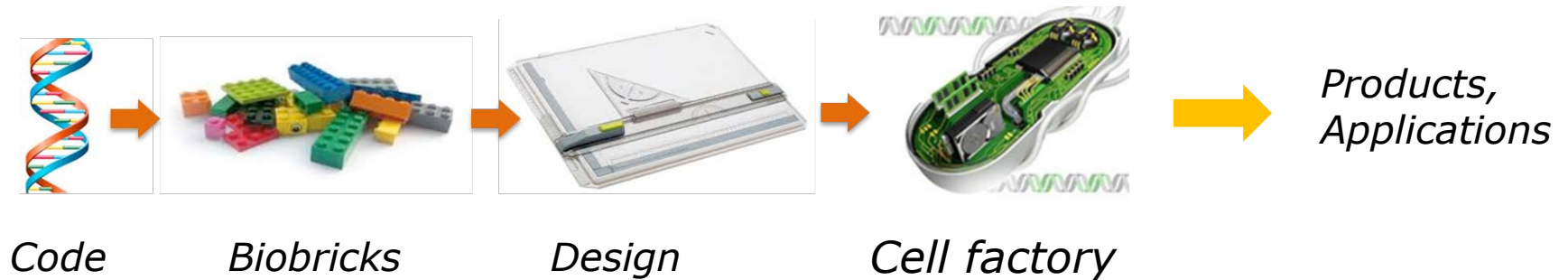
Synthetic Biology and Biosecurity Awareness

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What is synthetic biology?

The *engineering* of biology aiming at the *design* and *construction* of new biological parts, products, and applications





Products from Synthetic Biology



Cell factory



Medicines: artemisinin
antibiotics



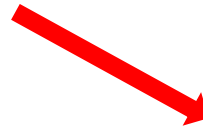
Flavours:
vanillin
stevia



Biofuels:
ethanol



Specialty chemicals:
squalene



BTWC



Controlled agent:
small pox virus



Controlled substance:
heroïn



Who is involved?

- Synthetic Biology is about engineering and design with biological components...
- This attracts:
 - Scientists
 - Students
 - Amateurs, artists, designers

universities, companies
schools, universities, **iGEM**
DIY-biology, community labs





iGEM Competition

- iGEM stands for international Genetically Engineered Machine.
- It is a yearly competition for **student teams**.
- Projects aim at solving '**real world**' **problems** and/or strive to create a **positive contribution** to the world by using Synthetic Biology.
- Each team manages its own project and has to actively consider and address **safety, security and implications of their work**.





Examples of iGEM projects

- **Health and Medicine:**

- Team Paris 2013: biological tools to fight tuberculosis;
- Slovenia 2012: inducible delivery system for medicines.

- **Environment:**

- Team Imperial UK 2014: bio-cellulose filter for water purification;
- Team Calgary 2012: biosensor to detect water pollution.

- **Food & Nutrition:**

- Team Wageningen 2014: biological control agents against banana disease;
- Team Groningen 2012: biosensor to detect rotten meat.

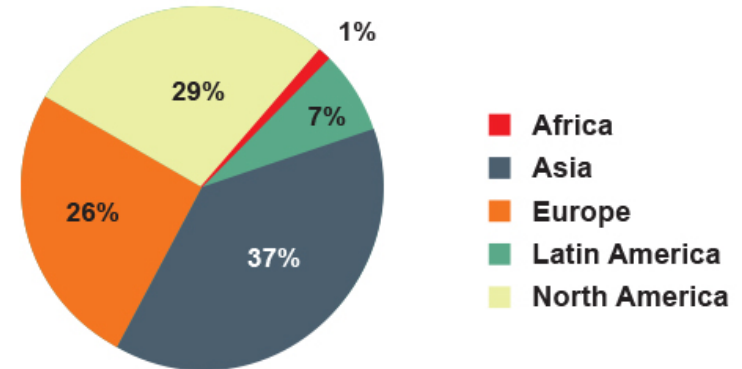


iGEM Competition - 2015

- The competition started with **5** student teams in **2004**.
- Next venue: 24-28 sept 2015 in Boston and **280** teams from all over the world are registered.



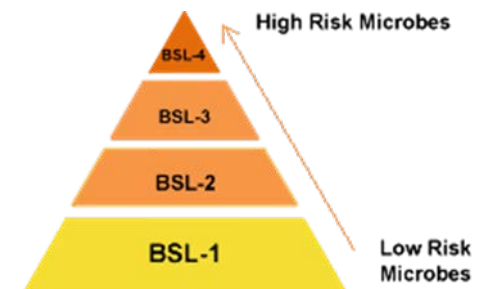
www.iGEM.org





iGEM: Biosafety and Biosecurity awareness-1

- iGEM organisation provides information on **website**
- Teams must complete **safety forms** to show safety and implication of their project.
- iGEM has a **Biosafety committee** composed of experts, gives advice on potential safety issues.
- **General rules:**
 - No use of BSL-3 and -4 organisms allowed;
 - No release of GMO or its product allowed.





iGEM: Biosafety and Biosecurity awareness-2

- **During project preparation** each team
 - is working in a local research organisation;
 - is supervised by two (local) academic instructors;
 - must follow biosafety rules of its institution;
 - must follow biosafety laws of its **own** country;



iGEM: Biosafety and Biosecurity awareness -3

- **During the Jamboree**
 - Project presentations are oral and by poster;
 - Presence of biological material is not allowed;
 - FBI present for individual Q&A, gives talk at Jamboree to raise awareness in biosecurity issues.
- In conclusion: iGEM teams operate professionally.



Do it Yourself (DIY-)Biology

- International network of amateurs interested in
 - Learning simple biological experiments;
 - Democratisation of skills and knowledge;
 - Application in art and design projects.





DIY-Biology communities

- Community labs in US, Europe, Asia, Australia.
- Virtual platforms on internet DIYbio.org, hackteria.org, reddit.com/r/diybio.
- Mission is to share knowledge and experience.
- Open source: knowledge and materials free and easy accessible.



DIY-Biology - Materials

- **Laboratorium equipment** is self-made or available from:
 - Commercial suppliers;
 - Second handed (online marketplace).
- **Chemicals** are sold in supermarket, drugstore
 - Salt, soap, alcohol, contact lense cleaner (proteases)
- **Micro-organisms** obtained by collaboration with (non-)professional labs
- **DNA sequences** can be ordered by internet, standard biobricks can be obtained from iGEM.



DIY-Biology - Biosafety and Biosecurity

- Biosafety by **Education**:
 - Most communities have professionals 'on board'
 - Internetplatform: 'ask a biosafety expert'
- 2011: conferences in US and EU resulted in two **Code of Ethics***
 - Aiming at secure, respectful and transparent activities within the community;
 - Codes are mostly similar, but address aspects in different order:
 - > EU: transparency – safety – open access – education (+6);
 - > US: open access – transparency – education – safety (+3).



* See diybio.org/codes/ and Eggleston in: Nanoethics (2014) 8: 187-192



DIY-biology – Malevolence

- **Up to now** malevolence is unlikely due to:
 - Culture of Responsibility within DIYbio community;
 - Lack in theoretical and practical skills;
 - Absence of expensive lab equipment to prevent contamination and infection.

- For the **future**, be aware of
 - De-skilling and easiness to exploit synthetic biology;
 - More and more knowledge available;
 - Dual use.

Jefferson, Lentzos, Marris in: *Frontiers in public health* (2014) vol. 2, article 115
Gronvall, *Mitigating the Risks of Synthetic Biology*. 2015. Council on Foreign Relations



IGSC for safe commercialization of synthetic DNA

- DNA sequences are basic material for scientists, iGEM and DIY-bio communities. Available by internet order – to anyone..
- International Gene Synthesis Consortium (IGSC):
 - to prevent synthesis and sale of sequences of concern;
 - comprises 80% of all companies providing gene synthesis services world wide.
- Protocol for screening the ordered **sequence** and the **customer**.





iGEM and DIY-Biology in The Netherlands

- **iGEM** and RIVM:

- Yearly collaboration with iGEM-teams
- Member of iGEM biosafety committee



- **DIY-biology**:

- Conclusions from Dutch study in 2014: 4 communities known, no indications for unsafe situations, members have little knowledge of safety.
- Since 2015 one community with licensed BSL-1 lab



waag society

institute for art, science and technology



In conclusion

- Risks from synthetic biology activities:
 - No substantial safety and security risk within **iGEM**;
 - Substantial biosafety risk within **DIY-biology community** not likely.
- **Awareness of Biosecurity** in non-professional organisations like iGEM and DIY-Biology could be further **improved by** national authorities by
 - Outreach, education and awareness raising;
 - Accessible information;
 - Maintain contact with stakeholders;
 - International harmonisation on regulations.