Spiez CONVERGENCE 2016

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SPIEZ LABORATORY, Switzerland

Spiez CONVERGENCE 2014/16

Spiez CONVERGENCE

Report on the second workshop
5–8 September 2016

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Office for Civil Protection FOCP
SPIEZ LABORATORY

- Informs about developments in chemistry and biology
- Offers informed discussions between Academia, Industry, Arms Control Experts
- Assessment of Policy Implications
- Expert level S+T Review

http://www.labor-spiez.ch/en/die/sc/index.htm

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Science Topics 2016

- Synthesis, Modification, Large Molecules

- Additive Manufacturing and 3D Printing

- Genome Editing CRISPR

- OMICS Technologies / Big Data

- DNA – Memory, Programming

- DNA – Origami

- Tacit Knowledge

- Policy

Synthesis, Modification, Large Molecules (biologically mediated manufacturing of chemicals)

- Biochemical conversion and bioprocessing of fuels and chemicals (sugars, starch, lignocelluloses)
  - Oil price affects market share
  - Sugar, starch less desirable (food source) but still dominant raw material today
  - Bioprocessing of lignocelluloses moves towards industrial application

http://www.nature.com

Synthesis, Modification, Large Molecules (biologically mediated manufacturing of chemicals)

- Automated carbohydrate synthesis for biotechnological and biomedical applications
  - Becoming commercially available
  - Shorter time for synthesis of complex biomolecules (months to hours)
  - New biomaterials (vaccines based on carbohydrate conjugates)
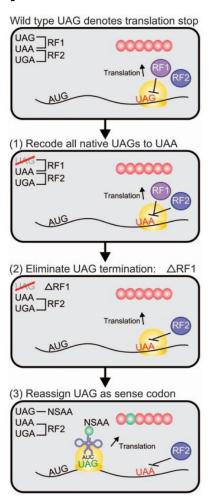

http://www.mpikg.mpg.de

Synthesis, Modification, Large Molecules (biologically mediated manufacturing of chemicals)

- Manufacturing of highly potent Active Pharmaceutical Ingredients (APIs)
  - Applied to 1/3 of novel drugs developed
  - Highly complex and high-safety bio-facilities
  - Resemble CWC S-1 facilities in many aspects
  - Generally below CWC declaration threshold for DOC

http://minakem.be

Synthesis, Modification, Large Molecules (biologically mediated manufacturing of chemicals)

- Genomically recoded organisms to enhance the chemistry of synthetic polymers and safety of GMOs
  - Conversion of cells into 'factories' enabled by advances in gene editing capability
  - Challenges remain for industry applications (time to market)
- Using non-standard amino acids for new genetic code
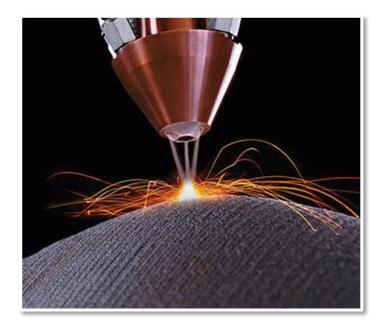 - Technology on horizon
  - Change of chemicals available for protein synthesis

http://www.kurzweilai.net

Additive Manufacturing and 3D Printing

- Advanced industrial manufacturing
  - Melted powder bed (metal, metal alloys, ceramics)
  - Continuous welding with electron or laser beam
  - Maturing technology shows limitations (welding defects)
  - Limitations for productivity
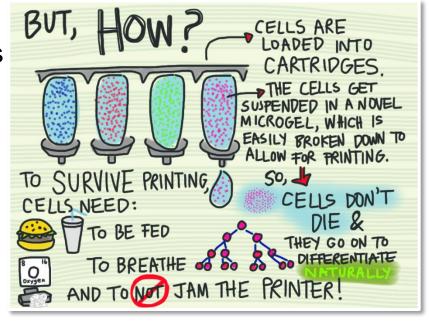 - Excellent tool for prototyping and repairs

w.pinterest.com

Additive Manufacturing and 3D Printing
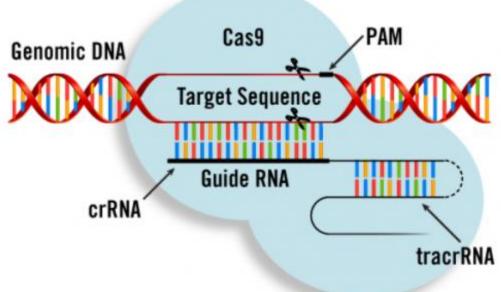
- 3D Tissues and bio fabrication for therapy
  - Living tissue and tissue models
  - 'Organ printing' remains big challenge
  - Today a research tool
  - Commercial availability of bio-inks

http://discovermagazine.com

Genome Editing CRISPR

http://www.bioscience.co.uk

- CRISPR/Cas9 technology
  - Gene editing technologies on US threat list
  - CRISPR/Cas9 new gene editing technology derived from bacterial defense against viruses
  - Simplifies gene editing, is accurate and precise
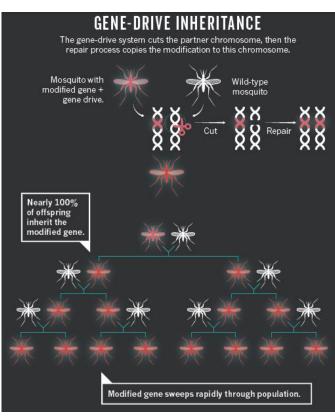 - Currently developing industrial applications in therapy, agriculture, medicine and commercial production

Genome Editing CRISPR

- Gene Drives
  - Force genetic modification through population by creating inheritance bias
  - Discussed as method for vector eradication (malaria)
  - Through genetic sterility or by interfering with parasite development in vector
  - Approach of eradicating entire population poses many questions

- Weapons relevance
  - Probably modest
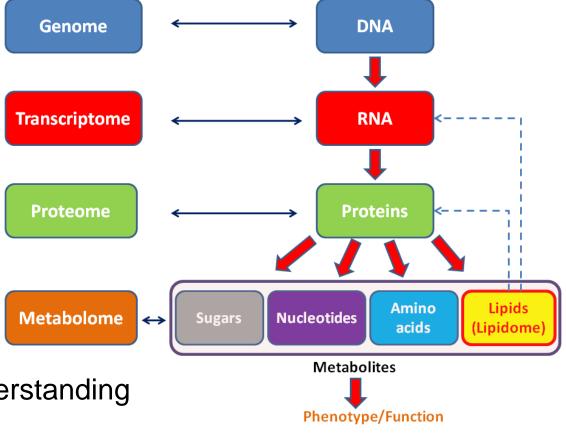 - Transformational technology
  - Good example for risk communication

http://www.nature.com

OMICS Technologies / Big Data

- OMICS
  - Genomics
  - Transcriptomics
  - Proteomics
  - Metabolomics
- From reading to understanding
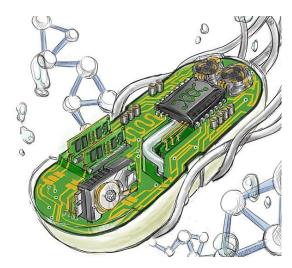- Data reliability

https://www.sciencebasedmedicine.org

DNA – Memory, Programming

- Long term data storage in DNA
  - Encapsulated in glass
  - High cost / MB (today)
  - Barcoding with DNA

http://www.rle.mit.edu

- DNA for computing functions
  - In living cells
  - Devices from programmed DNA
  - Circuits from devices
  - Modules from circuits etc.

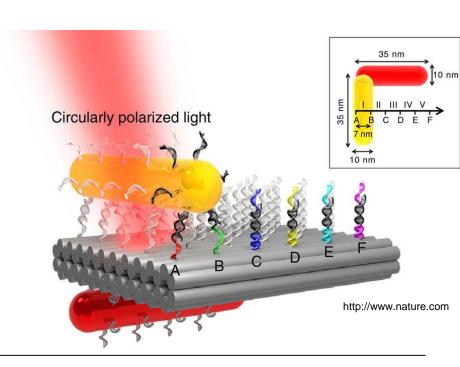- Research linked to synthetic biology and gene editing

DNA – Origami

- DNA Origami
  - Fundamental research
  - Nanostructures built with DNA
  - Structure stiffness modulated with multiple DNA strands
  - 3D movements of built in nano-particles (external trigger)
  - Goal to build 'nanofacotry', develop molecular robotics

Circularly polarized light

35 nm

10 nm

35 nm

I II III IV V

A B C D E F

7 nm

10 nm

A   B   C   D   E   F

http://www.nature.com

Tacit Knowledge

http://www.scarymommy.com

- Required that 'Something actually works'

- Hindrance for non-state actors

- Lack thereof does not prevent crude weapons

- Scenario and context affect risk

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Policy Discussion

- Convergence may affect Treaty Scope as well as Implementation
  - Requires good understanding of new developments
  - Take general approach for S+T review (don't focus on individual development only)
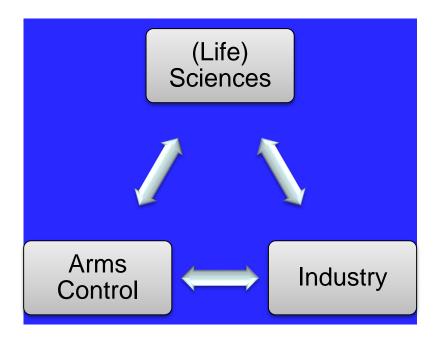
http://darksky.org/our-work/public-policy/

- Most developments affect implementation
  - Production technologies
  - Facilities producing Highly Active Pharmaceutical ingredients (HAPI)

- Be warry of the Hype!
  - Policy responses must be proportionate
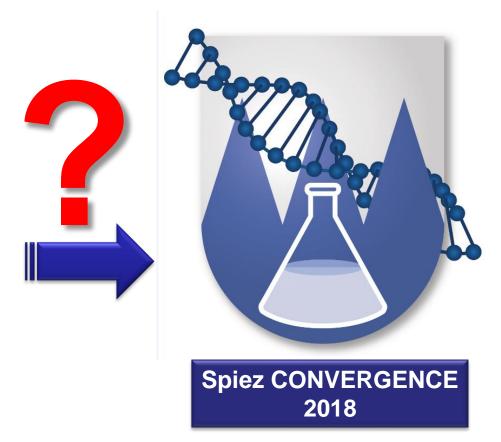
Policy Discussion

- Society will benefit from S+T Developments
    - Dual use potential

- Effective communication is important
    - Scientists are part of the solution, not the problem
    - Discussion of security threats is multidisciplinary

Outlook

http://www.imperial.ac.uk

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Thank You!

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