# Wageningen University & Research Centre

## *Introduction to CLIB*

Februari 13th, 2014. Ruud A. Weusthuis, Gerrit Eggink

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# Introduction

Prof. Dr. Gerrit Eggink

Professor Industrial Biotechnology

Bioprocess Engineering group

Dr. Ruud A. Weusthuis

Associate Professor Microbial Biotechnology

Bioprocess Engineering Group

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# Wageningen UR mission

‘to explore the potential of nature to improve the quality of life’

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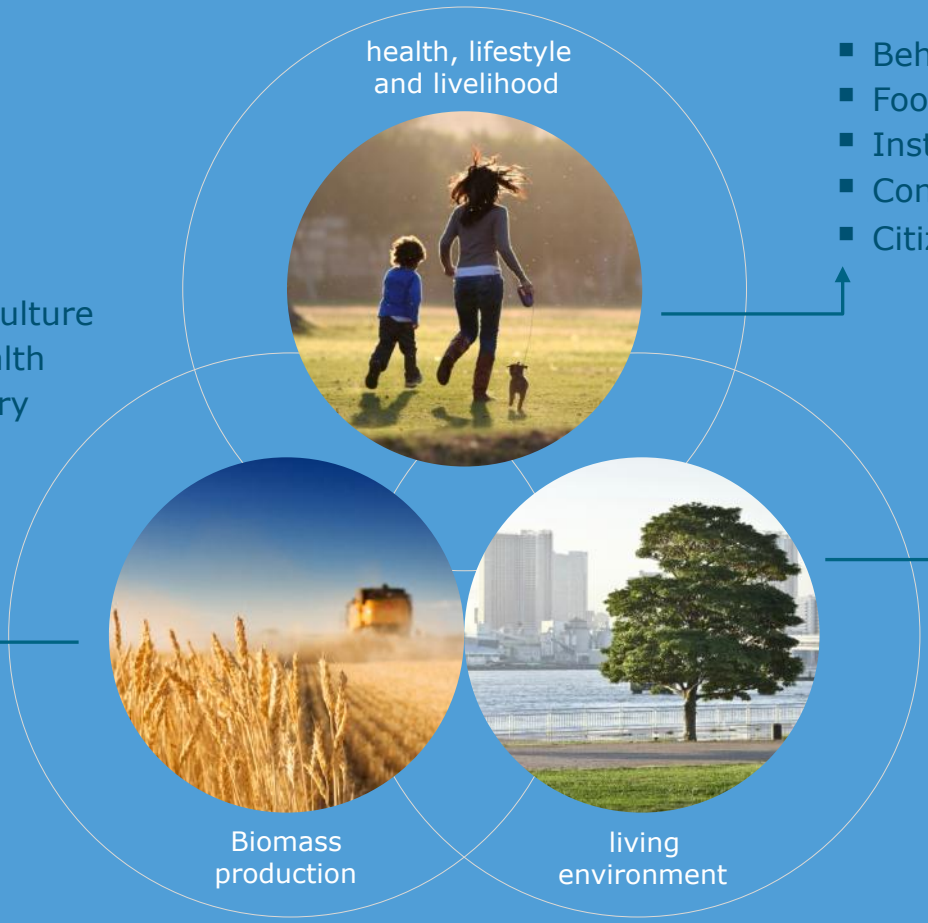
# The Wageningen UR domain: healthy food and living environment




- Behaviour and perception
- Food security
- Institutions
- Consumer
- Citizen

- Sustainable agriculture
- Nutrition and health
- Sustainable fishery
- Biomass
- Chains

- Marine resource management
- Landscape and land use
- Nature & Biodiversity
- Water management
- Competing claims

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# Wageningen UR

Research

- Top 3 in our domains
- Top 100 worldwide in university ranking
- Exploitation and valorisation of research

Education

- > 11,000 students
- > 6,000 faculty and staff
- Turnover € 710 million

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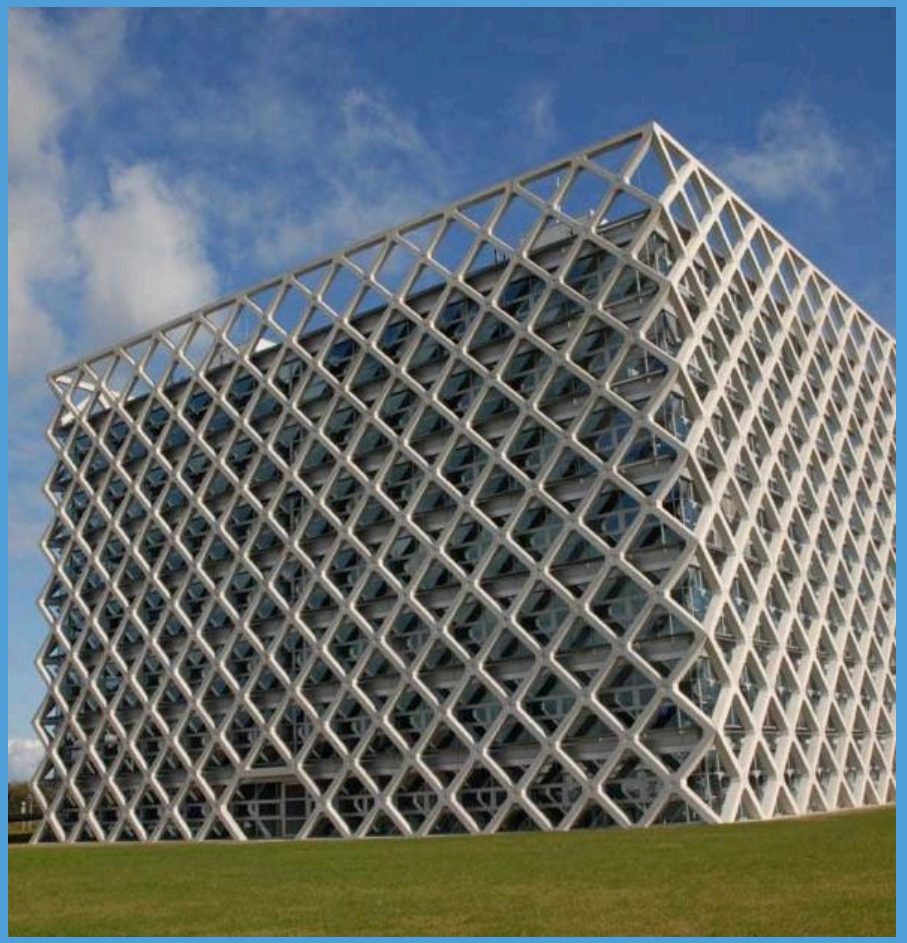
# Our challenges

- Increasing global population: 9 billion in 2050
- Environment, nature, climate and food supply under pressure
- Need of sustainable breakthroughs in knowledge and technology
- Economic crisis is limiting the investment capacity

# Our strengths

- Combination of university and market-oriented research institutes
- Cooperation between technological and social science disciplines
- Strong international position
- Strong cooperation Government-Industry-University
- Wageningen Campus

# Wageningen Campus



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# Our strengths

- Major interest in our themes:
  - 21st century agro-production
  - Water
  - Sustainable use of space
  - Bio-based systems and products
  - Food, health and behaviour

# Strong position in the rankings

- 75th position on the Times Higher Education World University Rankings (23 in Europe)
- 37th position on the Shanghai Index ranking for 'Life and Agriculture Sciences'
- The best university according to Dutch students in the Dutch guide for higher education (Keuzegids Hoger Onderwijs) for five years running
- The second best university worldwide for agricultural research according to the Taiwanese government

# Partners

Wageningen University

9 applied Research Institutes of Wageningen UR

- 8.000 BSc/MSc-students from >100 countries
- >1.700 PhD
- 2.475 fte Faculty and staff
- Turnover 2011: €304 million

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# Partners

Wageningen University

9 applied Research Institutes
of Wageningen UR

- 2.825 fte Faculty and Staff
- Turnover 2011: €353 miljoen

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# Organisational structure

# Our position in the world

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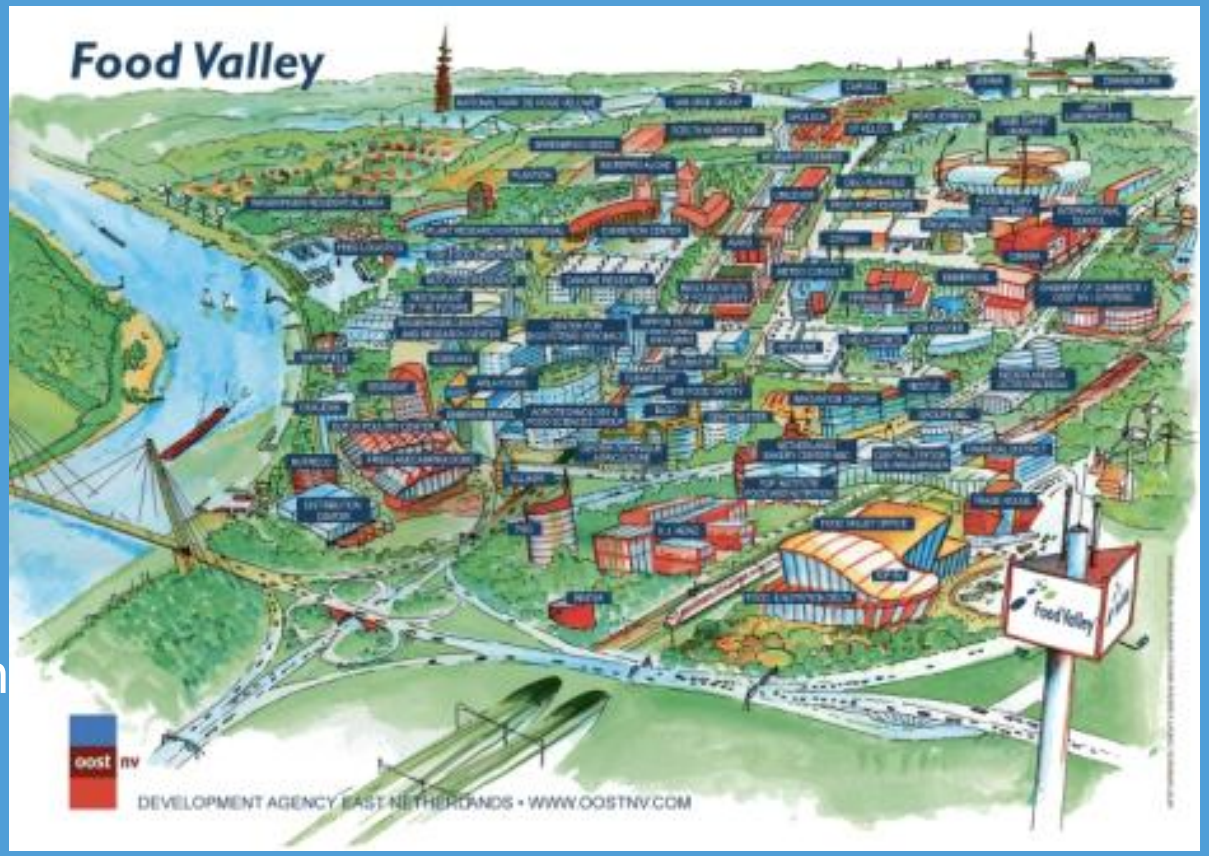
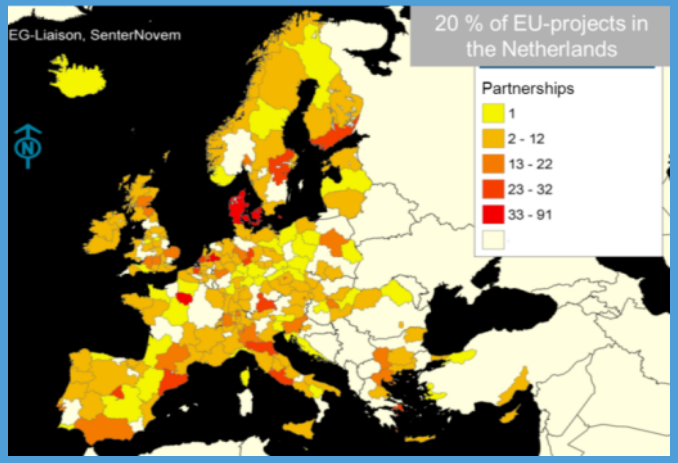
# Embedded in Food Valley

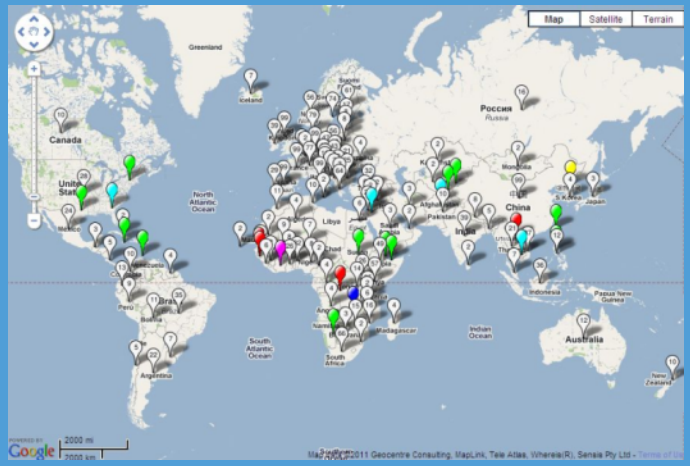
- A great network
- Close collaboration:
  - Business
  - Education & research
  - Government
  - Partnerships
- Aiming at innovation
- Facility sharing



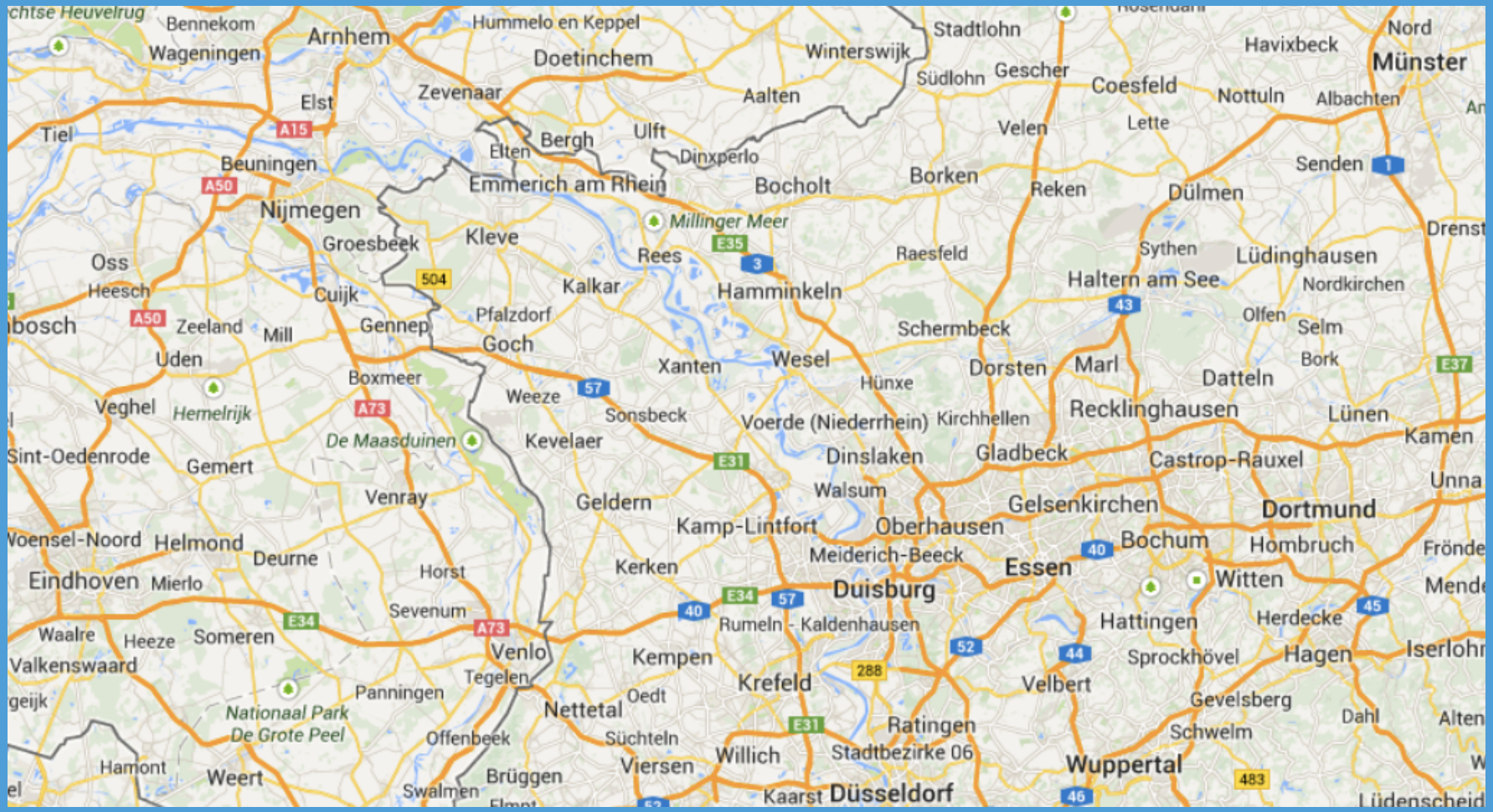
# Wageningen in the world

- Offices in Brazil, China, Chile and Ethiopia



# Proximity Wageningen – NRW

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# Our education

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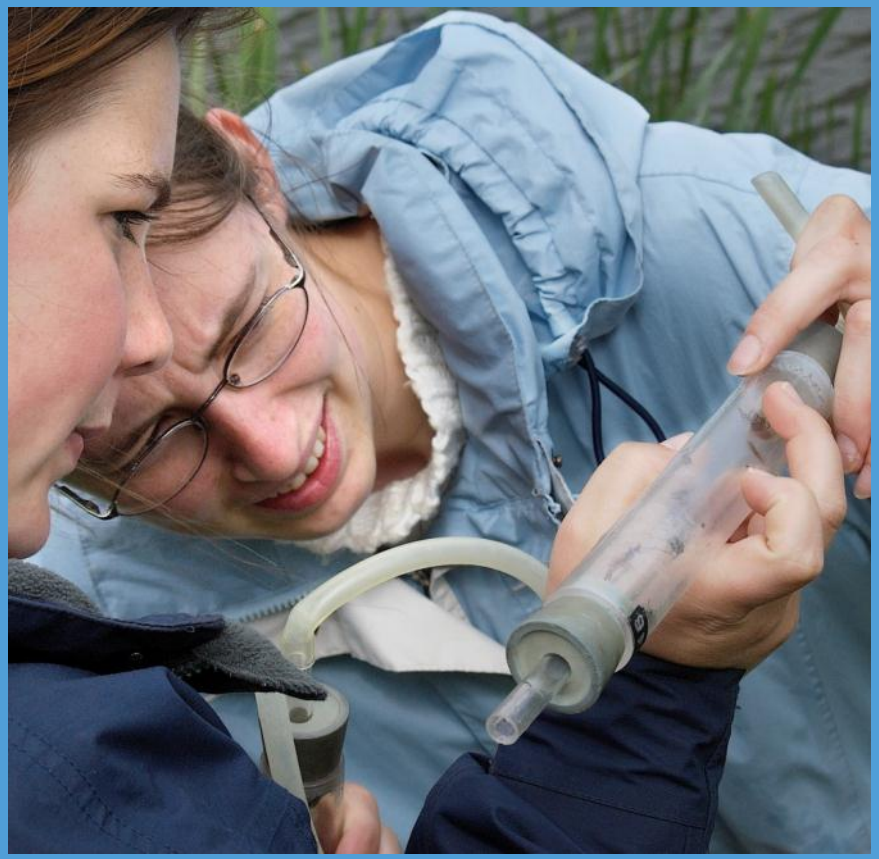
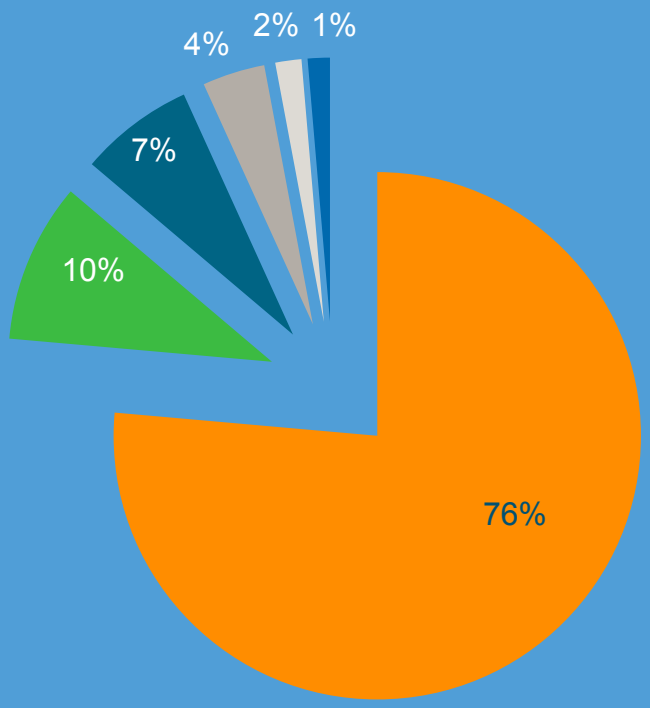
# Our vision: inspiring young people

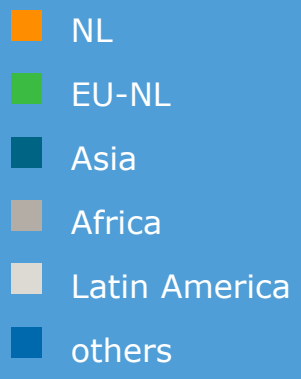
- Blended – various learning methods
- Content – new global challenges
- Various, dynamic and flexible learning tracks
- Personal attention – contact, involvement,
- Talent assessment, counseling



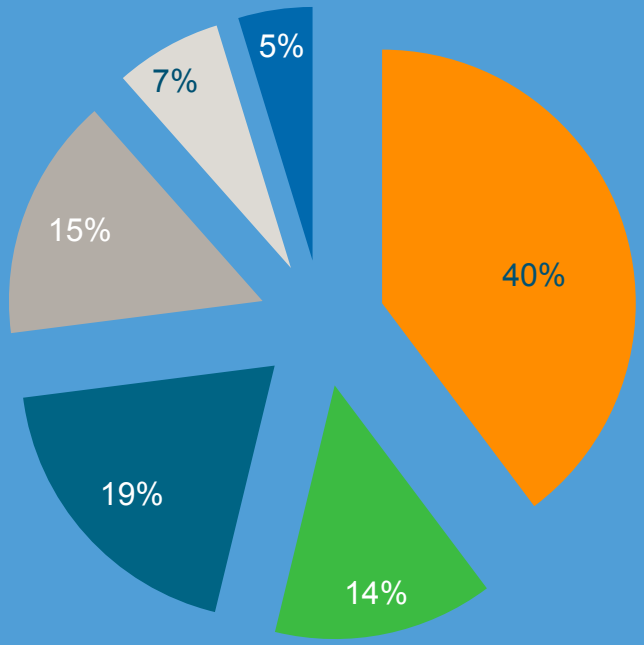
# Cultural diversity at Wageningen University

MSc students 2010-2011
Total 3000




PhD students 2010-2011
Total 1500

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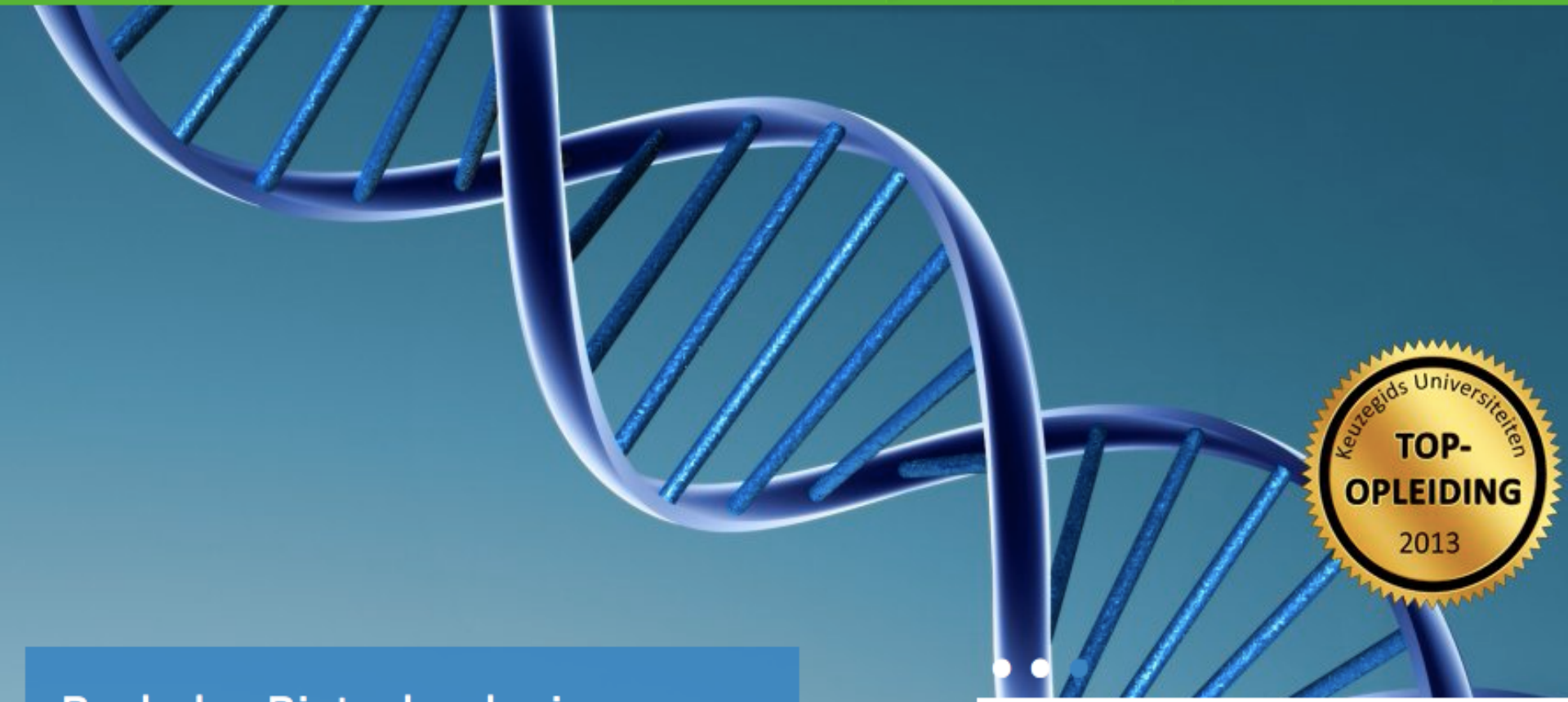



# Bachelor Biotechnologie

## 222 students

Bij de Bachelor of Science opleiding Biotechnologie leer je om biologische en technische processen te doorgronden en toepasbaar te maken op industrieel niveau. Deze breed georiënteerde opleiding strekt zich

### Vragen over deze opleiding?

Opleidingsdirecteur Biotechnologie
dr.ir. S (Sonja) Isken

Contactformulier

# Master Biotechnology

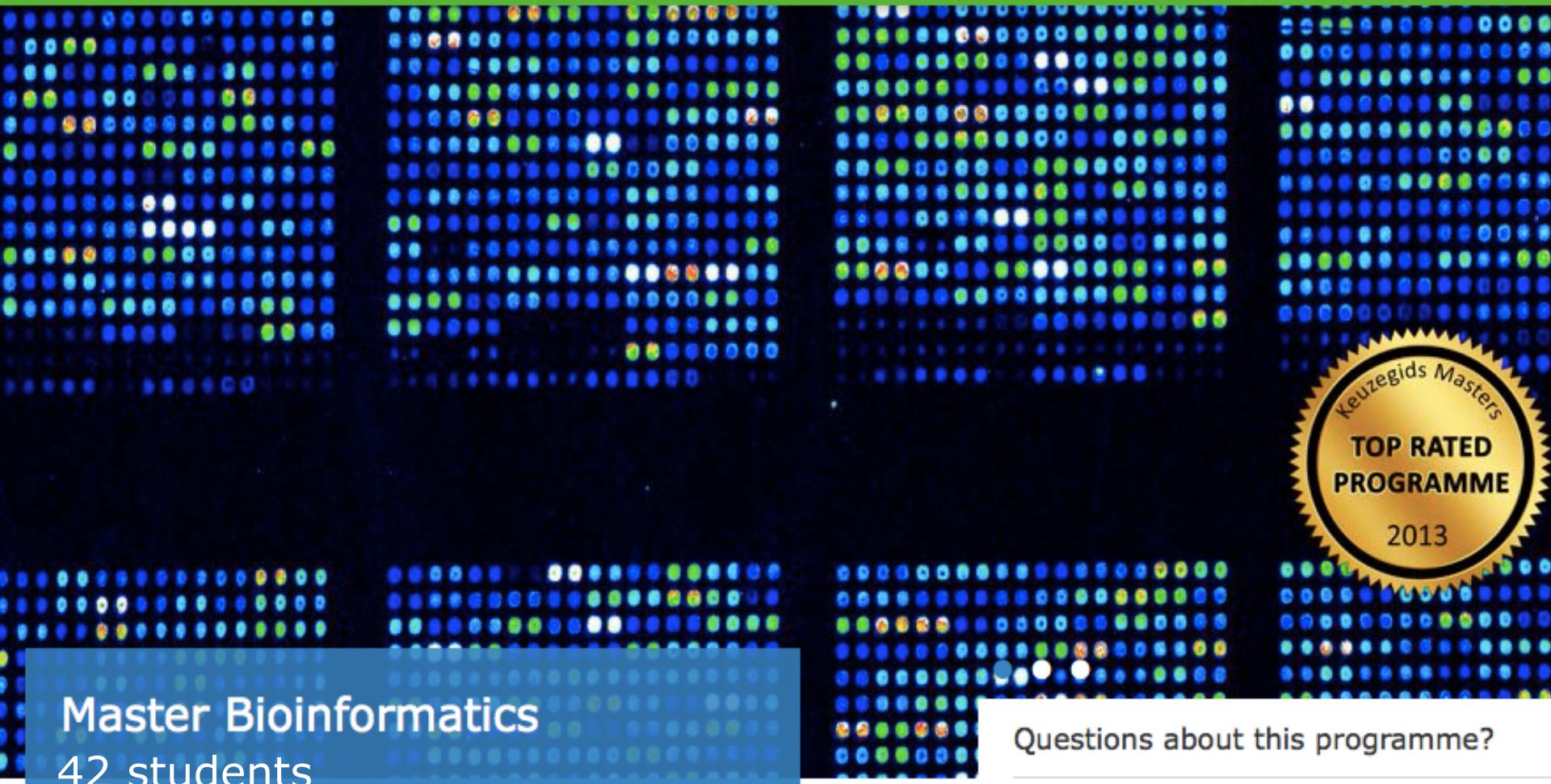
## 199 students

Biotechnology is defined as the industrial exploitation of living organisms or the exploitation of components derived from these organisms. Its practical applications include age-old techniques such as brewing and

### Questions about this programme?

Programme Director Biotechnology
dr.ir. S (Sonja) Isken

Contact form




# Master Bioinformatics

## 42 students

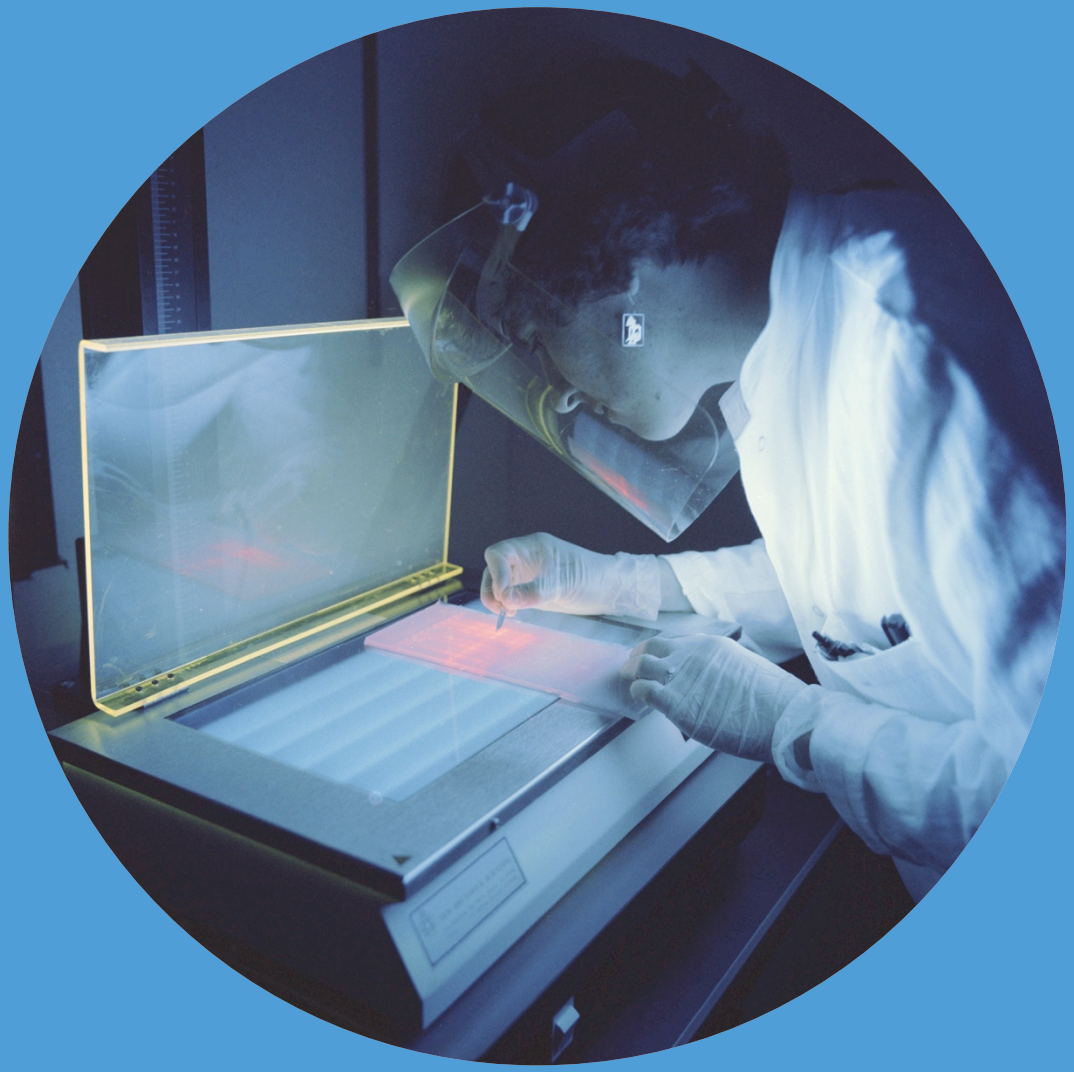
Bioinformatics is a new scientific discipline with roots in computer science, statistics and molecular biology. It was developed to cope with the output of genome

Questions about this programme?

Administration
P (Petra) van Dijk

Contact form

# Our research



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# Industrial Biotechnology @ WU

Cees Buisman

Huub Rijnaarts

Environmental Technology

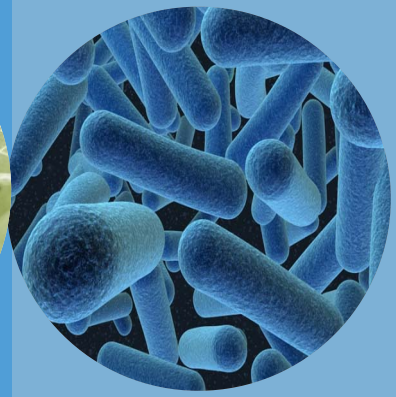
René Wijffels

BioProcess Engineering

Harry Bitter

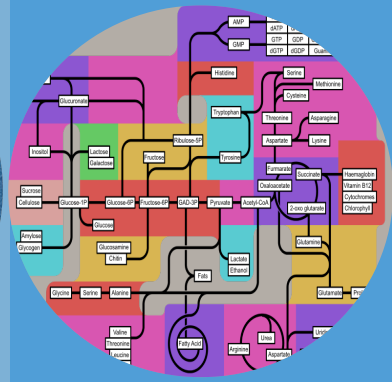
Biobased Commodity Chemistry

Willem de Vos



Microbiology

Vitor Martins dos Santos



Systems & Synthetic Biology

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# Industrial Biotechnology @ WU

- Scales: From molecule to environment
- Strong cooperation between groups
- People: 217
    - Staff: 80
    - PhD: 116
    - Technical support: 21

# Strategy Environmental Technology

- Convert agro industrial waste streams
- Into chemicals
- By means of mixed cultures

- Past: Anaerobic waste water treatment – upflow anaerobic sludge blanket reactor (UASB) (prof. Gatze Lettinga)

# Examples Environmental Technology

- Waste2Chemical:

Production of medium chain fatty acids


- Shell/Paques process

Microbial desulfurisation of natural gas to elemental sulfur

# Strategy Bioprocess Engineering

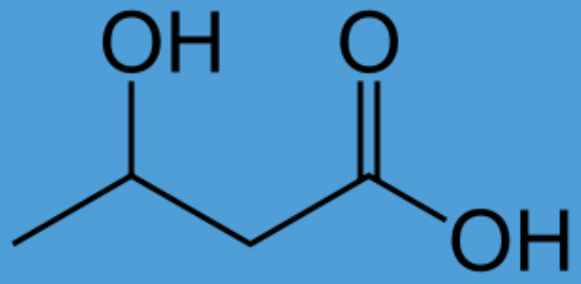
- Research in the context of a complete process
- Identification of bottle necks
- In depth research on these bottle necks

- Bioreactor design, Biorefinery, Metabolic engineering

# Example Bioprocess Engineering

- From reactor engineering to metabolic engineering
- Anaerobic production of chemicals
  - Aerobic conditions result in low yield and low productivity
  - Anaerobic product formation – redox balance

- 3-hydroxybutyric acid
- PHB competes with polyethylene
- Anaerobic production:




2 glucose → 3-hydroxybutyric acid + 2 ethanol + 4 $H_2$ + 4 $CO_2$

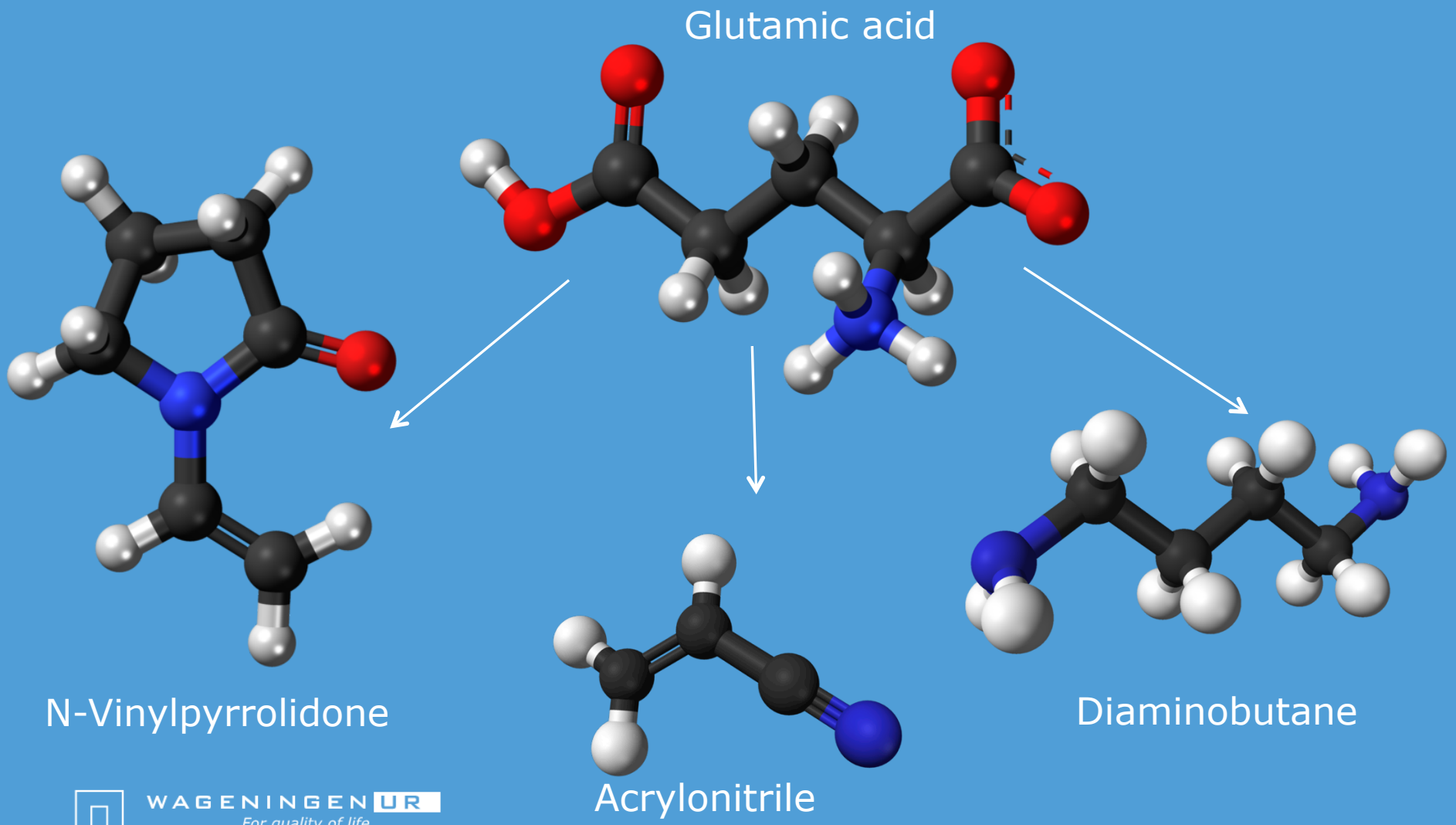
# Bioprocess Engineering: AlgaePARC

- Interaction between basic research and pilots
- Multidisciplinary approach
- Research topics
  - Efficient use of sunlight
  - Reduction of energy input
  - Use of residual nutrients
  - Lipid accumulation
  - Strain improvement
  - Scale-up
  - Biorefinery
  - Design scenarios/LCA's

# Strategy Biobased Commodity Chemistry

- Converting amino acids into N-chemicals
  - Nitrogen functionalisation is expensive
  - But already present in amino acids
  - Amino acid separation
  - Chemical and enzymatic conversions

# Example Biobased Chemistry: Glutamate

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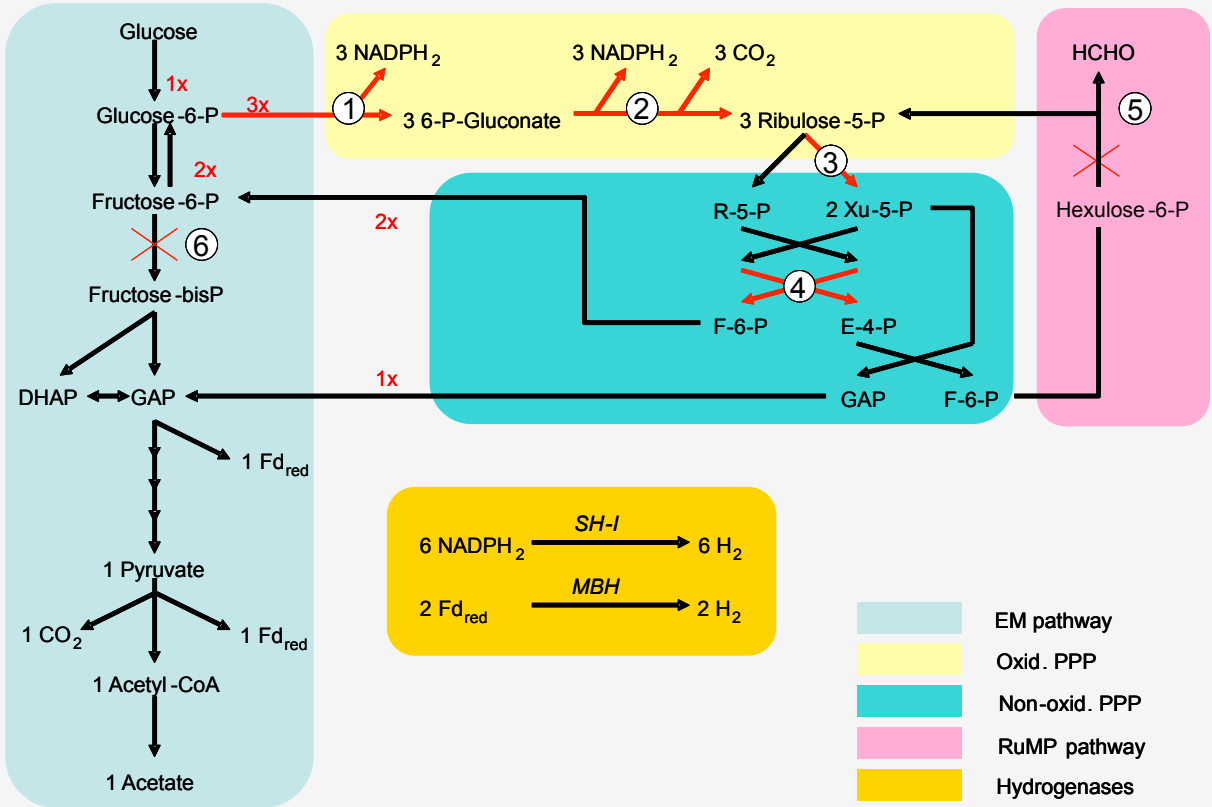
# Strategy of Microbiology

- Exploitation of thermophiles (bacteria and archaea)
    - Thermostable biocatalysts
    - Biohydrogen production
        - More favorable at elevated temperatures
    - Platform organism for 'green' chemicals
        - ability to hydrolyze lignocellulosic substrates to enable simultaneous saccharification and fermentation
- Engineering of Clostridia for the production of chemicals or biofuels
    - N-butanol and other alcohols

# Thermophilic $H_2$ production



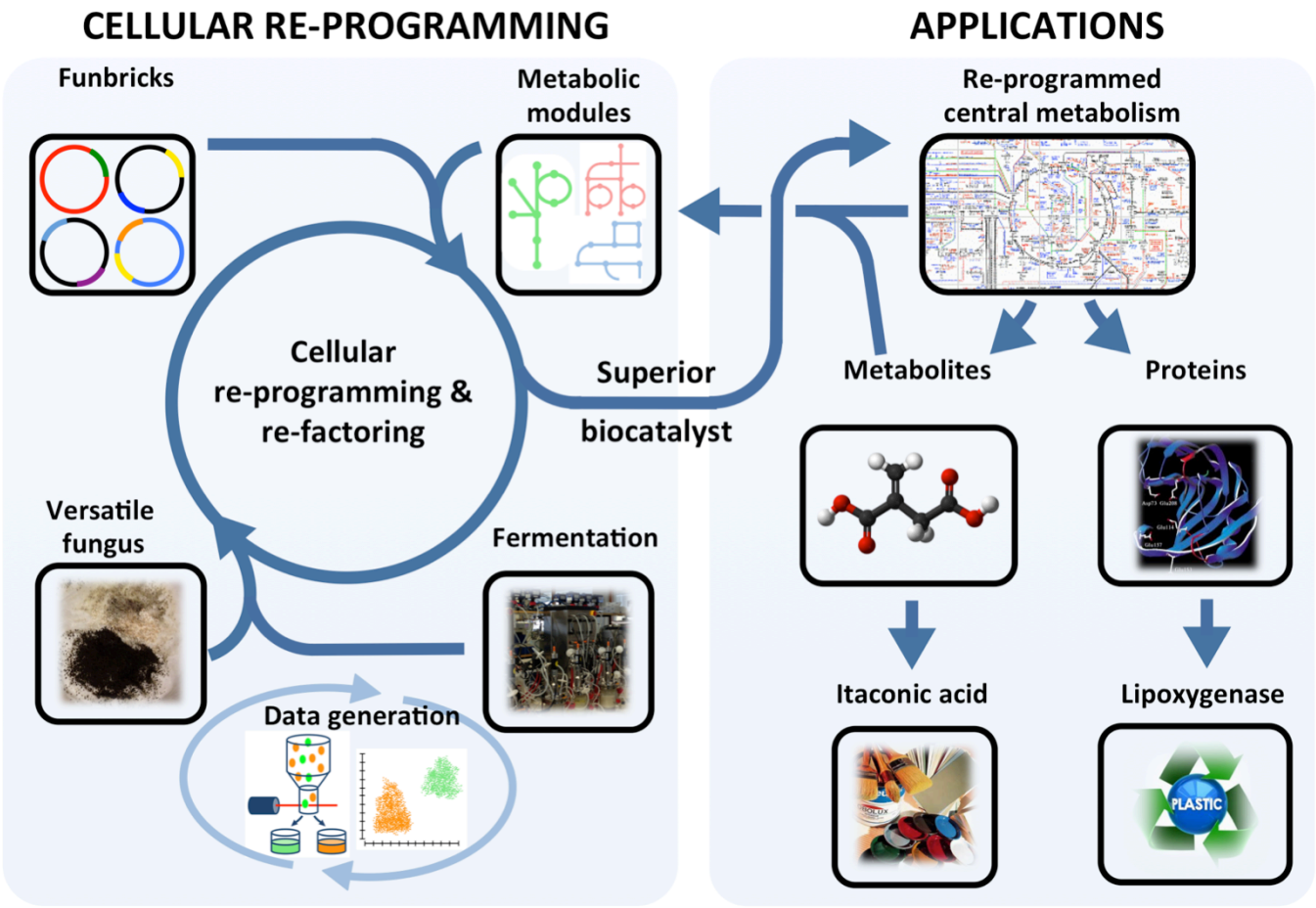

Introduction of 4 heterologous genes, combined with 2 gene knockouts should give extra reducing equivalents. Effect on the formation of reductant sinks ($H_2$, ethanol, alanine) is investigated.

**Net reaction:** $Glucose + 8\ H_2O \rightarrow 1\ Acetate^- + 4\ HCO_3^- + 5\ H^+ + 8\ H_2$

# Strategy Systems & Synthetic Biology

- Re-programming microbes for tailored biocatalysis
  - Through:
    - Model-driven network re-design
    - Intertwining model and experiment
    - Genome-scale engineering and re-factoring
- Using fungi
  - Model system for higher eukaryotes
  - High level of
    - Protein secretion
    - Metabolite production
  - Metabolic versatility

# Example Systems & Synthetic Biology



# Cooperation with CLIB partners

Cooperating in research and education

Keywords:

**Technologies:** metabolic engineering, systems biology, synthetic biology, reactor engineering, cultivation, biorefinery

**Microorganisms:** thermophiles, fungi, fermentative microorganisms, algae, mixed cultures

**Products:** enzymes, fuels, chemicals, N-chemicals, industrial strains, biomass (protein, oil)

# More info

E-mail: ruud.weusthuis@wur.nl; gerrit.eggink@wur.nl

| | |
|---|---|
| Websites: | www.wur.nl |
| Bioprocess engineering: | www.bpe.wur.nl |
| Environmental Technology: | www.ete.wur.nl |
| Systems & Synthetic Biology: | www.ssb.wur.nl |
| Biobased Commodity Chemistry: | www.vpp.wur.nl |
| Microbiology: | www.mib.wur.nl/uk |

# Thank you for your attention!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