Chemicals all around us

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My talk today

- Research and research-based advice for governmental agencies
- Chemical burden
- Mixtures
- Take-home messages

Mission

DTU will develop and create value using the natural sciences and the technical sciences
to benefit society

Education | **Innovation** | **Scientific Advice**

Research

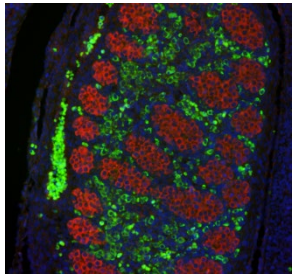
The big why

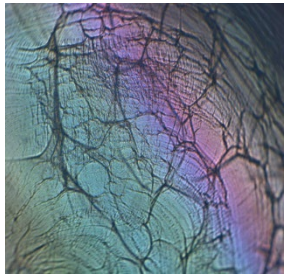
The National Food Institute's vision is to make a difference by generating future prosperity through research into food and health.

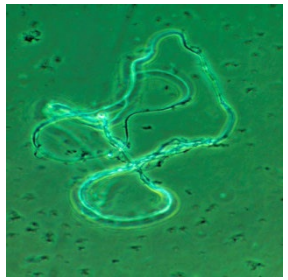
The National Food Institute:

- Prevents disease and promotes health
- Creates sustainable technological solutions
- Develops new and better food products for a growing population.

Research-based decision support

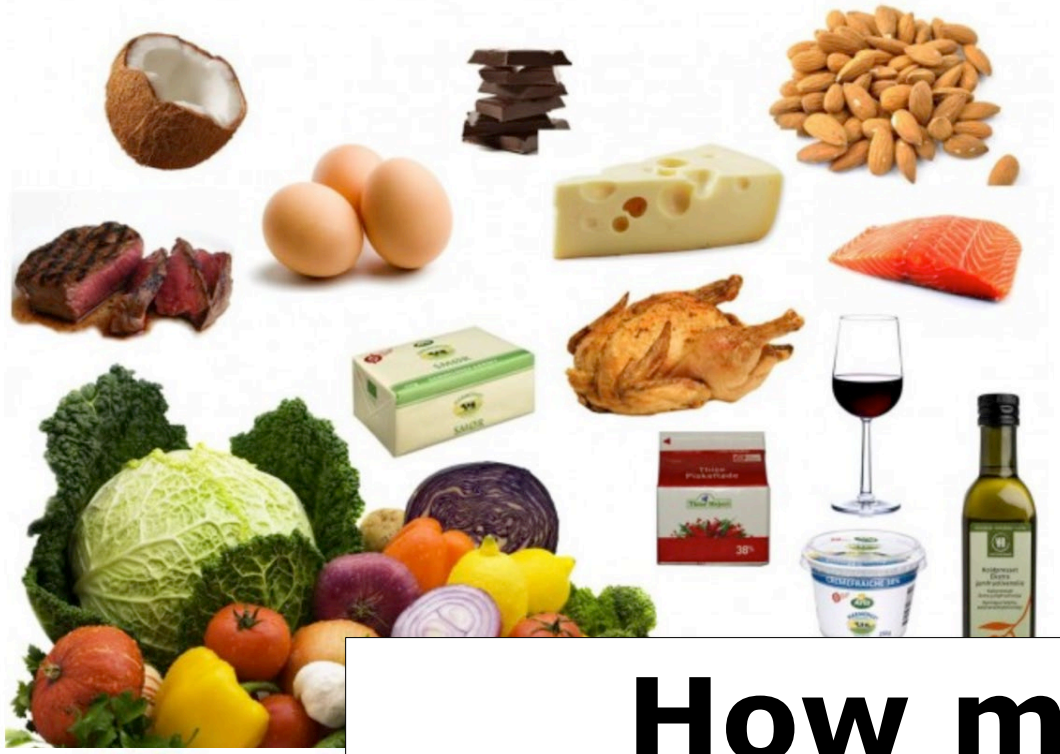






The National Food Institute delivers **independent and reliable scientific advice** to national and international authorities and companies.

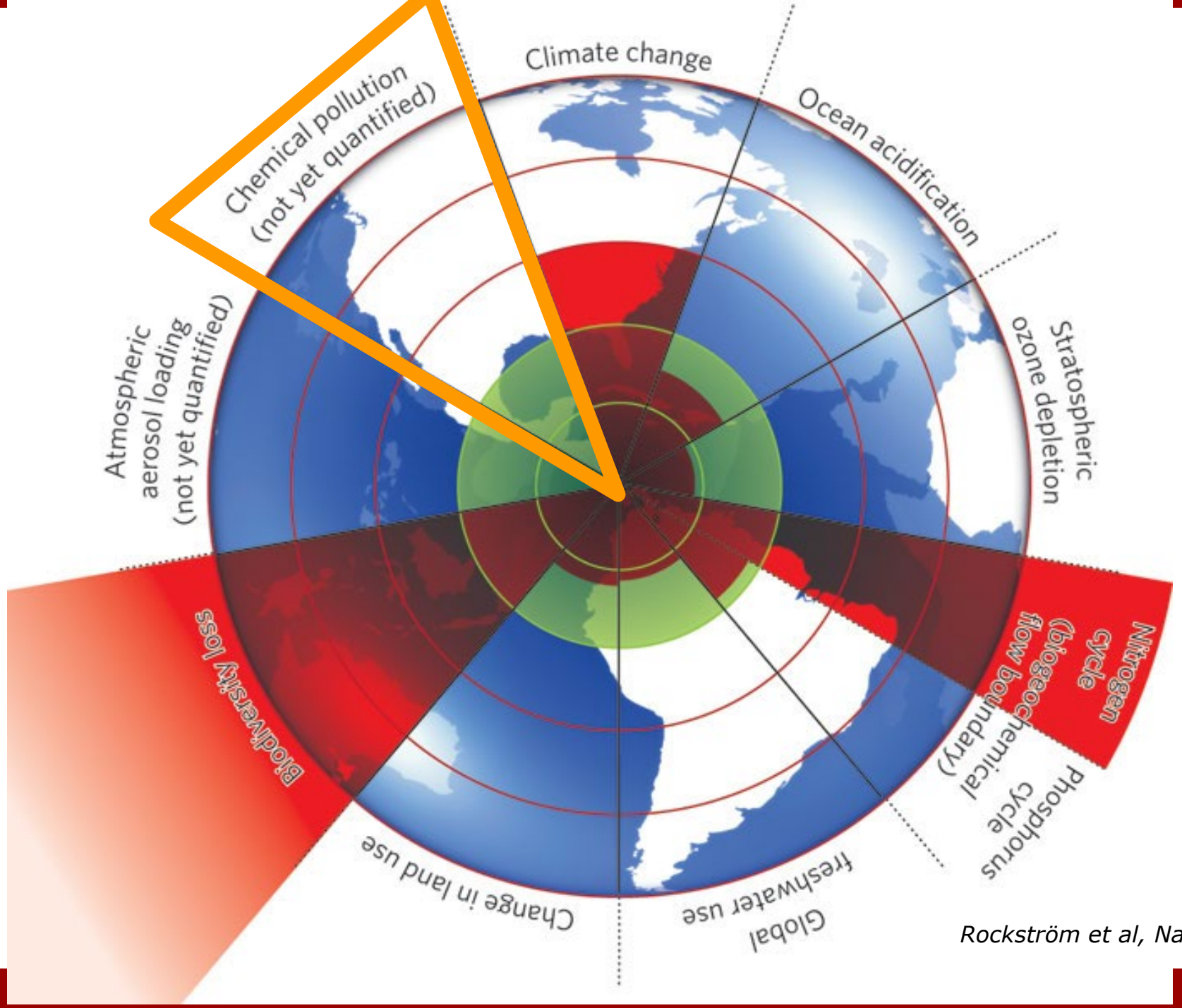
- Ministry of Food – National Food Agency
- Ministry of the Environment – Danish EPA
- European Union, EU and European Food Safety Authority, EFSA
- World Health Organization, WHO
- Organization for Economic Co-operation and Development, OECD
- Food and Agriculture Organization of the United Nations, FAO
- Individual food industries or entire sectors



How many chemicals?


EveryD
Spec
MAGGI
2 Minute


Weetabix
Pineapple Juice
Bakers
Rabbit & Duck
Friskies
CoCat
WALKERS
Mars
Twirl
DEEP & CRISPY
Cheese and onion flan
Chicken and mushroom flan
FIVE CHEESE & PEPPERONI
BACON
FESTIVE



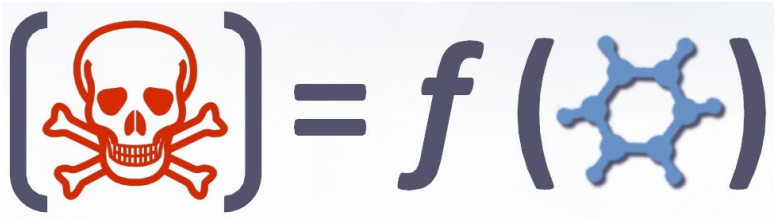
Rockström et al, Nature **461**, 472, 2009

40,000 industrial chemicals in use

Safety information on ~ 1,000 chemicals

What is (Q)SAR? (Quantitative) Structure-Activity Relationship

- (Q)SARs are **theoretical *in silico* models** that can be used to predict properties and activities, for example toxicity. It is so-called non-test methods which build on the hypothesis that **molecules of similar structure have similar behaviour**.



Online Danish (Q)SAR database

- **(Q)SAR predictions for >600,000 substances, including 72,000 EU REACH Industrial substances**
- **>200 predictions** for each substance in new software / DTU models
- Includes so-called **battery predictions** where 3 different QSAR systems (technologies) are used for the same training set
- **Screening** across all QSAR predicted properties and structures
- http://qsar.food.dtu.dk/ - it is free of charge

The Risk-Benefit Assessment

RISK ASSESSMENT

Hazard identification

Hazard characterisation

Risk characterisation

Intake distribution background concentration body burden

Exposure

Risk incidence duration, mortality, severity

Positive health effect identification

Positive health effect characterisation

Benefit Characterisation

Benefit incidence duration, mortality, severity

Common health metrics

BENEFIT ASSESSMENT

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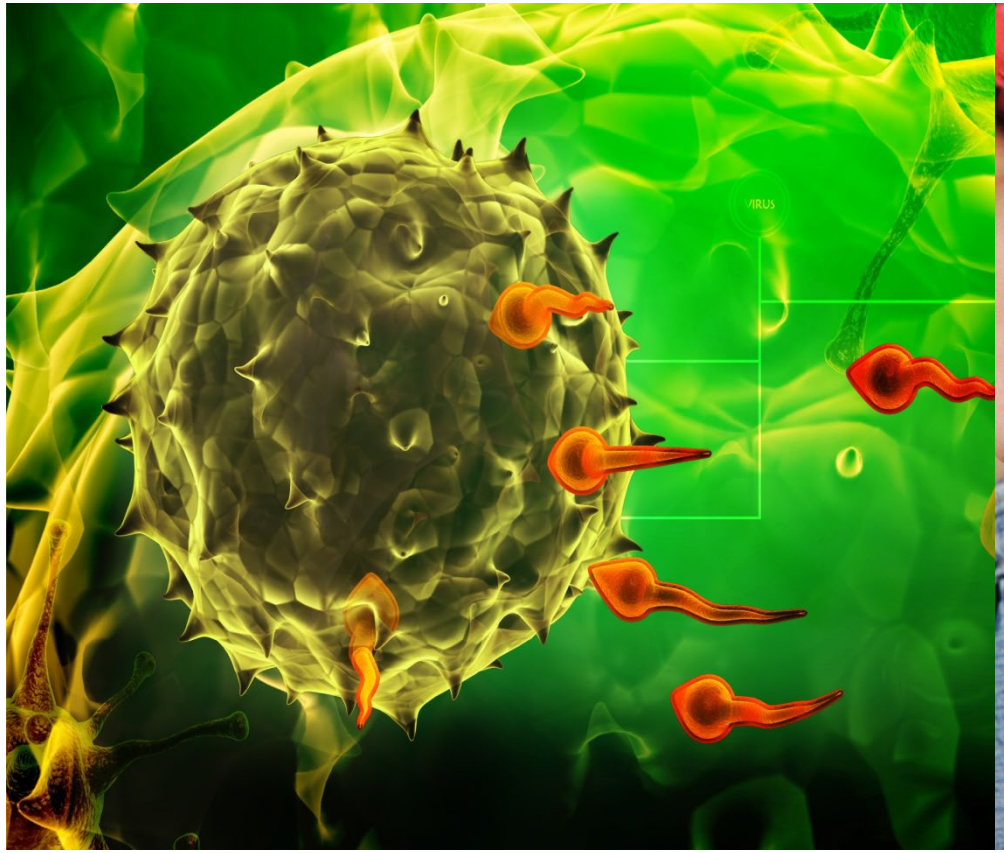
Chemicals affect human health



How to assess the risk of chemicals?

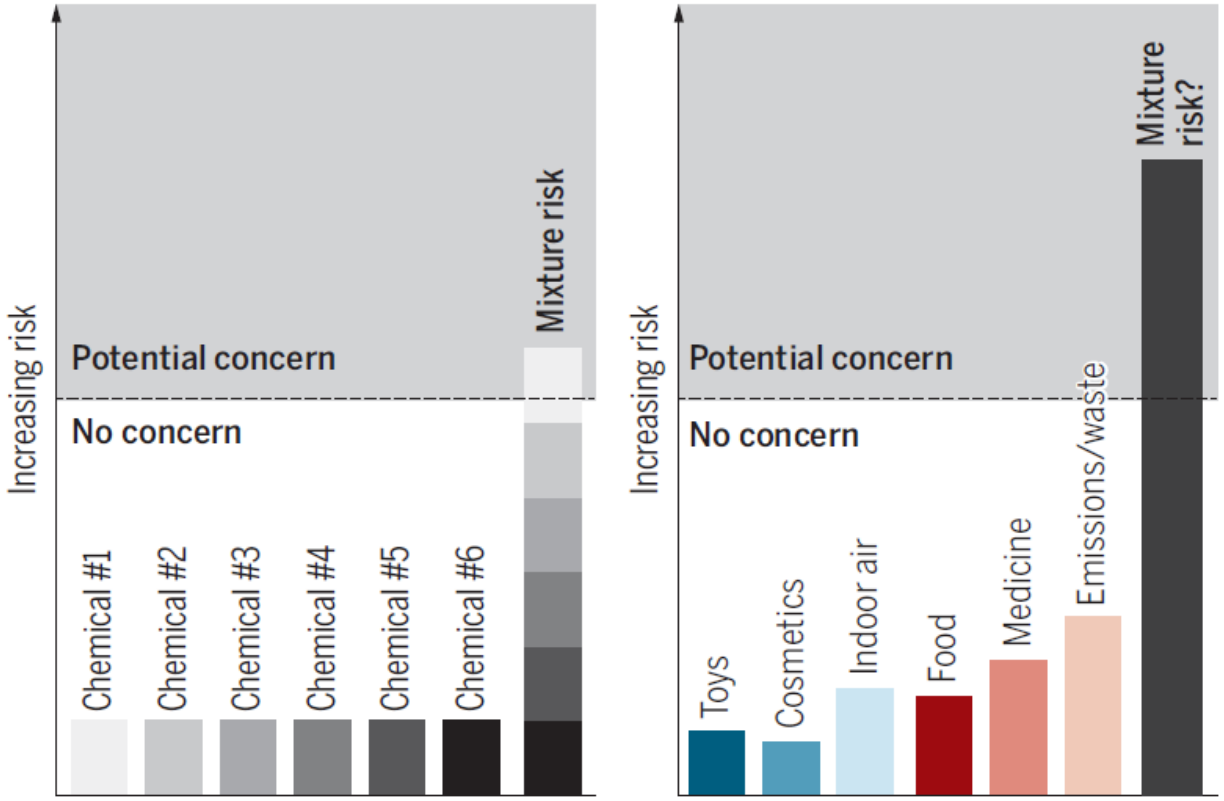
- How high is the exposure?
- What is the safe dose?

$$\frac{Exposure}{Safe\ dose}$$

- If the exposure exceeds the safe dose then we have a problem

- But what are the limit values for each chemical?
- And how much can be allowed in food, cosmetics, toys etc?

Regulatory gaps



Mixture effects
Experimental studies of up to 80 chemicals have shown that mixtures often have higher toxicity than the individual compounds.

Regulatory gaps
Humans and the environment are exposed to myriad chemicals from many different sources, but little is known about their combined risk.

Kortenkamp & Faust. Science, 20 July 2018, 361(6399)

Mixture risk assessment starts with risk assessing single chemicals

$$\text{Hazard Quotient} = \frac{\text{Exposure}}{\text{"Safe/acceptable level"}}$$

If the Hazard Quotient >1, a potential risk is identified

Grouping of chemicals

How to do that?

1. Adverse outcome/effect (e.g. liver tox)
2. Chemical structures (e.g. QSAR)
3. Mechanism/mode of action – experimentally or by computational tools

Grouping of endocrine disrupting chemicals

Dioxins
PCBs
Brominated
PFOS/PFOA
Triclosan

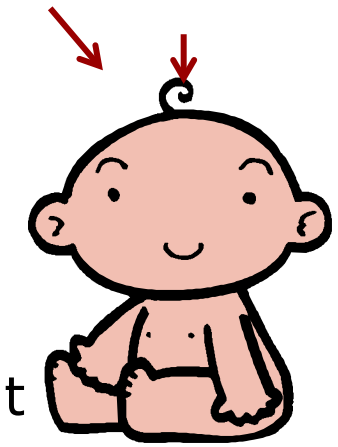
BHA/BHT
Parabens
Phenols
UV-filtres

Pesticides
Phthalates
Dioxins
PCBs

Thyroid disrupting

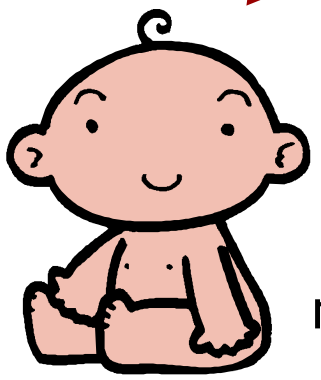
Estrogens

Anti-androgens

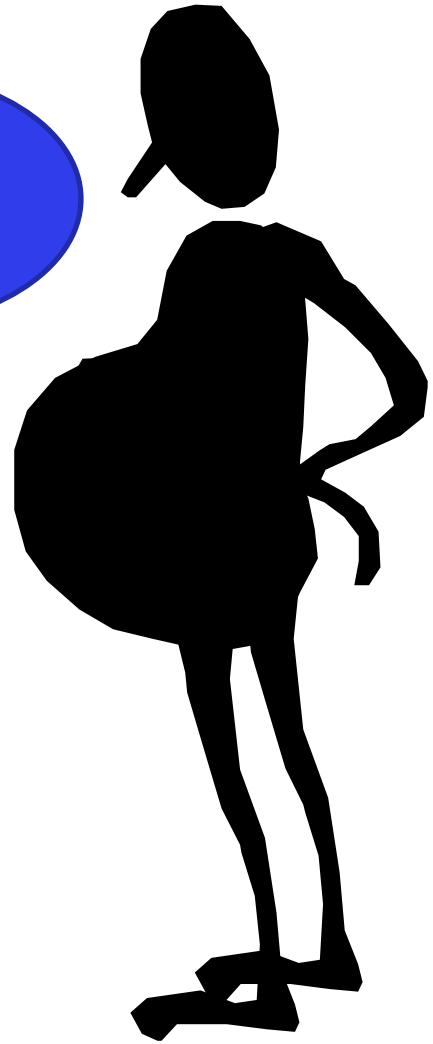


Growth

Brain development



Fertility, malformations



Experience with risk assessments in EU based on mixture calculations

- Pesticide contamination of foods
- Dioxins and PCB's in food and the environment
- Phthalate mixture risk assessment within the EU

4 compounds (DEHP, BBP, DBP & DIBP)– effect on male reproductive health

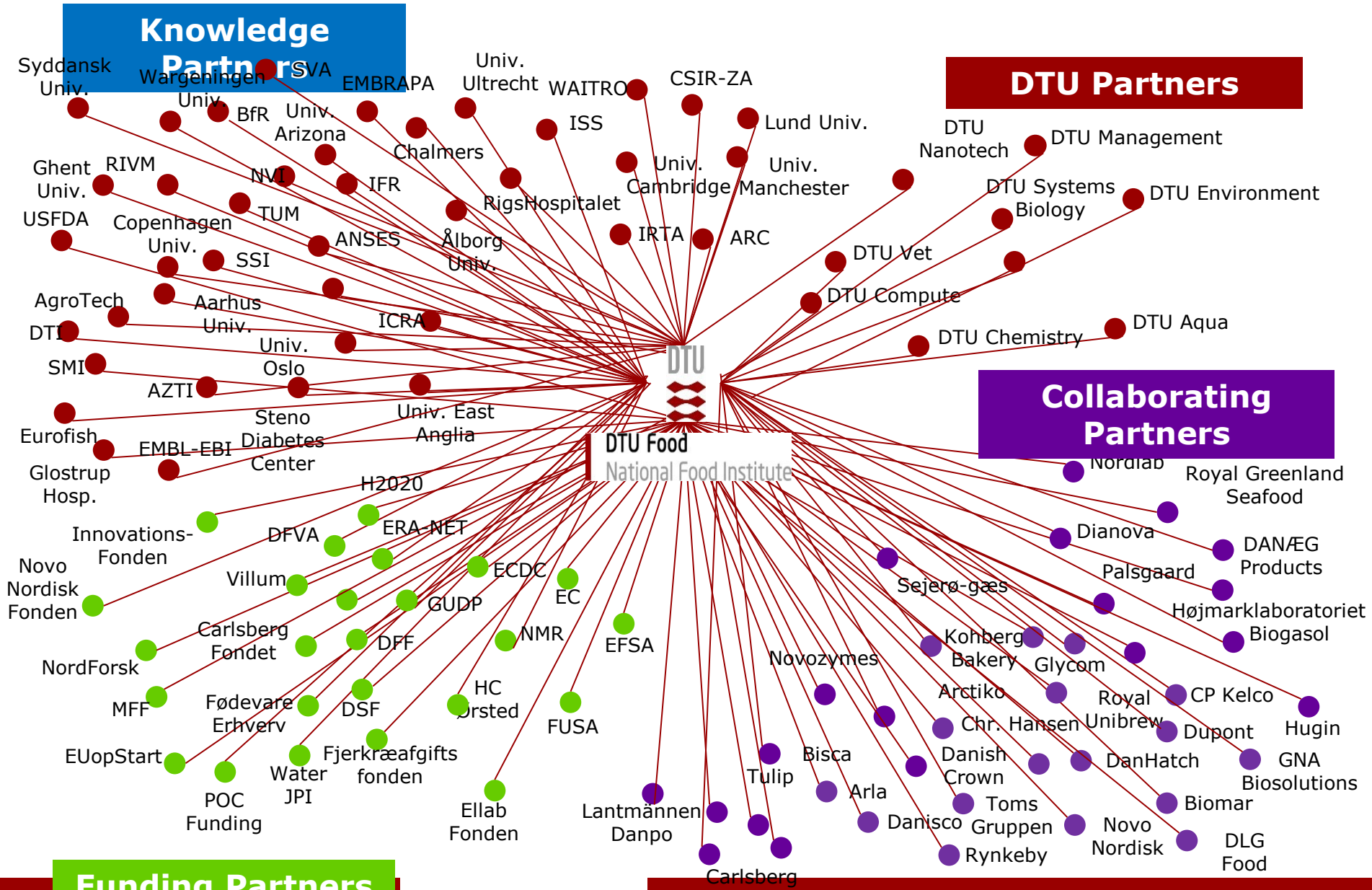
Dec 2018: EU abandons for the first time harmful chemicals because of cocktail effects

- Decision of the EU parliament 18th April 2019:

'There is increasing evidence showing that endocrine disruptors can work together to produce "mixture effects"'

Take home messages

- Chemicals affect humans, wildlife and the planet
- Mixture effects are seen at 'No Observed Adverse Effect Levels' for single chemicals - one chemical at a time underestimates the risk.
- Risk at high-end human exposures in some cases
- We can predict mixture effects in most cases, if we have adequate data for single compounds
- Risk-benefit assessments– adding also sustainability and cost
- Regulatory silos avoided: "One substance – One assessment"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