What is the Bioeconomy?

Integrating Bioeconomic Topics Across Different Subjects

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Do you feel prepared to teach your pupils about the bioeconomy?

Manifold Global Challenges…

Continued use of fossil resources causes severe greenhouse gas emissions and thus facilitates climate change.

Current land use exceeds the planetary boundaries and contributes to 22% of anthropogenic GHG emissions.

Non-renewable fossil resources are finite and generate significant ecological externalities are still used to meet our demands for food, materials as well as energy.

Growing population and economic development, especially in emerging economies threatens food-security and exacerbates social inequalities

Utilization of pesticides, herbicides and fertilizers as well as increasing landscape homogeneity, deforestation and the loss of marginal and uncropped habitats are the key drivers for the decline in biodiversity.

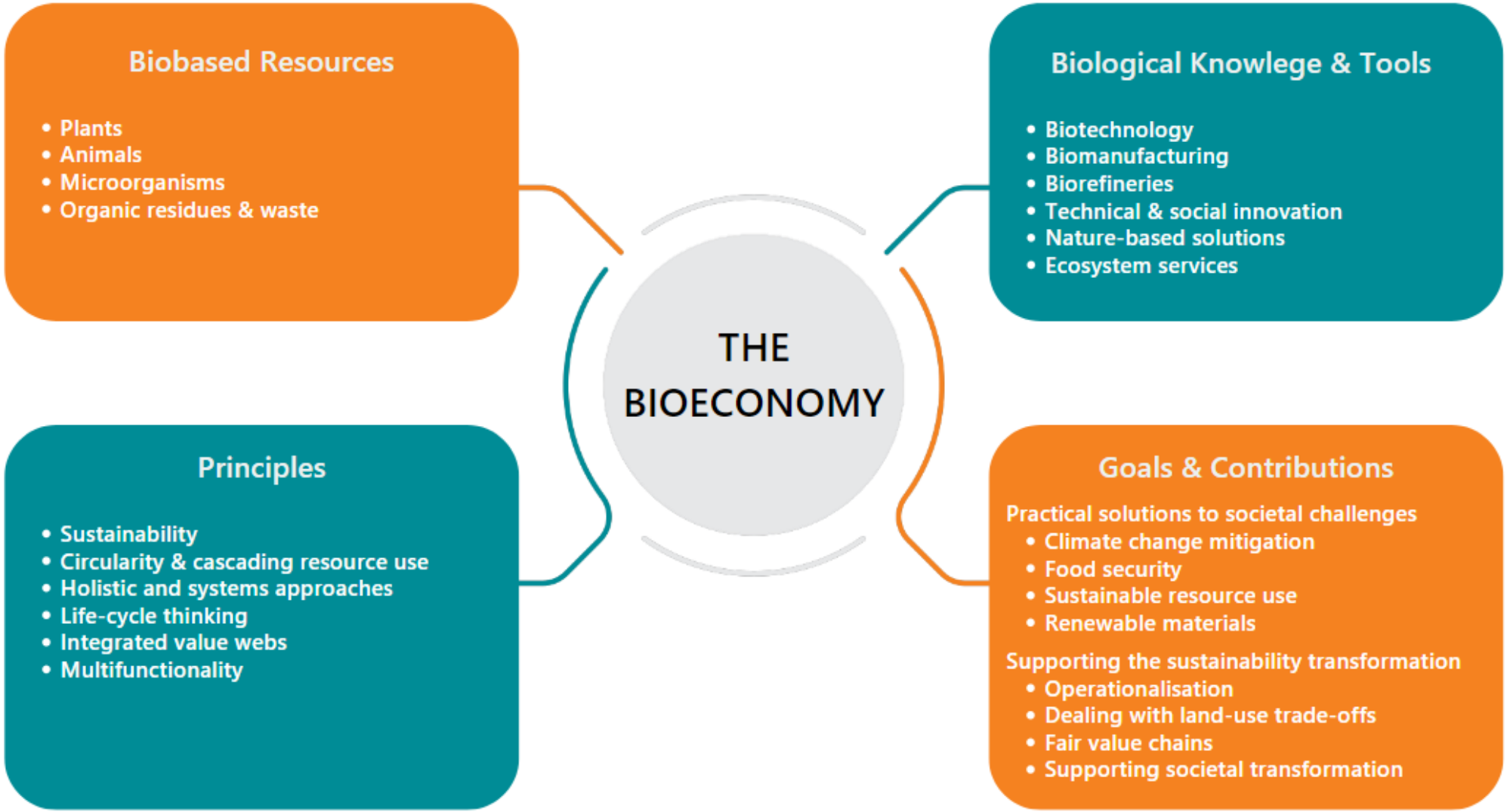
The Bioeconomy – A Promising Solution?

Resource substitution perspective
→ Replacing fossil-based by bio-based resources

Biotechnology innovation perspective
→ Research and application of life sciences and biotechnology

Green bioeconomy perspective
→ Sustainability and the importance of ecological processes

The bioeconomy



Getting to know the bioeconomy

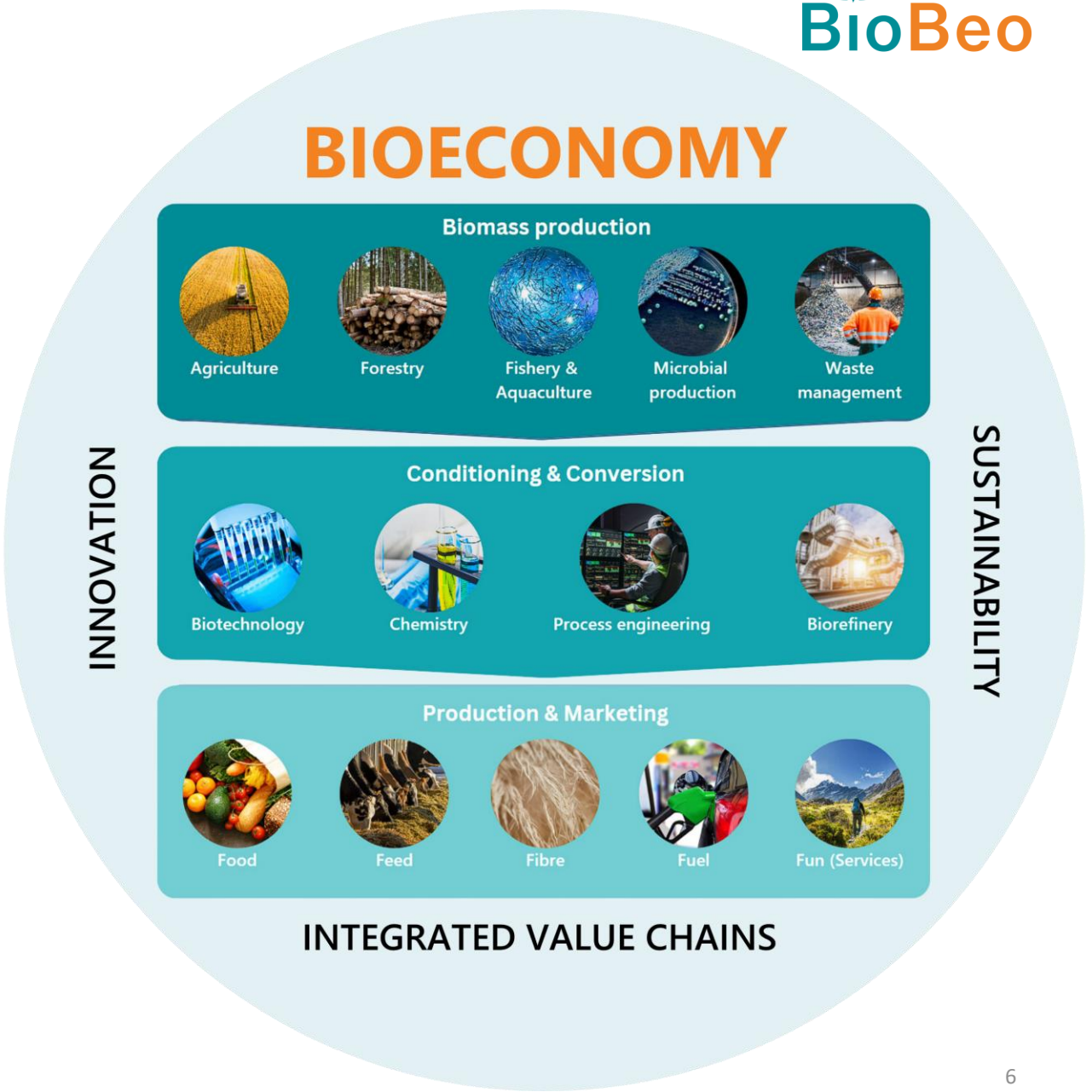
Bio-based resources

Bio-based resources = all renewable resources containing non-fossil, organic carbon, recently (<100 years) derived from plants, animals, algae, microorganisms or organic waste streams

Bio-based resources originate as **virgin materials from agriculture, forestry, aquaculture and microbial production** or in **recycled form from residual materials and biogenic waste streams**.

The **bioeconomy conditions and converts bio-based resources** to obtain intermediates, products or services. May involve thermochemical, biotechnological or biorefinery processes.

Untreated or processed materials can then provide products and services for food (wheat flour), feed (Wheat bran), fibre (Straw), fuel (hulls) and "fun" (wheat maze?, hiking).



Getting to know the bioeconomy

Bioeconomy Principles

Five principles form the backbone of the bioeconomy and guide its internal transition and innovation processes:

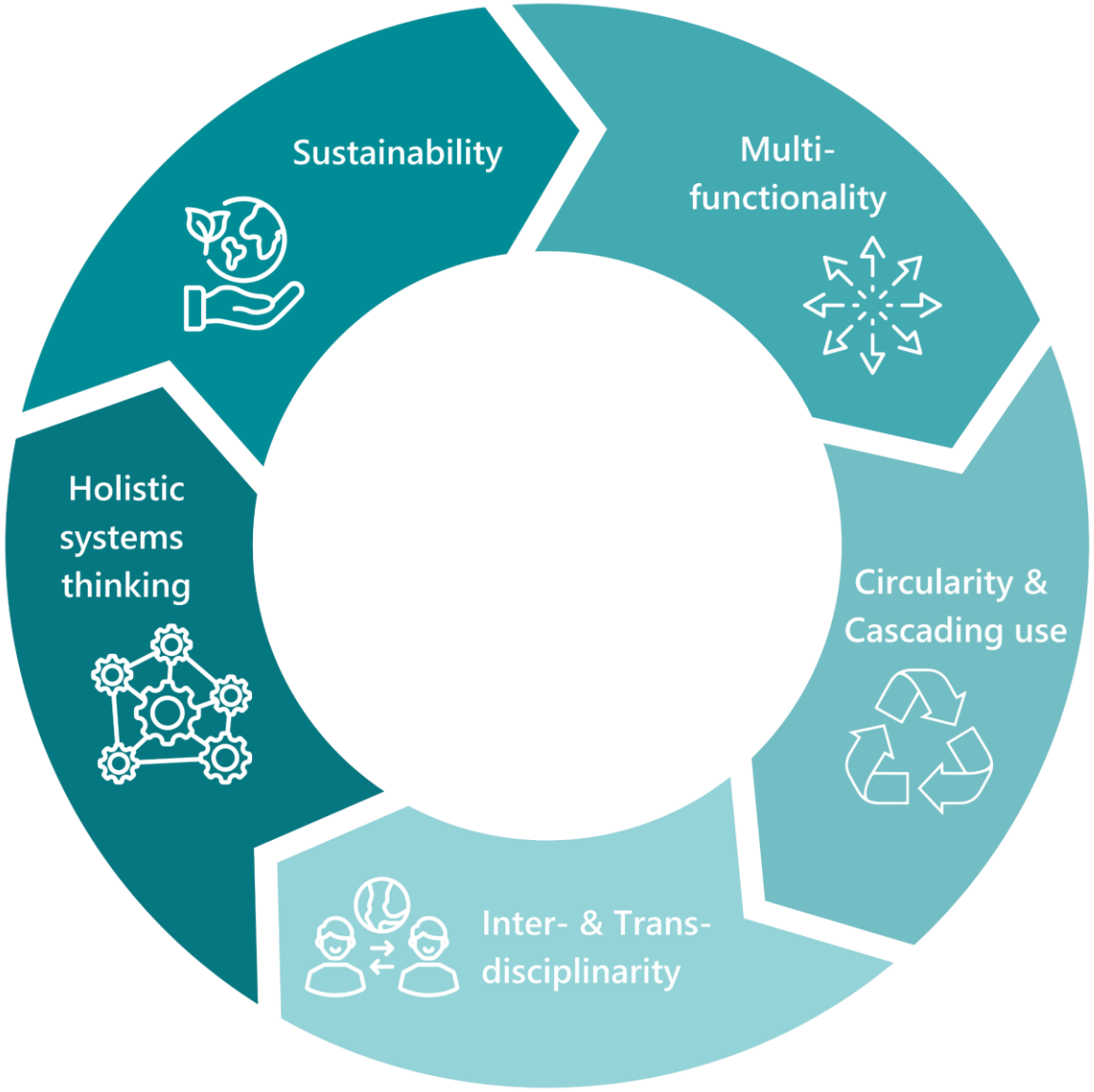
1. **Sustainability**: Ensuring that bioeconomic practices are sustainable by considering long-term environmental impacts, resource regeneration, and ecosystem health.

2. **Multifunctionality**: Fostering the capacity to fulfil multiple purposes simultaneously, including delivering economic value, environmental sustainability, and social benefits.

3. **Circularity and cascading resource use**: Promoting the reuse, recycling, and regeneration of resources to create closed-loop systems that reduce waste and increase resource efficiency.

4. **Inter- and transdisciplinarity**: Combining knowledge from different fields to address challenges and opportunities comprehensively while engaging diverse stakeholders, including policymakers, industries, communities, and researchers.

5. **Holistic systems thinking**: Understanding and evaluating bioeconomy with its interdependencies and contextualities, e.g., the entire life cycle of a product from resource extraction to disposal within socio-economic frame conditions.



Getting to know the bioeconomy

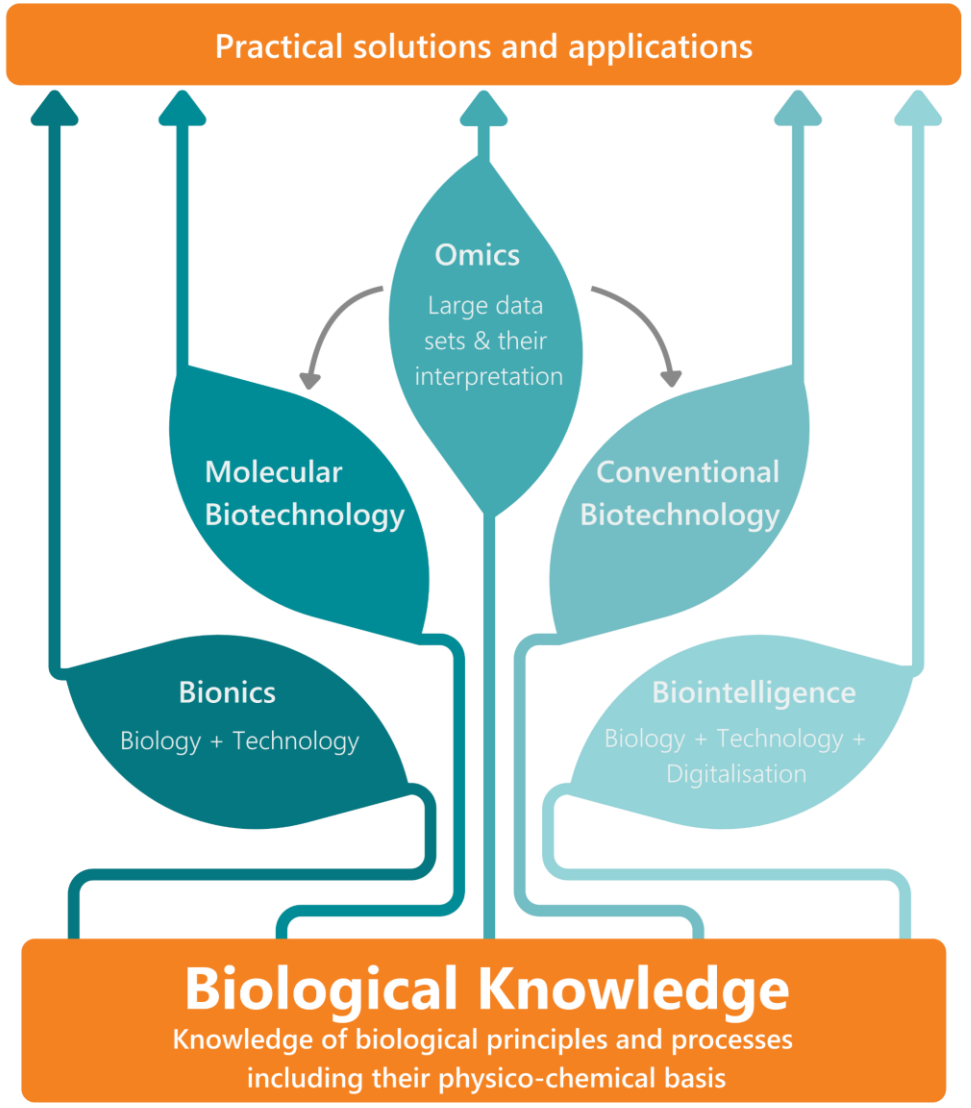
Biological knowledge & tools

Biological knowledge = Knowledge of biological principles, processes and data as well as the interpretation of their meaning.

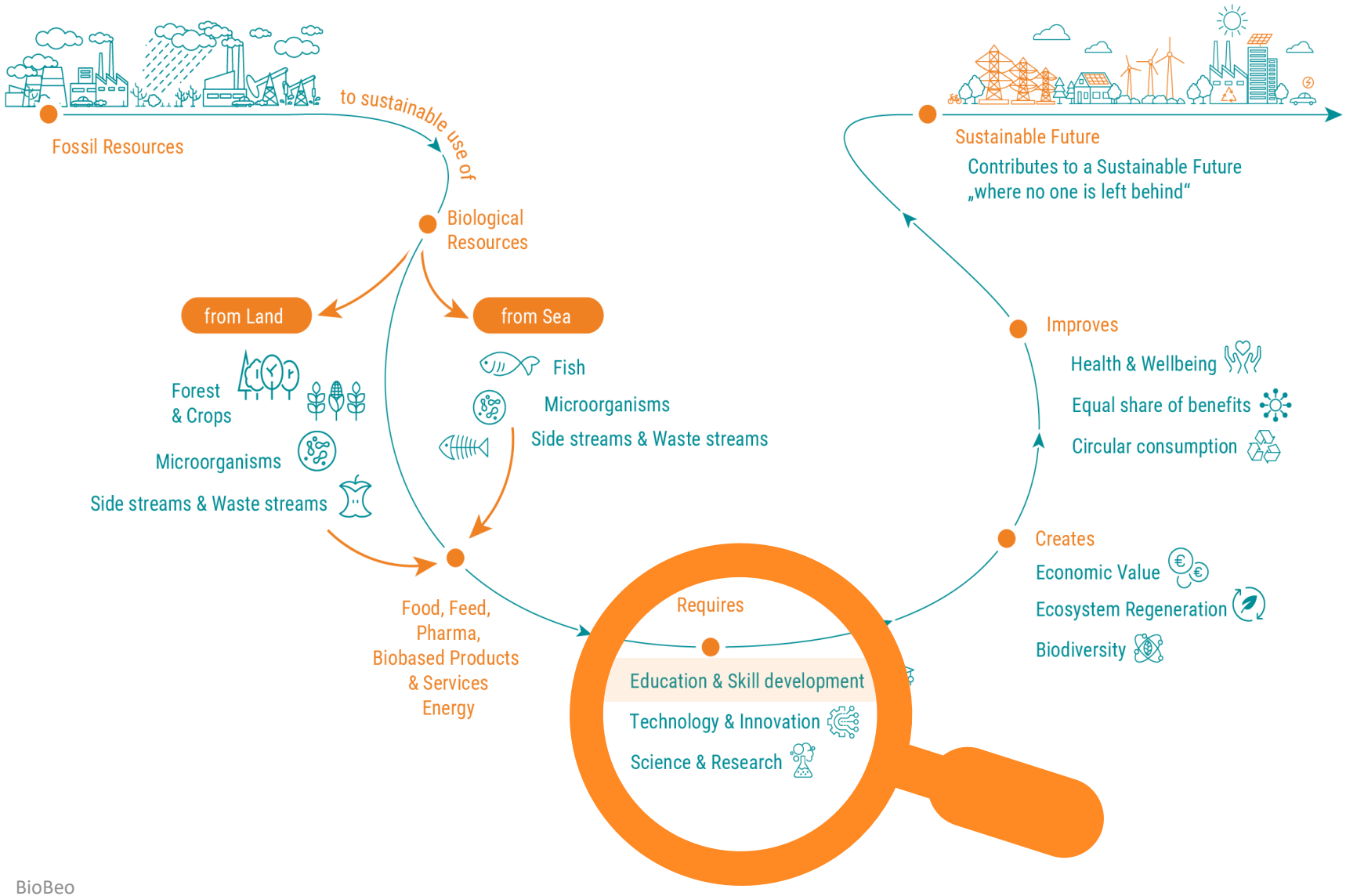
Biological knowledge is found across various scientific branches.

The bioeconomy makes use of biological knowledge to derive practical solutions and applications.

Aside of biological knowledge, the bioeconomy makes use of **nature-based solutions, ecosystem services and social & technical innovations** to improve the well-being of people across the globe.



The Bioeconomy – A Promising Solution!



The bioeconomy provides solutions to several global challenges. It is a systems-based approach that seeks to replace fossil resources in a sustainable manner with **renewable biological resources from terrestrial and marine ecosystems** to **produce food, feed, fibres, energy, bio-based products, and services within a circular economy framework** designed to optimise resource use based on a cascading hierarchy of utilisation options.

A sustainable and circular bioeconomy requires the application of education and training programmes as well as more scientific research and innovation. This way the bioeconomy may not only create economic value but also contributes to ecosystem regeneration, biodiversity and the well-being of society.

Through facilitating systemic changes, the bioeconomy contributes to a better and more sustainable future where no one is left behind.

Teaching the Bioeconomy

Examples for the integration of bioeconomy topics across different subjects.

The Current Status of Bioeconomy Teaching

Top-down introduction of novel educational content encounters barriers across countries

A stand-alone bioeconomy subject or a interdisciplinary competence area does not exist.

Teachers hence must take the responsibility to integrate bioeconomy content from a bottom-up perspective

Barriers related to introducing bioeconomy content into teaching

Legal barriers	Organisational barriers	Socio-cultural barriers
• Restriction connected to national curriculum frameworks • Compulsory subjects' constraints • Centralised decision-making processes • Bureaucracy Limited autonomy of schools • Assessment and examination standardization • Climate anxiety • Resource allocation and funding limitations	• Time-related barriers Infrastructure challenges • Barriers related to educational materials • Challenges in teacher capacities • Financial constraints	• Limited awareness and lack of acknowledgement • Cultural norms and values • Resistance to change and educational traditions • Climate anxiety

Biology

Teaching the Bioeconomy

Bioeconomy-related topics:

Species knowledge & Biodiversity
Environmental protection | Ecosystem services |

Food and nutritional science
Upcyclced Food | Healthy living | Personalised nutrition

Ecology & Plant physiology
Secondary plant compounds |

Biotechnology & Genetics
Fermentation | Genetic Engineering | Plant breeding

Microbiology & Life processes
Anaerobic digestion | Composting |

Sample lesson:

Acoustic Ecology
Age group: 10-12 Years

Studying the acoustic environment and so-called soundscapes can help making sense of the intricate ecosystems, that surround us. Within the field of acoustic ecology students get an idea of the many species in their environment and develop a sensitivity to the relationship between humanity and nature through the means of sound.

Learn more!

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Sample lesson:

Vegan cheese in under 10 minutes!

Age group: 12-14 Years

Through this experiment students learn to produce their own plant-based cheese. Plant-based cheese thereby stands representative for the wide range of novel plant-based foods and allows students to discuss advantages and disadvantages of plant-based and conventional food products in relation to their nutritional composition and healthy living. It also provides the entry-point for a discussion on upcycled foods.

Learn more!

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Anaerobic digestion | Composting |

Sample lesson:

Konrad‘s compost heap

Age group: 7-10 Years

In this app-based game elementary school students learn how to take proper care of a compost heap. By playing through several levels of increasing difficulty, they learn to distinguish which waste belongs onto a compost heap and which does not, while also exploring whether and how certain items can be reused. The game thus serves as an early introduction to the principle of circularity and highlights the potential of secondary resources for the bioeconomy.

Learn more!

Chemistry

Teaching the Bioeconomy

Bioeconomy-related topics:

Natural susbtances
Biomolecules | Bio-based chemicals | Secondary plant compounds

Energy & Chemistry
Sustainable energy production | Green hydrogen | Fuel cells | Biofuels

Plastics & synthetic materials
Fossil ressource replacement | Bioplastics | Recycling | Circular economy

Applied chemistry
Bio-based pharmaceuticals | biosurfactants | Upcycling

Separability of substances
Biocomposites | Recycling | Circular economy

Sample lesson:

DIY Biodiesel from cooking oil!

Age group: 13-16 Years

The students learn to make their own plant-oil-based biodiesel. Thereby they get a glimpse of how the bioeconomy can also support lower carbon energy generation, particularly for the transport sector. In the process the differences between biobased and fossil fuels can be explored and discussed.

Learn more!

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Sample lesson:

Create your own bioplastic!

Age group: 12-14 Years

Through this experiment students learn to produce their own starch-based bioplastics. Bioplastics thereby represent numerous other products produced from plants and other biomaterials. The students therefore learn to differentiate between fossil and biological production methods and can be incentivised to discuss the advantages and disadvantages of each.

Learn more!

Other STEM

Teaching the Bioeconomy

Bioeconomy-related topics:

Energy in Nature and Technology

Sustainable energy generation | Heating systems | Photovoltaics |

Products & Materials

Bio-based vs. fossil-based products | Characteristics of biomass |

Information processing

Biointelligence | Digital twins | Modelling

Product development

Sustainable manufacturing | Life cycle assessment | Process optimisation

Material cycles

Circularity & cascading use | Natural cycles |

Sample lesson:

Thermal properties of bio-based materials

Age group: 16+ Years

Students will model the heat transfer and the insulating efficiency of a set of chosen bio- and fossil-based materials. Thereby, they will be familiarised with practical knowledge regarding heat flow, while learning about the differences of bio- with fossil-based materials in regard to thermal conductivity.

Learn more!

Economics & Politcs

Teaching the Bioeconomy

Bioeconomy-related topics:

International relations
Bioeconomy strategies | Sustainable development | Place-based solutions

Economic policies
Sustainable economic growth | Externalities | True cost pricing |

Interplay between economy & culture
Economy vs. environment | Successful business models |

Global markets
Bio-based value webs | Fair trade | Resilient supply chains | Emission trading

Consumer attitudes
Demand for plant-based products | Purchasing behavior | Price formation

Sample lesson:

New ideas for a sustainable economy!

Age group: 16+ years

A sustainable bioeconomy has the potential to combine economic growth and environmental protection. However, many things need to be considered in order to ensure sustainable development. In a possible teaching unit, the students receive selected information about the bioeconomy and how it differs from the fossil-based economy and learn about the conditions that are important for its sustainable orientation. In this way, they develop subject-related expertise by linking different aspects of economic activity and relating them to each other, while also improving their methodological skills by using their newly acquired knowledge and developing their own product ideas in a self-organized manner.

Learn more!

Geography

Teaching the Bioeconomy

Bioeconomy-related topics:

Global challenges
Climate change | Land use | Globalisation | Resource scarcity

Resource management
Resource scarcity | Circular economy | Food security | Land grabbing

Urban living
City planning | Urbanisation | Marginalisation | Urban farming

Sustainable development
Sustainability | SDGs | Futures | Development cooperation

Ecosystems & Biosphere
Sustainable agriculture | Biodiversity | Ecosystem services

Sample lesson:

Local climate adaptation strategies

Age group: 13-16 Years

Focusing on the local level students are confronted with the question what climate change will look like in their own hometowns and what kind of adaptations are already in planning or would be needed. Therefore, students are tasked to analyse the local social and economic structures to identify stakeholders of interest, which feel the need for climate adaptation and would have the ability to make changes. The identified actors (e.g. local politicians, farmers, tourism employees) can then be interviewed according to their stances on the topic and eventually be aggregated.

Learn more!

Arts and Crafts

Teaching the Bioeconomy

Bioeconomy-related topics:

Design
Bio-based materials | Product design

Evaluation
Daily sustainability | Climate adaptation

Communication & interaction
"Green"- Communication | Sustainability in Advertisement

Architecture
Sustainable materials | Novel architectural concepts | climate adaptation

Fine Arts
Bio-based materials | Nature in Art

Sample lesson:

Sustainable construction

Age group: 13-18 Years

The class is introduced to the elements of sustainable construction. During the lesson a catalogue of materials and architectural elements, that qualify as sustainable will be created. Following these guidelines, students will then sketch their own designs for sustainable building projects.

Learn more!

Languages & Social Sciences

Teaching the Bioeconomy

Bioeconomy-related topics:

Socio-cultural orientation knowledge

Climate change | Globalisation | Human rights | Resource conflicts | Individual in nature

Intercultural communicative competences

Global perception of climate change | Cultural heritage vs. Innovation | Traditional knowledge

Functional Communicative competences

Bioeconomic topics as source material for mediation, reading & listening comprehension

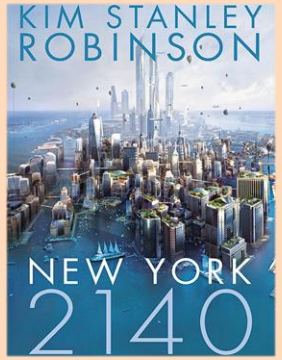
Text & Media Competence

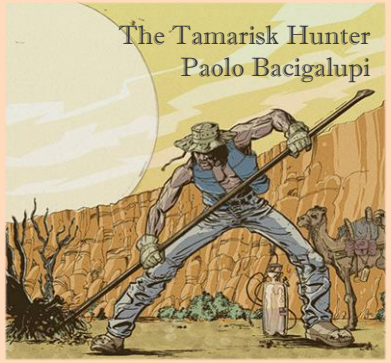
Climate Fiction | Utopian Fictions | Future Scenarios

Sample lesson:

Climate Fiction

Age group: 12-17 Years





Part of the challenge of climate change is that the apocalyptic consequences of our carbon use are emerging slowly and globally, rather than in a single newsworthy disaster, making it difficult to muster the vision and motivation to fight it. Fiction exploring the possibilities of a changed and changing climate can be a powerful way to make these abstract futures more immediate for students. These texts could be used for whole-class reading and could enrich a larger unit on climate change or lead to students researching and creating their own artistic explorations of futures altered by climate change, allowing the discussion of the bioeconomy as a means to a sustainable future.

Learn more!

Subject-independent Materials

Teaching the Bioeconomy

Resource Don‘t Go!

A **bioeconomy education boardgame** developed at the University of Hohenheim in order to give students, teacher and other interested parties playful insights into the possibilities and challenges of a sustainable and circular bioeconomy.

- Suitable for all age groups.
- Adjustable difficulty level
- Individual or team play
- Learners can co-create the game by develop their own playing cards.

Learn more and download here!

Subject-independent Materials

Teaching the Bioeconomy

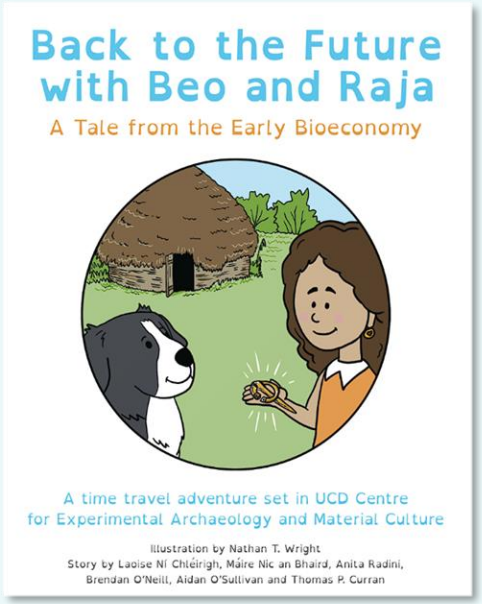
BioBeo Animated Storytelling Video Series

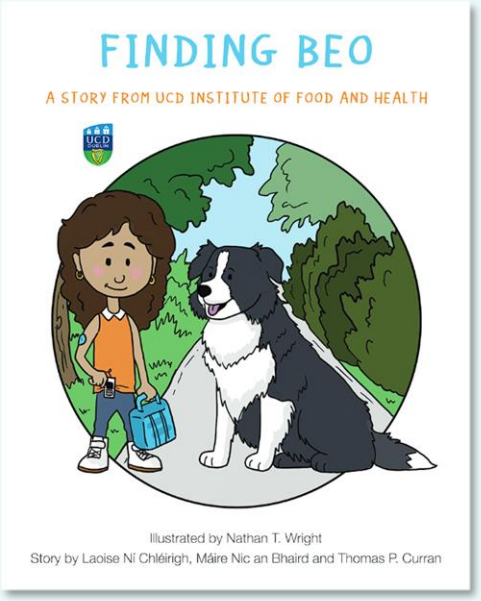
Through fun and engaging animations, the animated storytelling videos introduce the concept of the bioeconomy and illustrate how we can all participate in creating a sustainable world and fostering the understanding of environmental stewardship, innovation, and circularity.

Watch here!

BioBeo Comic Series

The BioBeo comics offer easy pathways into all the aspects, that constitute up the bioeconomy and allow a retrospective look at what a bioeconomy looked like in the past, highlighting the significance of traditional knowledge





Read & Download here!

Bioeconomy Textbook

The starting point for teachers interested in learning and teaching about the bioeconomy.

https://doi.org/10.1007/978-3-319-68152-8

Bioeconomy.de

The bioeconomy science communiation platform that allows you to stay up-to-date on all recent developments

https://biooekonomie.de/en

BIOÖKONOMIE DE

Bildungsbissen

Digital learning units on plants as a renewable resource (available in German only).

https://bildungsbissen.de/s2/home

BildungsBissen

Bloom School Box

Collection of bioeconomy related teaching resources.

bloom

https://bloom-bioeconomy.eu/schoolnetwork/schoolbox/

BioBeo

Learn more about BioBeo and all its resources:

www.biobeo.eu

Let’s explore some real live bioeconomy research!

What are your innovative ideas to teach about the bioeconomy?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RAIBH MAITH AGAT
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