Technische Universität Braunschweig

# BRICS

Braunschweig Integrated Centre of Systems Biology

*Understanding Health*

## BRICS – Braunschweig Integrated Centre for Systems Biology:

BRICS is an interdisciplinary and internationally oriented research centre for systems biology. We want to understand health to fight diseases better.

To achieve this, we are part of the Core Research Area **"Engineering for Health"** at the Technische Universität Braunschweig. We also have strong research institutions as cooperation partners and supporting organisations:

- the Technische Universität Braunschweig,
- the Helmholtz Centre for Infection Research (HZI),
- the Leibniz Institute DSMZ – German Collection of Microorganisms and Cell Cultures GmbH and
- the Physikalisch Technische Bundesanstalt (PTB).

## BRICS – Understanding Health

BRICS stands for the **Braunschweig Integrated Centre for Systems Biology**. Our goal is to understand health. To achieve this goal, as our name reflects, we primarily use systems biology methods by which biological systems can be completely determined and analyzed.

With the knowledge of health, we investigate the molecular causes of diseases, such as infections or neurodegenerative diseases. The causes of diseases are of interest because they are the basis for developing new treatments. We are working on these together with our partners in Braunschweig and worldwide.

## A systems biological look at cells

At BRICS, we want to gain a holistic understanding of biological cells. Systems biology can fully capture all important components of a cell – from DNA to complex proteins – and analyse their interactions.

For example, we use systems biology to clarify what genes an organism has and which of these genes are active and when. We also examine what proteins a cell produces and how they influence its metabolism: **if we understand in detail how a cell works, then we know exactly what constitutes health.**

When we know exactly what to look for and where to look inside the diseased cells, we can pinpoint the defect at the molecular level that triggers the disease.





## Explaining host–pathogen interactions with systems biology

The metabolism of a cell can be studied and described down to the smallest detail using systems biology. This allows us to understand diseases better than in the past – including infectious diseases.

An important aspect is the interplay between bacteria or viruses and the infected organism. By identifying the proteins of a pathogen and how these proteins interact on the surface of a host cell, we can look for weak points in the molecular structure of the bacterium or virus and use this knowledge to develop new treatments.

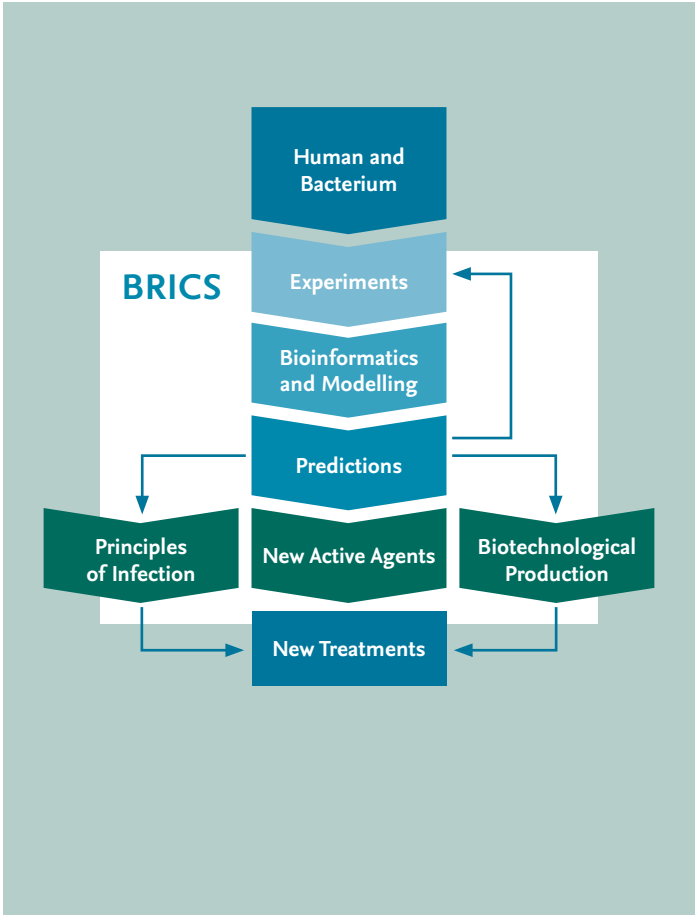
Systems biology continues to help in this regard: researchers at BRICS use it to modify the metabolism of beneficial bacteria to produce potential active agents with high efficiency.

## Metabolome research – gaining an overview of metabolism

The immune system and its metabolic processes play a decisive role in health. To measure the products of metabolism – the metabolites – inside immune cells, the researchers at BRICS use mass spectrometry. Every substance that occurs as a part of this metabolism can be detected individually.

**The scientists use tracing methods involving stable isotopes to precisely follow the pathways of the metabolites** – a technique that is especially far advanced at BRICS and which is in high demand from many cooperation partners.

In mass spectrometry, the metabolic products are identified by their characteristic mass. It is also possible to quantify the amounts of the substances of interest inside the cells. With these methods, the BRICS researchers are gaining a complete overview of the metabolism in healthy and sick immune cells.



## Technology development: pushing the boundaries of research

At BRICS, we have the expertise to develop highly complex experimental technologies. In microscopy, for example: scientists of BRICS Biophysical Chemistry have combined various methods of microscopy with laser technology.

Thus, the researchers can stimulate living neurons at precisely defined points only about 200 nanometres in size (a little bit bigger than a coronavirus) and then observe in real time how the triggered signal propagates.

**This allows them to better understand how neurons communicate with each other.** Such knowledge is the basis for understanding neurodegenerative diseases such as Alzheimer's or Parkinson's disease.





## Microscopy against Alzheimer's disease

Alzheimer's and Parkinson's disease are still incurable. BRICS is investigating the scientific principles for future treatments against these and other neurodegenerative diseases.

Proteins play a major role – especially protein folding. Protein misfolding can cause a disease.

The researchers at BRICS are using various methods of laser microscopy to gain a precise understanding of protein folding and misfolding. Furthermore, they have developed their own new experimental methods where they focus lasers on a cell. By inducing temperature jumps, they simulate a fever – and use laser microscopy to observe how the newly formed cell proteins fold: in the right or wrong way.

## Microbiology – from natural substances to industrial production resources

Bacteria are pathogens, but not all of them. Some bacteria are of great benefit to us. They can produce substances that are important for manufacturing active pharmaceutical ingredients (APIs). As an example, we are working with enzymes that can be used to produce new antibiotics.

It takes many developmental stages before bacterial enzymes can be used to manufacture APIs: the enzyme has to be active, stable, long-lasting and storable. The microbiologists at BRICS are working, among other topics, on giving microbial enzymes and other substances the desired properties that make pharmaceutical production possible.





## Biochemical engineering: understanding the microcosm of the gut

The human gut is a highly complex bioreactor: certain bacteria – the so-called microbiome – make the ingredients of our food usable for us.

**Researchers at BRICS have developed a tube bioreactor system as a model of our gut**. A nutrient solution flows continuously through the reactor at the same slow pace as through a human gut. Inside, it can be adjusted to body temperature, there is no atmospheric oxygen and the peristalsis of the gut is also simulated. Furthermore, the researchers can take water and content samples from the system at any time.

The system is relevant in studying the actions of antibiotics, for example: are the drugs harmful to the gut bacteria? Or: what do infectious agents do to the microbiome? With the help of this tube bioreactor system, the BRICS scientists can better understand the microcosm of our gut, its health and the diseases that originate from there.

## Bioinformatics – essential to the systems biological approach

In order to understand health, scientists at BRICS use many different investigative methods. All of them produce large amounts of data. This is necessary because the aim of the systems biology approach is to determine and learn as much about the living cell as possible.

**The role of bioinformatics at BRICS is to bring the data from different laboratories together, to structure and to store the data and finally to analyse them bioinformatically.** The researchers look for patterns that indicate whether a cell is healthy or not. Specific patterns can be used to diagnose certain diseases and identify therapeutic agents.

This makes BRICS a centre of expertise that builds a bridge from understanding health to finding new treatment approaches.





## Young talent promotion at BRICS

As important as our focused research is the training of young scientists. **Accordingly, we supervise bachelor's, master's and PhD students from different countries at BRICS.**

Of course, we also support young researchers on their way to becoming professors. We have already established several junior professorships at BRICS.

## Contact

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