

## Tübingen

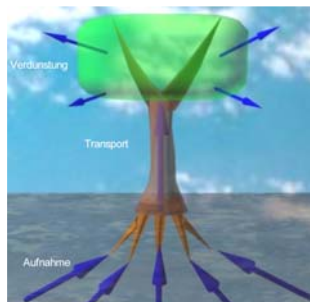
### Profile



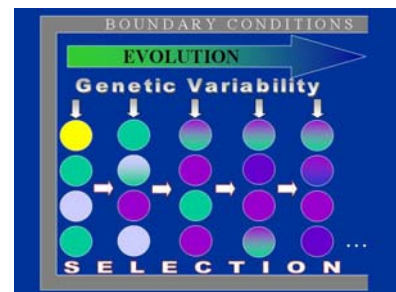
The project group *Functional Morphology and Biomimetics* at the Institute for Geosciences (IFG), University of Tübingen, focuses on all aspects and the biomimetic applicability of fluid movements in and around plants. These comprise mass flow, heat flow, diffusion and interfacial effects. The aim is to reveal an integrated form-function analysis of the considered process. Numerous national and international research collaborations were established with regard to these research topics. The project group *Functional Morphology and Biomimetics* is a member of the competence network *BIOKON* and of the Baden-Württembergian “Competence Network Biomimetics” (together with the University of Freiburg and the Institute of Textile and Process Engineering Denkendorf – ITV).

### Approaches to Bionics

Bionics in Tübingen is rooted in analyses of biological form-function relationships which are the result of evolutionary processes. Evolution leads to optimum solutions of functional problems, because on one hand the reproductive success of organisms increases with increasing functional performance. On the other hand evolution has to be based on pre-existing structures which leads to functional changes of biological structures or to the adding of new functions. Intense and dynamic environmental pressures enhance the selective forces leading to evolutionary optimization. In this manner, evolution can give rise to “unexpected” technical solutions. An example is water transport in plants which is based on negative pressure: the water is subject to mechanical tension in the transport tissue. Water is thus not pumped through the plant but pulled upwards. A thorough analysis of the underlying biophysical principles of such counter intuitive biological techniques is expected to yield numerous innovative technical effects.



Water transport in plants – a counter intuitive mechanism generated by evolution.

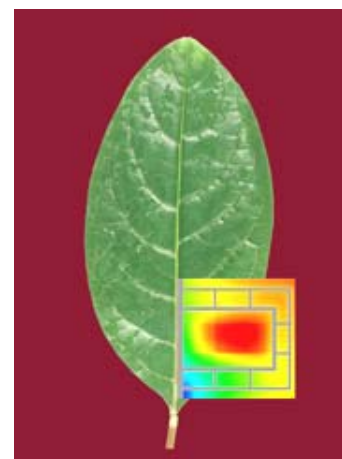


The process of evolution, based on natural selection and the genetic variability of the individuals.

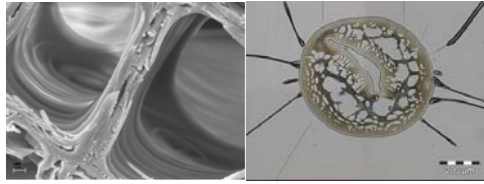
### Research and development projects in bionics

Besides detailed anatomical studies of the biological objects, current techniques especially comprise mathematical modelling and computer simulations of the considered processes. These approaches are very suitable for studying biological fluid flow phenomena on the micrometer/nanometer scale – a level which is expected to be very promising with regard to innovative form-function relationships. Results of the biological research with respect to underlying biophysical principles of the organismic function thus represent the fundamental basis for the approaches in bionics.

Current biomimetic projects are based on water flow through plants. The aim is to construct innovative technical textiles. Water transport in plants is unique, because plants are able to maintain an intense mass flow of water through the wood without expending energy. The water is then subject to mechanical tension. Numerous adaptations and structural devices are able to allow for the stability of the water column under tension. These mechanisms are analyzed in order to transfer the principles of plant water



Simulation of the water pressure inside the venation of a leaf.

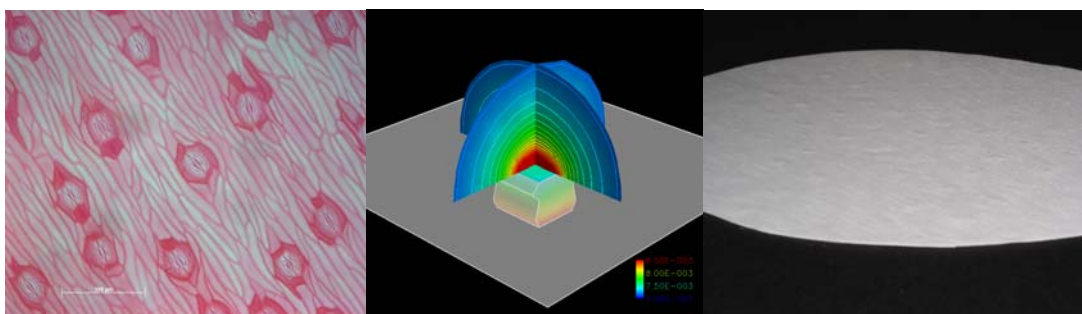


SEM-picture of water conduits of a plant and a technical fibre which is part of the bionic concept.

transport into concepts for technical textiles with long-distance transport function of low-viscous fluids (in co-operation with the ITV Denkendorf and the University of Freiburg). Current laboratory models comprise structures consisting of various technical fibres (ITV Denkendorf).

Another project considers the process of water vapour diffusion through the plant surface. Water vapour diffuses through pores, termed as stomata. These pores are able to close or open according to the level of water supply.

Exploring suitable methods for transferring this biological self-regulating system into a technical construction serves for the construction of membranes and fabrics with self-controlled gas permeability (in co-operation with the ITV Denkendorf). This concept is interesting for many products in which a controlled gas permeability is beneficial.



Stomata (pores on the plant surface), simulation of their diffusive capacity and first prototypes of the bionic application.

## Study courses and professional training

At the Institute for Geosciences, University of Tübingen, all aspects of evolution and biological form-function relationships are considered in lectures and seminars. The concepts of bionics represent an increasing part of the curriculum. Additionally, members of the project group *Functional Morphology and Biomimetics* give lectures and courses in bionics and biomimetics at other institutions.

## Contact

For further information, please contact:

**Dr. Anita Roth-Nebelsick**  
 Project Group *Functional Morphology and Biomimetics*  
 Institute for Geosciences  
 Sigwartstr. 10  
 D-72076 Tübingen  
 Germany  
 Phone: +49 (0)7071-2973561  
 Fax: +49 (0)7071-295217  
 E-mail: [anita.roth@uni-tuebingen.de](mailto:anita.roth@uni-tuebingen.de)