

Why-questions in functional biology

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Functional biology

- How-questions
- Proximate causes
- Decoding of genetic program
- Reductionistic

Evolutionary biology

- Why-questions
- Ultimate causes
- Origin of genetic program
- Historical

Ultimate causes are the source of biology's autonomy

My claims

- Functional biologists address why-questions in addition to how-questions
- Functional explanations have a nonreductionist character
- Functional explanations make sense of organisms without considering their history
- The source of biology's autonomy is complexity

Why-questions in functional biology

- Introduction
- Different issues in functional biology
- Two types of function
 - function as biological role
 - function as biological advantage
- Functional explanation
- Conclusions

Tinbergen's four why's

- Immediate causation
- Function / survival value
- Development
- Evolution

Six issues with regard to the form and activity of an item or behaviour

- Description
- Biological role (function)
- Individual level causes and mechanisms
- Biological value (functional explanation)
- Development
- Evolution

Tinbergen versus Wouters

- Immediate causation
 - **Function**
 - Development
 - Evolution
- Description
 - **Biological role**
 - Causes and mechanisms
 - **Biological value**
 - Development
 - Evolution

Important distinctions

- function as biological role / function as biological advantage
- ‘what is the function?’ / ‘why does *o* have an *i*?’
- specifying a function / giving a functional explanation

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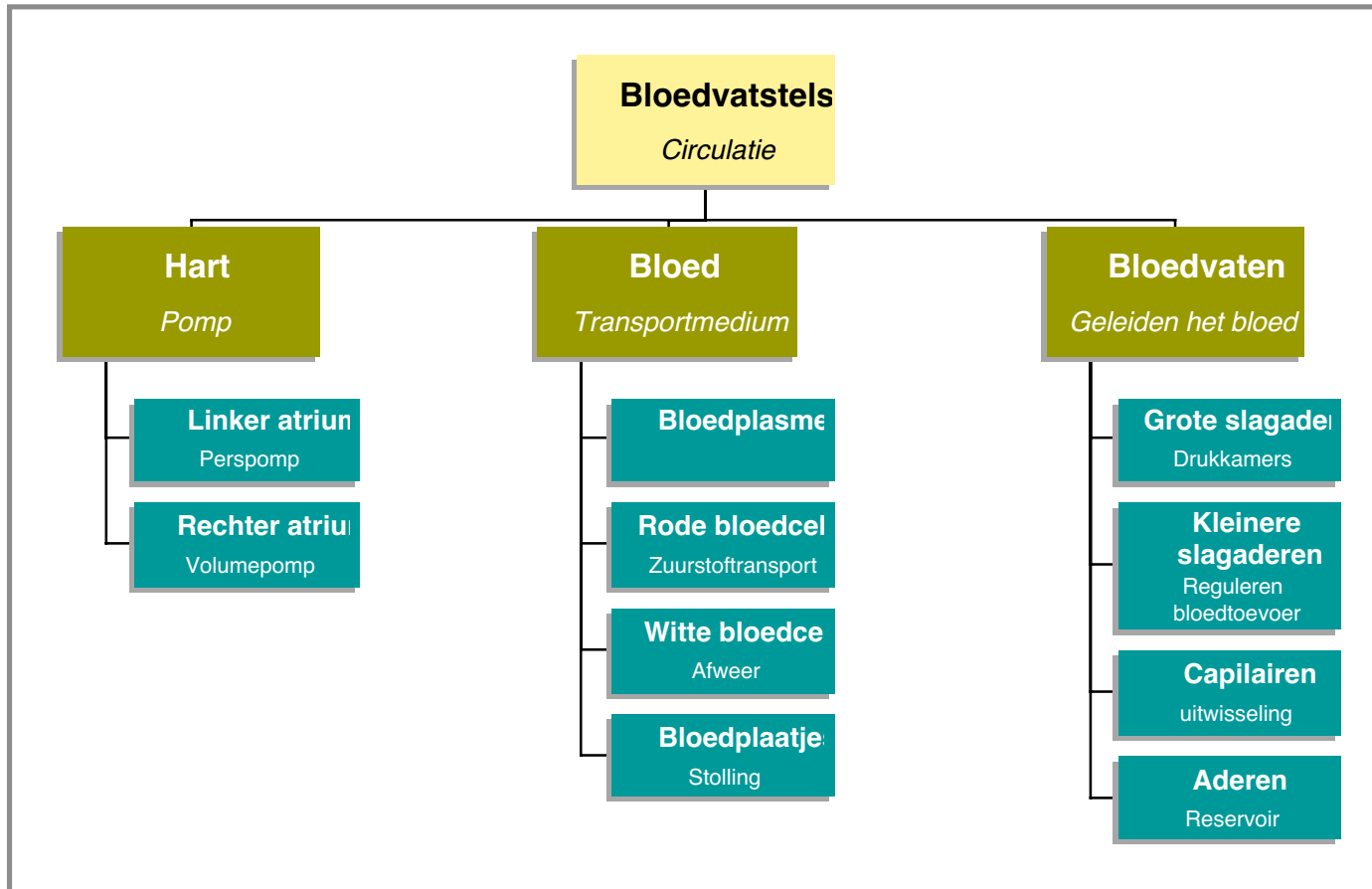
Function as biological role

The role of an item / activity is the manner in which that item / activity contributes to the activity of a complex system

Nagel (1961), Cummins (1975), Boorse (1976), Craver (2001)

Examples biological role

- The lungs have the function of gas exchange
- Some functions of the circulatory system are to transport oxygen, carbon dioxide, nutrients and heat.
- The heart propels the blood



Function as biological advantage

How a trait effects that the fitness of its bearers is higher than the fitness of hypothetical organisms in which this trait is replaced by another one would be

Examples function as biological advantage

- An advantage of the presence of a circulatory system is that oxygen is transported much faster by means of convection than by means of diffusion alone
- An advantage of the increased surface area of gills and lungs is that it increases the amount of oxygen intake in a certain amount of time

Advantages are comparative

- To find an advantage of trait *a* relative to *b* an organism (with *a*) is compared to a hypothetical organism in which *a* is replaced by *b*
- The organism with which the real organism is compared need not be real

v is an advantage of a relative to b

- v is something that is different in organisms with a than in organism in which a is replaced by b
- that difference is the result of the replacement
- due to this difference, organisms with a have better life chances than organism in which a is replaced by b

Role and value

- The advantages of an item / activity having a certain character are often assessed in relation to the biological role of this item
- The role of an item provides a tacit fitness criterium
- The value is external to the role

Role vs. Advantage

- **Role**

- items / behaviours
- absolute
- position in an organization
- empirical generalisation

- **Advantage**

- traits
- comparative
- value
- law-like

Biological role is central

- Position / task of an item
- Mechanistic explanations
- Design explanations
- Selection explanations

- **Mechanistic explanation**

How does a Vertebrate transport oxygen?

- **Functional explanation (design explanation)**

Why does a Vertebrate need to transport oxygen actively?

- **Selection explanation**

How did the circulatory system evolve in the course of Vertebrate history? Why did it do so?

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Functional explanation

- Why does this organism have this item / performs this activity?
- Why does this item / activity has the character it has?

Structure of design explanaton

- 1) What is the biological role of this item / activity?
- 2)
 - a) Why does the organism need to perform this role?
 - b) Why is the role performed in the way in which it is performed rather than in some alternative way?

Fick's law of diffusion

$$J = -D A \Delta C / \Delta x$$

Nature of functional explanation

A functional explanation shows how a trait of an organism functionally depend on other traits of that organism

For example: living on land is functionally dependent on having lungs

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Proximate (Mayr)

Ultimate (Mayr)

Functional explanation

proximate causes

ultimate causes

utilities

functional biology

evolutionary biology

functional biology

how

why

why

reductionist

historical

holistic

decoding genetic program

history genetic program

relations parts /
behaviour /
environment

how things work

how / why things
evolved

how things hang
together

experimentation

comparison

comparison /
experimentation /
calculation

Causes

Interdependencies

Individual

Mechanisms &
development

functional
explanations

Lineage

evolution

Conclusions

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