IDEM
Immunity, DEvelopment and the Microbiota
Understanding the continuous construction of biological identity

ERC Starting Grant
Thomas PRADEU
Underlying philosophical problem

Biological identity
- Individuality
- Sameness ("diachronic" identity)
Biological identity
Immunology

Evolution

Biological identity

- Hull (1980), Individuality and Selection
- Sober (1991), Organisms, Individuals and Units of Selection
- Okasha (2006), *Evolution and the Levels of Selection*
- Godfrey-Smith (2013), Darwinian Individuals
- Clarke (2013), The Multiple Realizability of Biological Individuals

Pradeu & Carosella (2006), The Self Model and the Conception of Biological Identity in Immunology
Pradeu (2010), What Is an Organism? An Immunological Answer
Pradeu (2012), *The Limits of the Self: Immunology and Biological Identity*
PI’s earlier work on this subject

- Historical and conceptual analysis of the **self-nonself** framework.
- **Inadequacy of the self-nonself framework.**
  - Immune *tolerance*, in particular to microbiota.
  - A mammalian: 90% of bacterial cells.
PI’s earlier work on this subject

• Crucial role played by the immune system in the **delineation of the organism’s boundaries**.

• A new framework: the “**discontinuity theory**”


➢ **Philosophy of science can change science.**
Biological identity as a composite reality

=> Every organism hosts huge quantities of foreign entities, which are actively tolerated by its immune system. Every organism is a ‘holobiont’ (Gilbert, Rosenberg)
What is the exact influence of these microbes on host development and physiology, and to what extent does it change our conception of biological identity?
Biological identity must be understood at the interface between microbiology, immunology and development

- Decisive influence of the microbiota on host development
- Decisive influence of the microbiota on host physiology
- Critical involvement of the immune system in the development of the organism

Sommer & Bäckhed (2013), The gut microbiota: Masters of host development and physiology, Nature Reviews in Microbiology.
McFall-Ngai et al. (2013), Animals in a bacterial world, PNAS.

• => Every organism is constructed and maintained through the continuous and regulated integration of foreign biotic entities.
Host development can depend on microbes

- Development of isolated lymphoid follicles (ILFs) in the mouse gut.
- Development induced by the microbiota, which activates host genes.

Bouskra... Eberl, *Nature*, 2008
The microbiota, an organ of the body

- Major functional roles: digestion, immunity, development.
- Abnormal gut microbiota composition is linked to pathologies

**Obesity** (Turnbaugh et al., *Nature*, 2006)

**Stress**: germ free mice display increased motor activity and reduced anxiety (“careless”); return to normal state if colonized early by appropriate gut microbiota. (Heijtz et al., *PNAS*, 2011)
A. Identity, internalism and externalism in the biological sciences

B. Disentangling the causes of development

C. The “holobiont” and its construction through the integration of microbes

D. The role of the immune system in the maintenance and construction of the organism

PhD1

PD1

PD2

PhD2+PD3
IDEM Methodology

- Collaborations with scientists: **active interdisciplinarity**
- PhDs & PDs: double background in philosophy and biology
- **6 months in a partner scientific lab**:

<table>
<thead>
<tr>
<th>PD1</th>
<th>Causality of development</th>
<th>Development lab, Villefranche-sur-Mer</th>
<th>E. Houliston</th>
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</thead>
<tbody>
<tr>
<td>PD2</td>
<td>Holobiont</td>
<td>Microbiology, Institut Pasteur, Paris</td>
<td>G. Eberl</td>
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<tr>
<td>PD3+PhD2</td>
<td>Immunity &amp; construction</td>
<td>Centre for immunology, Marseille</td>
<td>E. Vivier</td>
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<tr>
<td>PhD1</td>
<td>Internalism/Externalism</td>
<td>Centre for immunology, Bordeaux</td>
<td>J-F. Moreau</td>
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<tr>
<td>PI</td>
<td>All sub-projects</td>
<td>Centre for immunology, Bordeaux</td>
<td>J-F. Moreau</td>
</tr>
</tbody>
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- Participation in lab activities and experimental designs.

Experiments → Results → Interpretation

Philosophy of science
An international network of external experts

Biological identity (philo)

Microbiology
Margaret McFall-Ngai (Wisconsin)
Eric Bapteste (Paris)
Rob Knight (Colorado)

Immunology
Eric Vivier (Marseille)
Gérard Eberl (Institut Pasteur, Paris)

Developmental biology
Scott Gilbert (Pennsylvania)
Evelyn Houlston (Villefranche-sur-Mer)
Alessandro Minelli (Padova)

John Dupré
Maureen O’Malley
Peter Godfrey-Smith
Alan Love

Julie Dechanet & Jean-François Moreau
(Bordeaux)
IDEM’s impact

On biology
- New concepts, theories, experimental designs

On philosophy of biology
- Biological identity and individuality
- Philosophy of biology beyond evolution only
- Articulation biology-medicine

On philosophy of science
- Practice that can modify science

On general philosophy
- Identity in metaphysics: e.g., substantialism (Wiggins 2001)
Impacts the understanding of ourselves in our societies

“I can tell you the exact date that I began to think of myself in the first-person plural – as a superorganism, that is, rather than a plain old individual human being” (‘Some of my best friends are germs’. New York Times, May 15, 2013).
Output of IDEM project

- Publications in leading journals (both in philosophy of science and science)
- Interdisciplinary contributions to international conferences
- Outreach (public conferences, popular press and books)
- Four workshops
- Dedicated website
- Final conference
- Including about an ERC priority at the interface between humanities and medicine: “Personalizing health and care”
- Training of students