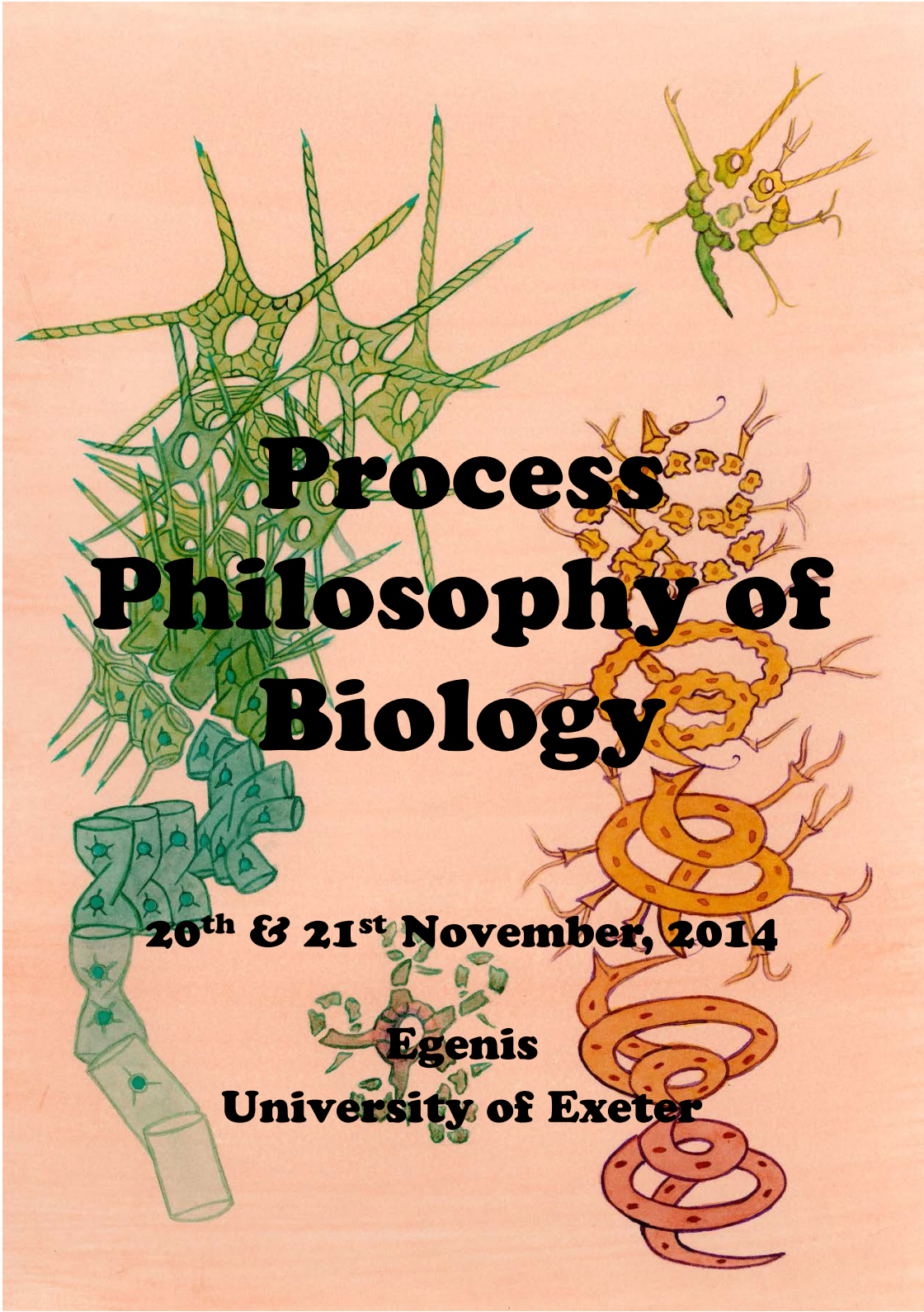

Process Philosophy of Biology

20th & 21st November, 2014

Egenis

University of Exeter

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Workshop Program

- 20th November: Process Philosophy

09:00 – 09:30	Registration & coffee
09:30 – 10:10	**John Dupré** (*Exeter*): "Living Systems: Processes or Things?"
10:10 – 10:50	**Peter Simons** (*Trinity College Dublin*): "Processes, Precipitates, and Participants"
10:50 – 11:30	**Johanna Seibt** (*Aarhus*): "Biological Process Architectures and Their Artificial Simulations: Ruminations on Process-Ontological Structuralism"
11:30 – 12:00	Coffee break
12:00 – 12:40	**Anne Sophie Spann** (*Innsbruck & Exeter*): "Persons as Biological Processes: Towards a Bio-Processual Way Out of the Personal Identity Dilemma"
12:40 – 13:20	**Karola Stotz** (*Macquarie*): "A Non-Essentialist Process View of Human Nature"
13:20 – 14:20	Lunch break
14:20 – 15:00	**Thomas Pradeu** (*Bordeaux & Sorbonne*): "Genidentity and Biological Processes"
15:00 – 15:40	**Stephen Mumford** (*Nottingham*) & **Rani Lill Anjum** (*NMBU*): "A Process Theory of Causation"
15:40 – 16:20	**Dan Nicholson** (*Exeter*): "Mechanisms as Abstractions of Biological Processes"
16:20 – 16:50	Coffee break
16:50 – 17:30	**James DiFrisco** (*Leuven & Exeter*): "Time Structure in Cellular Processes"
17:30 – 18:30	General discussion

- 21st November: <u>Process Biology</u>

09:00 – 09:40	**Paul Griffiths** (*Sydney & Exeter*): "How DST became a Process Theory"
09:40 – 10:20	**Flavia Fabris** (*La Sapienza & Exeter*): "Beyond Waddington's Epigenetics: Canalization and Adaptive Plasticity"
10:20 – 10:40	<u>Coffee break</u>
10:40 – 11:20	**Denis Walsh** (*Toronto*): "Methodological Vitalism: Agency, Emergence, and Evolution"
11:20 – 12:00	**Frédéric Bouchard** (*Montréal*): "Symbiosis, Transient Biological Individuality, and Evolutionary Processes"
12:00 – 12:40	**Eric Bapteste** (*Pierre and Marie Curie University*): "Intersecting Processes in Evolutionary Biology: From 'Chunks of Trees' to 'Chunks of Networks'"
12:40 – 13:30	<u>Lunch break</u>
13:30 – 14:10	**Pierre-Olivier Méthot** (*Laval*) & **Staffan Müller-Wille** (*Exeter*): "Are Diseases 'Things' or 'Processes'?"
14:10 – 14:50	**Marta Bertolaso** (University *Campus Bio-Medico*): "Robustness as Dynamic Coupling of Biological Processes: Learning from the Biology of Cancer"
14:50 – 15:10	<u>Coffee break</u>
15:10 – 15:50	**James Wakefield** (*Exeter*): "Processes, Pathways, and Mechanisms in Cell Biology"
15:50 – 16:30	**Stephan Güttinger** (*Exeter*): "IDPs: 'Intrinsically Disordered Proteins' or 'Intriguing (but) Dispensable Processes'?"
16:30 – 17:10	**Ann-Sophie Barwich** (*KLI & Exeter*): "Evo-Devo and Olfaction: Developing Process Categories for Perception"
17.10 – 17.30	<u>Coffee Break</u>
17:30 – 18:30	General discussion

Participant Names and Contact Details

John	Dupré
Peter	Simons
Johanna	Seibt
Anne-Sophie	Spann
Karola	Stotz
Thomas	Pradeu
Stephen	Mumford
Rani	Anjum
Dan	Nicholson
James	DiFrisco
Paul	Griffiths
Flavia	Fabris
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Frédéric	Bouchard
Eric	Bapteste
Pierre-Olivier	Méthot
Staffan	Müller-Wille
Marta	Bertolaso
James	Wakefield
Stephan	Güttinger
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Gemma	Anderson
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Jane	Calvert
Giovanna	Colombetti
Gregor	Halfmann
Tarquin	Holmes
Andy	Jones
Caglar	Karaca
Jim	Lowe
Thibault	Racovski
Brian	Rappert
Michael	Schillmeier
Helen	Steward
Niccolo	Tempini

Living Systems: Processes or Things?

John Dupré *(Exeter)*

This talk will address an ancient and fundamental ontological issue in biology, whether the living world should be thought of as a hierarchy of objects, or rather as composed of processes, and thus as essentially dynamic. I shall spend some time attempting to clarify the question. What is the difference between a thing and a process? Does a process require a thing, or things to which it happens? I also propose to reflect on the status of this question, and the kinds of ways we might attempt to address it. Is it an empirical question, to be answered by the progress of science, or at least by philosophical reflection on the progress of science? Or is it something that might be answered by a priori reflection? Might the question be partly normative? Finally, does it matter? Does it matter to science how we resolve this kind of ontological issue?

Processes, Precipitates, and Participants

Peter Simons *(Trinity College Dublin)*

At first sight, biology appears to be about things: organisms. Then it also appears to be about the processes in which they and their parts are involved as participants: reproduction, growth, respiration, hibernation, migration, interaction, selection, adaptation, evolution. The deeper one goes, the more processes seem to matter: mitosis, meiosis, catabolism, anabolism, and so on. Yet at each stage we are confronted with the same dichotomy of things and the processes in which they are involved, down to molecules and their reactions. Is it possible to conceptualise a metaphysically superior revisionist biology in which everything basic is processual, without losing touch with the things of standard biological discourse? Following ideas of Whitehead, we argue that it is, understanding things at different levels of granularity as the precipitates of processes, so construing the whole organic sphere as *au fond* processual. Some interesting and perhaps unsettling implications are drawn.

Biological Process Architectures and Their Artificial Simulations: Ruminations on Process-Ontological Structuralism

Johanna Seibt *(Aarhus)*

General Process Theory (GPT) is a monistic process ontology that offers some straight-forward descriptive tools to articulate a large variety of complex dynamic architectures ('mechanisms', positive and negative feedback, self-maintenance, recursive self-maintenance). The descriptive power of this ontology hinges on a conception of processes as non-particular individuals, and the insight that such individuals are characterized by finite and context-relative mereological partitions. The overall effect of this shift from particular to non-particular individuals is a built-in structuralism of sorts that is more palpable than in other process-ontologies, e.g., Whitehead's philosophy of organism in Process and Reality. Do process-ontologies in general, and GPT in particular, erase the distinction between 'real' and 'simulated' processes? I argue that this is not the case.

Persons as Biological Processes: Towards a Bio-Processual Way-Out of the Dilemma of Personal Identity

Anne Sophie Spann *(Innsbruck & Exeter)*

Traditional attempts to account for the fairly obvious fact that persons persist over time remain unsatisfactory. While reductionist ('complex') theories tend to ultimately eliminate personal identity by reducing it to merely gradual relations of continuity, non-reductionist ('simple') theories which propagate the ontological primitiveness of personal identity end up in turning it into a transcendent, non-analysable mystery. The first task pursued in my talk is to show that this dilemma is directly connected to the 4D/3D controversy together with the antagonism between two opposing models of what persons are. Reductionist theories usually presume that persons are composed of various temporal parts such that their persistence is just a derivative function of this composition. In contrast, non-reductionist theories take persons to be enduring substances that move as wholly present entities through time and whose numerical identity is presupposed as a primitive fact, prior to and unaffected by any temporal determinations. I then, secondly, wish to draw attention to a striking similarity between these apparently quite distinct approaches: namely that both delete real change from the metaphysical picture of reality. I will argue that a convincing account of personal identity is missed exactly to the extent that a convincing theory of change as a real and essential ingredient of persistence, personal or non-personal, is missed. Having thus identified an inherent affinity to a static thing ontology as ultimately responsible for the failure of the reductionist and non-reductionist theories of personal identity available at the market, I finally shall sketch how a bio-processual conception of persons as dynamical systems may bail us out.

A Non-Essentialist Process View of Human Nature

Karola Stotz *(Macquarie)*

In the light of current biological knowledge any scientifically credible conception of human nature must leave behind the folk-biological idea of an inner essence that makes us what we are. The psychological, social and behavioral sciences need to take up this challenge and assimilate both their own findings and the results of the biosciences with a new and very different conception of human nature. To understand human nature is to understand the plastic process of human development. Drawing on the framework of 'developmental systems theory' wedded to the idea of developmental niche construction I argue that human nature is not embodied in one input to development, such as the genome, and nor is it relevant only to universal or typical characteristics. Both similarities and certain classes of differences are explained by a human developmental system that reaches well out into the 'environment'. This paper grounds the process of development in mechanisms of extended inheritance to make explicit how an organization of reliable developmental factors embodied by the so-called developmental niche can shape the developmental system of brain, body, and its environment.

Genidentity and Biological Processes

Thomas Pradeu *(Bordeaux & Sorbonne)*

The concept of genidentity has been suggested by psychologist Kurt Lewin (1890-1947) and then further explored by philosopher Hans Reichenbach (1891-1953), mainly in the context of physics. According to the genidentity view, which conflicts radically with every kind of substantialism, the identity through time of an entity X is nothing more than the continuous connection of the states through which X goes. In this paper (based on a project conducted with philosopher of physics Alexandre Guay), I try to show how the genidentity view can shed light on the long debated problem of what constitutes biological identity. I describe the centrality of the concept of genidentity in David Hull's reflection on biological identity, and I then suggest an extension of Hull's view on the basis of recent data demonstrating the ubiquity of symbiotic interactions in the living world. I conclude by showing that genidentity leads us to adopt a multilevel view on biological processes

A Process Theory of Causation

Stephen Mumford *(Nottingham) &* ***Rani Lill Anjum*** *(NMBU)*

Since the advent of Modern philosophy, causation has been treated as a relation between two separate events. Any worldly dynamism is then provided by the succession of essentially static events. Recent decades have seen a revival of interest in powers or dispositions but this has been hampered by an acceptance of many of the presuppositions of Modern philosophy, most conspicuously those of David Hume. Simply dumping powers on top of the static Humean framework will not do. The recent causal dispositionalism offers a more dynamic notion, where an instance of causation is a single process rather than a relation between distinct events. This theory has a number of advantages over the Modern framework. It can account for change as well as stability, long- and short-lived processes, genuine complexity and real emergence, nonlinear interaction of causes, extreme context-sensitivity and contrary powers. We argue that this is a more plausible framework for understanding causation in biology, both ontologically and epistemically, as it is essentially dynamic and accepts the organism to be an open system responsive to context.

Mechanisms as Abstractions of Biological Processes

Dan Nicholson *(Exeter)*

Although there is little agreement over how best to define mechanisms, there is close to universal agreement regarding their metaphysical status. Whatever else they may be, one thing everyone agrees on is that mechanisms are 'real systems in nature' (Bechtel 2006: 33); that is, that they are 'real and local' (McKay and Williamson 2011). The reason for this consensus has to do with the way we think about paradigmatic mechanisms like a clock or a fridge. These are clearly 'real and local', and are of course 'real systems in nature'. But is this still the case when 'mechanism-talk' is applied to biological phenomena? The history of the usage of the concept of mechanism in biology reveals that term has gradually come to be used to designate an extremely wide range of processes like natural selection, inheritance, or the immune response, and in doing so, it has lost its original machine connotations, becoming a dead metaphor. Unlike terms like microtubule, mitosis, or metabolism, 'mechanism' does not appear in the glossaries of textbooks, nor is it listed in its indexes. Instead, it is a term that simply 'comes up' in scientific practice, and its meaning is inferred from the explanatory context in which it is invoked. Most philosophers have assumed that one thing that has remained attached to the term 'mechanism' in biology is that it refers to 'real systems in nature'. I challenge this conviction by taking seriously two implications that follow from the realist view of mechanisms. If biological mechanisms are 'real and local', we should be able to answer two key questions: (a) how many mechanisms make up an organism? and (b) when is a description of a biological mechanism complete? By showing the impossibility of providing principled answers to these questions I will show that the best way to understand biological mechanisms is not as ontological building blocks of the living world but as abstract spatiotemporal cross-sections of biological processes that heuristically pick out certain causal relations involved in the production of the phenomena we are interested in explaining.

Time Structure in Cellular Processes

James DiFrisco *(Leuven & Exeter)*

This paper examines some differences in time structure between living systems, machines, and mechanisms as a way of evaluating mechanistic or object-based ontology versus process ontology in biology. Machines typically exhibit a time evolution of linear degradation toward loss of function. This is not the case with living systems due to their structure of organizational closure, which allows the same stable dynamics to recur indefinitely. Research on fundamental biological rhythms (e.g., Lloyd and Rossi 2008) in particular attests that living systems are endogenously active and temporally extended rather than being reactive object-like mechanisms. These unique organizational features are sustained by a complex temporal structure involving coupled nonlinear and non-sequential operations—a structure not found in human artifacts. Differences in temporal structure add to the evidence against the machine metaphor for understanding organisms which mechanistic views of life rely on more or less explicitly. One influential account, for instance, characterizes mechanisms as "productive of regular changes from start or set-up to finish or termination conditions" (Machamer et al. 2000, 3). The temporal structure of living systems, however, is such that they do not have identifiable starting and finishing conditions—unlike machines, which typically do. Such considerations have been recognized by Bechtel (2012, 2013a, 2013b) as creating problems for both the ontic conception of mechanisms as well as mechanistic research strategies. While Bechtel seeks to address these problems by expanding the mechanistic framework to include dynamical systems approaches, I argue that this can only occur at the cost of emptying the term "mechanism" of meaning. Instead, I suggest that considerations of temporal structure motivate a processual conception of living individuals and of their mode of persistence in time. On this view, a living system may include mechanisms without constitutively being a mechanism.

How DST Became a Process Theory

Paul Griffiths *(Sydney & Exeter)*

Griffiths and Gray (1994) argued that developmental systems are best conceived as processes, rather than sets of developmental resources and interactions between those resources. This conclusion was reached in response to the need to capture biological processes that were more or less impossible to represent in a 'multiple replicator' framework that tries to represent developmental systems as an extension of the replicator/interactor framework for evolutionary theory (Griffiths & Gray, 1997; Sterelny, Dickison, & Smith, 1996). This paper explores in more depth the features of developmental systems that favour a process account of those systems.

Griffiths, P. E., & Gray, R. D. (1994). Developmental Systems and Evolutionary Explanation. *Journal of Philosophy, XCI (6)*, 277-304.

Griffiths, P. E., & Gray, R. D. (1997). Replicator II: Judgment Day. *Biology and Philosophy, 12*(4), 471-492.

Sterelny, K., Dickison, M., & Smith, K. (1996). The Extended Replicator. *Biology and Philosophy, 11*(3), 377-403.

Beyond Waddington's Epigenetics: Canalization and Adaptive Plasticity

Flavia Fabris *(La Sapienza & Exeter)*

The concept of *canalization*, coined by Waddington to illustrate the complex functioning of all developmental processes, is now subject to some neopreformationist interpretations centered on the role of the notion of *cryptic genetic variability*. Waddington attributed to this concept the evidence of the genetic assimilation of the acquired characters, claiming that all organisms developed specific abilities to influence their evolutionary pathways through the regulation of buffering mechanisms of genetic variability. However, the contemporary approach of biotechnology has misrepresented the original content of the concept of cryptic genetic variability, transforming its sense to a mere genetic informationism. Consequently, the heuristics value of the concept of canalization has been reduced to a static representation of an "a-contextual developmental system", closed with respect to its environment. The following thesis will analyze the contemporary assumptions of canalization in Molecular Biology researches with the aim to recover the original Whiteheadian meaning of the concept as an open process of interaction between the organism and its environment.

Methodological Vitalism: Agency, Emergence, and Evolution

Denis Walsh *(Toronto)*

It has often been remarked that the category organism has been left out of evolutionary theorizing. This is perhaps not surprising given what organisms are. Uniquely among natural phenomena, they are self-organizing, self-building, and self-maintaining entities that synthesize the very materials out of which they are made. They are purposive entities—agents—that construct and maintain themselves in ways propitious for the pursuit of their particular ways of life. Certain widespread metaphysical assumptions militate against the assimilation of organisms into evolutionary thinking these include the idea that the elements of a domain of a scientific theory are objects, and that objects are mereological sums of their parts. I explore the idea that an organism is the realization of a goal-directed process whose spatial parts and temporal phases are to be explained primarily in terms of the purposive trajectory of the process as a whole. I outline some of the implications for evolution of this emergent organismal agency for the process of evolution

Symbiosis, Transient Biological Individuality and Evolutionary Processes

Frédéric Bouchard *(Montréal)*

Whereas individual organisms acted as the paradigm case to think about biological individuality, the study of multi-organisms assemblages such as colonies and communities has forced us to consider other ways biological individuality can emerge. In this regard, symbiosis research has given philosophers of biology tools to rethink the nature of biological individuality. We will discuss how the adaptations linked to symbiotic communities highlight a new research dilemma: should we think of a biological ontology focused on individuals and their traits, even if it means positing non-orthodox emergent individuals with non-standard properties? Or should we instead get rid of individuals altogether and focus instead on intersecting evolutionary processes? While I will offer reasons to favor the former, I will explain why this dilemma highlights the question of the different temporal scales on which evolution can occur. A defense of short term evolution and the transient individuals it may give rise to will be offered.

Intersecting Processes in Evolutionary Biology: From 'Chunks of Trees' to 'Chunks of Networks'

Eric Bapteste *(Pierre and Marie Curie University)*

In this talk, I will first recall that the biological world is sustained by countless intersecting processes. I will assume that at least some of these processes result in evolutionary transitions, and provide a few examples of such evolutionary transitions involving members of distantly related lineages (e.g. from the emergence of composite genes to the emergence of composite organisms). I will briefly recall that such transitions are not satisfactorily represented by a tree-like model of evolution, and that alternative network-based models (from n-rooted phylogenetic networks to gene and genome sequence similarity networks) are beginning to be considered to better account for these evolutionary outcomes. I will then introduce that, in addition, other strategies exist to account for intersecting processes and for the stability of their outcomes, such as systems of differential equations typically explored by Eigen to explain early life evolution. I will propose that his remarkable work already illustrated the need for a typology of processes, and, within such a typology, I will argue that there is a most important type: intersecting processes that creates 'systems', assemblages composed of heterogeneous parts in functional interaction with somewhat persistent or recurrent phenotypes. I will provide some examples of such systems in the biological world, involving a microbe or a microbiome as a component. I will propose that in general "knowledge of 'systems' is power", because 'systems' constitute an essential ground for pragmatic analyses. Then, specifically, I will suggest that considering these systems as fundamental objects of studies for evolutionary biology could make the notion of evolution increasingly popular.

Are Diseases 'Things' or 'Processes'?

Pierre-Olivier Méthot *(Laval) &* ***Staffan Müller-Wille*** *(Exeter)*

Since a few years, John Dupré invites philosophers of science to view biological objects in a new light: rather than thinking about hierarchies formed by, say, genes, cells, and organisms in terms of 'entities', Dupré argues it would be more realistic to consider them as forming a hierarchy of 'processes'. What does this shift in our ways of viewing the biological world entail? Should philosophers and biologists stop characterizing biological objects in terms of entities? The implications of Dupré's argument remain to be explored and, to this end, medical history could bring some interesting insight. Dupré's argument, indeed, resonates with an older debate in medical history where historians have repeatedly asked whether diseases are 'things' or 'processes'. These two perspectives, known as the 'ontological' and the 'physiological' approaches, have alternated several times, as described by medical historian Owsei Temkin in his essay 'The Scientific Approach to Disease: Specific Entity and Individual Illness'. Typically, an ontological approach treats a disease as a static and spatiotemporally fixed entity; a 'thing' that befalls living beings. Bacteriology offers a clear illustration of this view. Conversely, a physiological concept of disease treats illnesses from a process-oriented perspective. It looks, essentially, at disease as a deviation from what is considered normal; here, a disease is an individualized and dynamic phenomenon that results from an ensemble of heterogeneous factors (hereditary, environmental, etc.) acting together over time to produce a unique set of symptoms. Being in the age of personalized and individualized medicine it is tempting to view the ontological as out of fashion, after running a successful course in the 20th century. However, as Nathaniel Comfort has recently reminded us, Temkin's conclusion was that *neither* of these two approaches to disease was the 'right' one. Instead, one should treat disease ontologically or physiologically depending on whether one is a patient, a doctor, a

medical scientist, a pharmaceutical industrialist, or a public health officer. Returning to biology and philosophy of biology, we argue that a similar conclusion could be drawn: viewing complex and evolving hierarchies of biological objects as things or as processes will ultimately depend on the research context, the methods employed, and the intended goals that drive the investigation.

Robustness as Dynamic Coupling of Biological Processes: Learning from the Biology of Cancer

Marta Bertolaso *(University Campus Bio-Medico of Rome)*

The main challenge bio-medical sciences is accounting for the dynamic stability of the organism and for its lifetime processes. From a scientific point of view this implies providing an explanation of robust global structural changes. From a philosophical point of view, it means understanding how robustness emerges as a new property of pattern of interactions and their regulation in living systems. I will address these issues in terms of balance between autonomy and connectedness of cells belonging to a multicellular organism. Cancer, with its causal complexity, is clearly paradigmatic of such dynamics. It compromises, in fact, different levels of biological organization–from the tissue organization to the genetic structure of cells–offering a glimpse into the complex and nested interactions through which levels of biological organization are maintained. My thesis is that biological robustness can be better understood as coupling of generative (proliferation) and functional (differentiation) mechanisms, which derive from cyclical processes in living systems and make possible the robust recurrence of the various developmental stages. That is, life cycle's robustness of multicellular organisms ensures the stability of emergent stages and not the other way around, as evidences of apoptotic processes induced by inflammatory and stress factors show. From an epistemological point of view this implies moving from statics to process dynamics adopting an embodied –i.e. context dependent–perspective on biological processes. The dynamic approach associates a clock to the degrees of freedom of a system, but measuring the global structural changes requires the observing of the constraints' stratification/modification, which is precisely the history of the 'embodied' system. Such heuristic framework can be fruitful in disentangling the ambiguities of causation

in complex systems, and has relevant non-reductionist ontological implications such as the ontological priority of differentiation over proliferation in multicellular organisms.

Processes, Pathways, and Mechanisms in Cell Biology

James Wakefield *(Exeter)*

Life, as a semi-open system in a never-ending journey to "becoming", is in a constantly changing relationship to its environment. This is just as apparent at the level of the cell - the fundamental unit of life - as it is at the level of the organism. My laboratory uses an integrated approach, combining qualitative observational cell and developmental biology and genetics with quantitative biochemistry, proteomics, image analysis and bioinformatics to investigate the process of Cell Division. In this process, the cell uses spatial and temporal cues to re-arrange a protein called Tubulin into a coordinated array of polymeric Microtubules, in order to form a structure termed the Mitotic Spindle - which is capable of exerting force upon chromosomes and ultimately securing their segregation to two daughter cells. I will demonstrate how the remarkable flexibility and robustness of Mitotic Spindle formation is orchestrated through co-ordination between distinct protein-protein interaction pathways. This work reconciles disparate historical views of spindle assembly, built from a mechanistic viewpoint, suggesting a new paradigm whereby spindle assembly modules are constantly involved in "conversations" with each other. This view explains both why mitotic spindle formation can occur in absence of one of these pathways, and why the mitotic spindle ultimately reaches a dynamic steady-state capable of perpetuating life.

IDPs: 'Intrinsically Disordered Proteins' or 'Intriguing (but) Dispensable Processes'?

Stephan Güttinger *(Exeter)*

The picture that biology draws of the processes it studies often seems to be firmly substance-based: there might be constant change and development in biological systems, but all of this is ultimately based on stable things like proteins or DNA molecules. Proteins are especially important for this picture, as they are seen as the fundamental drivers of biological processes. Proteins are the 'machines' of cells and like any machine their activity depends on their structure and the properties of their parts. This view is captured by the 'structure-function' paradigm, which states that the function of a protein is determined by its three-dimensional structure, which is determined by its amino acid sequence. The recent discovery of 'intrinsically disordered proteins' (IDPs), however, has led researchers to re-evaluate this paradigm. IDPs are proteins that perform specific functions yet don't possess a fixed three-dimensional structure. Instead, the whole protein (or parts of it) is changing shape continuously. Importantly, this constant change is crucial for the ability of IDPs to engage in stable functional complexes. In theory IDPs therefore pose a serious challenge to a substance-based view of biological systems–processes that were previously explained by reference to stable entities (structured proteins) now have to be explained by reference to stabilised processes (IDPs). The goal of this talk is to analyse whether IDPs indeed pose such a challenge. To do so I will review some of the recent research on IDPs and how it has been integrated with previous work in protein biology. This analysis will show that the SF paradigm has not been affected by the discovery of IDPs. Interestingly, it will also show that the paradigm did not support a substance-based view in the first place. I will end by discussing this 'neutrality' and what it might mean more generally for the use of examples from biology in the discussion about specific ontologies.

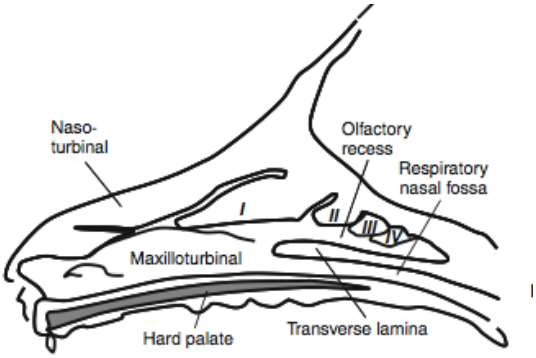
Evo-Devo and Olfaction: Developing Process Categories for Perception

Ann-Sophie Barwich *(KLI & Exeter)*

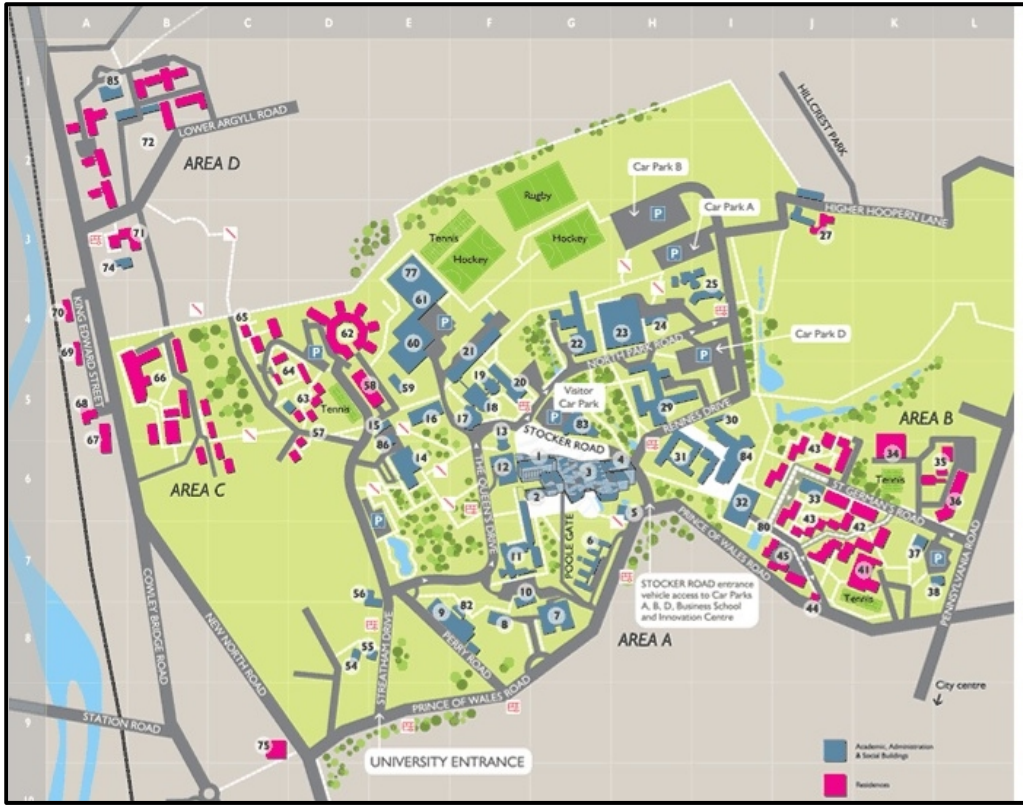
I propose an evo-devo (evolutionary and developmental) perspective on perceptual categories. Analysing the relation between physiological factors and sense-dependent behaviour for understanding perception is long overdue. Olfaction presents a particularly obvious case for a demonstration of the benefits of such an approach. Smells, traditionally, have been subordinated to taste. Today, flavours are biologically understood through retro-nasal (mouth-breathing) smell. This puts traditional classification of the senses and sense modalities in philosophy into question. Retro-nasal smell is the result of evolutionary (biological and cultural) changes, namely the adoption of bipedalism, the development of human cuisine and the morphological differentiation between the primary and secondary nose. The latter describes the disappearance of the bony transverse lamina in human (and other primate) nose anatomy. The bony transverse lamina divides the olfactory and the respiratory tract in macrosmatic animals such as dogs (fig. 1). One result of this change is that olfactory recesses in humans are no longer separated from respiratory ones, creating a nasopharyngeal space. The implications of the development of retro-nasal smell and, in turn, smell-flavour perceptions in human evolution are fundamental for understanding what the human sense of smell *is* and how its characteristics are much more elaborated than popular opinion views it.

I will show how process-based biological categories associated with smell in animal behaviour studies (e.g. social, survival, foods, botanic) provide a better understanding for the "odour worlds" of humans than object-centred cognitive categories (e.g. discussion of "representational objects" or "objects of perception" in analytic works). A comparison of the biological odour worlds of mice and men shows differences in

sensitivity and retention to particular odour groups. These differences are illuminating when interpreted in light of evolutionary and developmental changes. An interspecies comparison of olfactory abilities is of biological interest as olfaction exhibits striking evolutionary characteristics: the basic morphology of the olfactory system in general, and receptor amino acid sequences in particular, have been preserved throughout the evolution of different taxa (fish, insects, vertebrates). These characteristics allow for tracing and modelling the development and variations of signalling processes and their constituents. It is in the light of such recent scientific insights, often challenging traditional understanding of the senses, that the development of perceptual categories in philosophy requires a better biological grounding.



Campus Map



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Amory **29 5H**
Bill Douglas Centre **7 8G**
Building:One **84 6I**
Byrne House **37 7K**
Catholic Chaplaincy **74 3A**
Clayden **54 8D**
Clydesdale House (Postgraduate Centre) **63 5D**
Cornwall House **32 6I**
Cornwall House Swimming Pool **80 7I**
Devonshire House **2 6G**
Exeter Northcott Theatre **13 5F**
Family Centre **59 5E**
Forum **3 6G**
Geoffrey Pope **20 5F**
Great Hall **1 6G**
Harrison **23 4H**
Hatherly **6 7G**
Henry Wellcome Building for Biocatalysis **19 5F**
Innovation Centre **25 4I**
Institute of Arab and Islamic Studies **16 5E**
INTO International Study Centre **83 5G**
Kay Building **24 4H**
Kay House Duryard **85 1A**
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