E4S – Programme & Session Outlines

Programme:

Sunday August 24th

Arrival participants

Monday August 25th

9:00 – 9:30 **Welcome to the E4S**
by Halldor Stefansson/Sheila Jasanoff/Giuseppe Testa

Introducing classificatory systems and concepts of species boundaries from the historical, the scientific and the philosophical points of view

Chair: Halldor Stefansson

9:30 – 11:00	Morning session 1 Detlev Arendt, EMBL "The hierarchy of the hierarchies: genes, cell types and species classification in animal evolution"
11:00 – 11:30	Morning coffee break
11:30 – 13:00	Morning session 2 David Hull, Northwestern University, "Species Once Again"
13:00 – 15:00	Lunch
15:00 – 16:30	Afternoon session 1 Amanda Rees, York University "Naming is a serious matter": taxonomy, classification and hierarchies in society"
16:30 – 17:00	Afternoon coffee break
17:00 – 18:00	Afternoon Discussion session
18:00 – 19:00	Students' Summary Session
19:00 –	Beer session & snacks

20:00 Dinner at Kulturbrauerei

Tuesday August 26th

Part I: Genomic diversity and the concept of 'the normal', 'the abnormal, and 'the pathological'

Chair: Sheila Jasanoff

9:00 – 10:30	Morning session 1 David Healy (Cardiff University) "Trussed in Evidence"
10:30 – 11:00	Morning coffee break
11:00 – 12:30	Morning session 2 Agnar Helgason (decode Genetics) "In what sense are genetic variants "normal", "advantageous" or "pathological"?
12:30 – 14:00	Lunch

Part II: Social, political and scientific consequences of separating humans into races

14:00 – 15:30	Afternoon session 1 Richard Tutton (Lancaster University), "Genomics and the Biopolitics of Race and Ethnicity"
15:30 – 16:00	Afternoon coffee break
16:00 – 17:30	Afternoon session 2 Kaushik Sunder Rajan (UC Irvine) "Globalization of Clinical Trials: Otherness, Subjectivity and the Political Economy of Biomedicine"
17:30 – 18:30	Discussion session
18:30 – 19:30	Students' Summary Session
19:30 –	Beer session & snacks
	Dinner free choice

Wednesday August 27th

The science of re-assessing and re-making human/non-human species boundaries.

Chair: Giuseppe Testa

9:00 – 10:30	Morning session Alain Prochiantz (College de France) "Re-thinking human/non-human species boundaries"
10:30 – 11:00	Morning coffee break
11:00 – 12:00	Discussion
12:00 – 14:00	Lunch

14:00 – 15:30 Afternoon session
Jonathan Marks (Univ. of North Carolina)
"Constructing a Natural Order and Our Place within It"
15:30 – 16:00 Afternoon coffee break
16:00 – 17:00 Discussion Session
17:00 – 18:00 Students' Summary Session
18:00 – Beer session & snacks

Dinner free choice

Thursday August 28th

Remaking lineages within and outside of the body: epistemic, legal and sociological aspects

Chair: Halldor Stefansson
9:00 – 10:30 Morning session 1
Giuseppe Testa (EIO-ESMM)
"Indexing life: the scientific and political production of lineages"
10:30 – 11:00 Morning coffee break
11:00 – 12:30 Morning session 2
Sheila Jasanoff (Harvard Kennedy School)
"Ontological Politics"
12:30 – 14:00 Lunch
Free afternoon
Proposed Tours:`Philosophenweg, Schloss, etc.

Friday August 29th

What is biological about synthetic biology?

Chair: Sheila Jasanoff
9:00 – 10:30 Morning session 1
Andres Moya (University of Valencia)
"Synthetic biology: some philosophical considerations"
10:30 – 11:00 Morning coffee break
11:00 - 12:30 Morning session 2
Stephen Hilgartner (Cornell University)
"Synthetic Futures –
Anticipatory Knowledge and Emerging Technologies of Life"

12:30 – 14:00 Lunch
14:00 – 15:30 Afternoon session
Paul Oldham (Lancaster, UK)
"Synthetic Biology: Of Property and Vision"
15:30 – 16:00 Afternoon coffee break
16:00 – 17:00 Discussion Session
17:00 – 18:00 Students' Summary Session
18:00 – Beer session & snacks

Dinner free choice

Saturday August 30th

The political economy of the new biology; Intellectual property, university-industry relations and the circulation of bioknowledge in the public sphere.

Chair: Giuseppe Testa
9:00 – 10:30 Morning session 1
Hilary Rose, Bradford University
"The Political Economy of the Technosciences of Bios"
10:30 – 11:00 Morning coffee break
11:00 – 12:30 Morning session 2
Patrick Taylor (Harvard University)
"Defining Death, Life and Identity through
Novel forms of Property"
12:30 – 14:00 Lunch
14:00 – 15:30 Afternoon session
Steven Wainwright (London University)
"Sociological reflections on stem cell translational research:
Can Bourdieu help us?"
15:30 – 16:00 Afternoon coffee break
16:00 – 17:00 Afternoon Discussion session
17:00 – 18:00 Students' Summary Session
18:00 – 19:00 Summer School Closing Session

20:00 BBQ organized by Claus in the IWF garden

Sunday August 31st

Departure of participants

Session outlines:

Day one

The hierarchy of the hierarchies: genes, cell types and species classification in animal evolution

Detlev Arendt

Biography:
I am a Group Leader at the European Molecular Biology Laboratory in Heidelberg. I studied Biology at Freiburg University in Germany and enjoyed a broad education in classical zoology, comparative embryology and finally molecular biology. During my studies, I noticed that the evolution of animals is much easier to understand if one assumes that vertebrates turned upside-down during their evolution and this overall theme, the evolution of animal body plans, has accompanied my science ever since. Meanwhile, my laboratory is exploring the molecular mechanisms of development of a marine worm, an annelid, with focus on nervous system development. Our aim is to understand the evolution of the nervous systems in animals.

Session outline:

Cell types are the fundamental units of multicellular life but their evolution has been almost completely obscure. How did the first cell types emerge and get distinct in animal evolution? What were the sets of cell types that existed at important evolutionary nodes representing the eumetazoan or urbilaterian ancestors? How did these ancient cell types diversify further during the evolution of organ systems in the descending evolutionary lines? The recent advent of cell type molecular fingerprinting has yielded first insight into the evolutionary interrelationships of cell types between remote animal phyla and has, for the first time, allowed defining some first principles of cell type diversification in animal evolution. Key to the study of cell typogenesis is the identification of homologous cell types between species (that evolved from the same precursor cell type in the last common ancestor), and of related cell types within a given species, so-called sister cell types. In combination, the identification of homologous cell types between species and of sister cell types within species is expected to unravel the course of cell typogenesis along major branches of the animal evolutionary tree in the next few years. I will explain how the cladistic hierarchy of cell types is embedded into the cladistic hierarchy of species, and how both

relate to the hierarchy of interrelated genes and gene families.

Suggested readings:

Arendt, D. (2003). Evolution of eyes and photoreceptor cell types. *Int. J. Dev. Biol.* 47, 563-71.

Arendt, D. (2005). Genes and homology in nervous system evolution: comparing gene functions, expression patterns, and cell type molecular fingerprints. *Theory in Biosciences* 124, 185-197

Vickaryous, M.K. & Hall, B.K. Human cell type diversity, evolution, development, and classification with special reference to cells derived from the neural crest. *Biol Rev Camb Philos Soc* **81**, 425-55 (2006).

Denes, A., Jekely, G., Raible, F., Snyman, H., Ferrier, D. and Arendt, D. (2007) Molecular architecture of annelid nerve cord supports a common origin of nervous system centralisation in Bilateria. *Cell*, 129:277-288

Species Once Again

David Hull

Biography:
I am emeritus in the Department of Philosophy at Northwestern University. In my undergraduate work I majored in pre-med but switched to History and Logic of Science at Indiana University in Bloomington, Indiana. I was the first philosopher to earn a degree in that newly developed department. I taught twenty years at the University of Wisconsin-Milwaukee and another twenty at Northwestern University. I also visited at Indiana University, the University of Chicago, the University of Illinois at Chicago and UCLA. Because I knew so little about academia, I took my professors at their word and published in history of science, philosophy of science as well as biology, primarily systematics and evolutionary biology. Nowadays, philosophers publishing in Science does not sound all that strange. It was at the time.

Session outline:
From the ancient Greeks to the present, entities such as species have played an important role in how we conceive the world, not just the living world but the world in general. However, when we refer to species today, we almost always

mean biological species – the things that evolve. Within biology proper, the variation in species concepts is daunting. Rick Mayden (1997) lists 22 species concepts used by biologists. 22 concepts just in biology? In my discussion I limit myself just to species concepts as they function in biology, not because I think that biological species concepts are somehow more fundamental than or prior to other species concepts, but simply because I know them best. In what respects are species concepts in biology similar to or different from other sorts of species concepts? To answer this question, we need a significant amount of interdisciplinary research. Species as they function in biology are not widely understood. Add species in other contexts, and the occasion for confusion is only multiplied. For example, one hears that species have boundaries, but two different senses of "boundary" are being used – morphological and genealogical. Morphological boundaries occur in conceptual space, while genealogical boundaries are to be found in physical space – "real" space. And there are disciplinary boundaries as well!

Suggested readings:

David L Hull, 1988, On Human Nature, in PSA 1986 2:3-13.

Robert F. Weir, Susan C. Lawrence, and Evan Fales (eds.), 1994, Genes and Human Self-Knowledge, University of Iowa Press, Iowa Citty.

Rick Mayden, 1997, A Hierarchy of Species Concepts, in M. F. Claridge, H. A. Dawah, and M. R. Wilson (eds). Species: The Units of Biodiversity, pp. 381-422.

Jon Cohen, 2007, Venter's Genome Sheds New Light on Human Variation, Science, 317: 1311.

Jocelyn Kaiser, 2008, A Plan to Capture Human Diversity in 1000 Genomes, Science, 319:395.

"Naming is a serious matter": taxonomy, classification and hierarchies in society"

Amanda Rees

Tutor biography:
Based at the University of York, UK, my academic background lies firmly in the history and sociology of science. My research interests can be found in three main areas: the human/animal relationship and its variations both across and

within cultures; the history and ethnography of the field sciences and their significance and relationship with laboratory work; and the problems of culture and evolution – and in particular, the attempts to account for culture through evolutionary theory. I have also published widely in the history of primatology, and my book, *Natural Born Killers?: Infanticide, Primatology and the Art of Field Science* will shortly be published by the University of Chicago Press.

Session Outline:
Systems of classification, as Ritvo points out, can tell us as much about the classifiers as the classified. Historically, however, discussions of these systems – especially those that apply specifically to the 'natural' world – have often treated the questions that they raise to be purely philosophical or technical in nature. Fortunately, the last two decades have seen a resurgence of interest in the history and sociology of such classificatory systems, and in the economic, political and cultural – as well as the biological – context within which these systems have emerged.

The aim of this part of the workshop will be to introduce students to the variety of different taxonomies that have been created, from Aristotle through to Linneaus, and from the quinary system to the emergence of cladistics. An overview will be provided of the different historiographical perspectives that have developed within this area of the history of biology, as well as an outline of the backgrounds to the origins of these taxonomies and the consequences of challenging these systems of classification.

Indicative Bibliography:

Brooke, John Hedley (2000) "'Wise men nowadays think otherwise': John Ray, natural theology and the meanings of anthropocentrism", *Notes Rec. Roy. Soc. Lond.* 54: 199-213
Carey, Daniel (1997) "Compiling nature's history: travellers and travel narratives in the early Royal Society", *Ann. Sci.*, 54: 269-292
Dupré, John (2002) *Humans and Other Animals*, (Oxford: Clarendon Press), Chs 1-3
Mack, Arien (ed.) (1999) *Humans and Other Animals* (Ohio: Ohio State University Press), Section 1, 'Categories
Mcout, Gordon (2001) "Cataloguing power: delineating 'competent naturalists' and the meaning of species in the British Museum', *BJHS*, 34: 1-21
Panchen, Alec L (1992) *Classification, Evolution and the Nature of Biology*, (Cambridge: Cambridge University Press), Chs 2,3,6,7
Ritvo, Harriet (1997) *The Platypus and the Mermaid and Other Figments of the Classifying Imagination*, (Cambridge MA: Harvard University Press), Chs 1, 5

Sorlin, Sverker (2000) " Ordering the world for Europe: science as intelligence and information as seen from the Northern periphery", *Osiris*, 15: 51-69
Vernon, Keith (1993) "Desperately seeking status: evolutionary systematics and the taxonomists' search for respectability 1940-1960", *BJHS*, 26: 207-227

Day two:

Trussed in Evidence

David Healy

Biography:
I am a Professor of Psychiatry at Cardiff University. My background has been in psychopharmacology – serotonin reuptake mechanisms, before the SSRIs – and in the history of psychopharmacology and of other physical treatments in psychiatry. I have previously been the secretary for the British Association for Psychopharmacology. I have played a role in bringing to light the risks of suicide on psychotropic drugs as well as the increasing ghostwriting of medical literature.

Session Outline:
Modern medicine was borne in opposition to what were seen as the excesses of a patent medicines industry, where exaggerated claims were made for treatments that were often worthless. Medicine took its stand on science – primarily laboratory science. It was opposed to medicines being patented or marketed. It depended heavily on drugs produced by what was termed the ethical pharmaceutical industry. Later in mid-20th century it embraced clinical trials and evidence based medicine (EBM).

In the course of the 20th century, ethical companies turned slowly to branding, most medicines became available on prescription only, and the patent status of pharmaceuticals changed so that only one company could develop a product. These developments have laid the basis for the emergence of blockbuster pharmaceuticals.

The primary medical defence against the marketing of blockbusters has lain in EBM. But from the 1970s companies have taken over the running of clinical trials, the writing of the medical literature and the guardianship of the raw data from studies. And from the 1970s, there is increasing evidence that the statistical approaches taken to pharmaceutical issues amount to a "junk epidemiology", crediting the drugs with efficacy beyond the evidence and

denying hazards for which there is a robust evidence.

The aim of this session is to acquaint the participant with a feel for the history of how marketing, the prescription status of medicines, and patent status of drugs interact, and for the dynamics of a set of analytic processes that give the benefit of doubt to the product rather than the patient. What applies to drugs today is almost certain to apply to any products of the human genome tomorrow which will in all likelihood be marketed through pharmaceutical companies.

Bibliography:
Applbaum K (2004). The Marketing Era. Routledge, New York
Chambers T, Elliott C (eds). Prozac as a Way of Life. University of North Carolina Press, Chapel Hill S Carolina, 72-79.
Gaudilliere J (2008). How pharmaceuticals became patentable: the production and appropriation of drugs in the twentieth century. History and Technology. 24, 99-106.
Healy D (2002). The Creation of Psychopharmacology, Harvard U Press.
Healy D (2006). The Antidepressant Tale: Figures Signifying Nothing? Advances in Psychiatric Treatment 12, 320-328.
Healy D (2007). The New Engineers of Human Souls and Academia. Epidemiologia e Psichiatria Sociale 16. 205-211.
Petryna A, Lakoff A, Kleinman A (ed) Global Pharmaceuticals. Ethics, Markets, Practices. Duke University Press, Durham, pp 61-84
PLoS Medicine (2006). Disease Mongering. Volume 3 Special Issue April.
Timmermans S, Berg M (2003). The Gold Standard. The Challenge of Evidence-Based Medicine and Standardisation in Health Care. Temple University Press, Philadelphia.

In what sense are genetic variants "normal", "advantageous" or "pathological"?

Agnar Helgason

Tutor biography:
Agnar Helgason completed his undergraduate training in Anthropology at the University of Iceland in 1992, after which he obtained a research-based Masters degree in social anthropology in 1995 at the same institution. In 1996 Agnar graduated from the University of Cambridge with an MPhil in Biological Anthropology and with a D.Phil in the same subject from the University of Oxford in 2001. In 2000 he joined deCODE Genetics where he is currently a senior research scientist in biological anthropology and population genetics as well as

being an associate research professor at the Department of Anthropology in the University of Iceland. Agnar's research areas include the genetic history of the Icelanders and the Inuit, the use of genealogical data in population genetics, the identification of patterns of natural selection at loci associated with complex diseases and traits such as pigmentation, the impact of population structure on association studies, and statistical analyses of ancient DNA. Agnar is an author of more than 30 articles in peer-reviewed scientific journals.

Session outline:
The concepts of “the normal”, “the abnormal” and “the pathological” are at the heart of contemporary research in human genetics. In medical genetics, considerable effort and progress has been made in the past three years in identifying genetic variants that are associated with complex disease phenotypes, such as type 2 diabetes, age-related macular degeneration, prostate cancer, myocardial infarction and Crohns disease. Simplistically, this might be viewed as a hunt for pathological or abnormal genetic variants. At the same time, in the field of population and evolutionary genetics, many groups have been trawling the human genome for variants that have been under positive selective pressure in the past due to their impact on phenotypic traits that contributed to a relative increase in reproductive success. At face value, this might be viewed as a hunt for advantageous genetic variants. Extending this distinction between pathological and advantageous genetic variants, the variants that fall into neither category could be viewed as normal (essentially equivalent to the category of neutral variation in evolutionary theory).

In fact, things are not as simple as this. While the definition of particular phenotypic traits as pathological (for example, the aforementioned diseases), advantageous or normal may be useful, appropriate or inescapable in human societies, it does not follow that these labels can be directly transferred to the genetic variants that are found to be associated with such traits at a particular time in at least one population.

The vast majority of an organism’s phenotypic traits are the product of an interaction between genotype and environment (which includes the other genotypes in an organism’s genome). A given genetic variant may have variable impact on the same individual in different environments or on different individuals in the same environment. This principle, known as the norm of reaction, is relatively well-established in the genetic study of non-human species. However, until recently, few examples of variable genotype x environment interactions were known in humans, primarily because so few genotype x phenotype associations had been identified. One result of this, perhaps, is a rather speculative and counterproductive nature-nurture debate surrounding very complex traits such as I.Q.

In my talk, I will use some examples from research I have been involved in

at deCODE Genetics to illustrate the norm of reaction of genetic variants in humans. The implications of such findings for our understanding genome diversity and function in relation to labels such as pathological, advantageous and normal will be discussed.

Suggested readings:

Gudmundsson J, Sulem P, Steinthorsdottir V, Bergthorsson JT, Thorleifsson G, Manolescu A, Rafnar T, et al. (2007) Two variants on chromosome 17 confer prostate cancer risk, and the one in TCF2 protects against type 2 diabetes. Nat Genet 39:977-983

Helgadottir A, Manolescu A, Helgason A, Thorleifsson G, Thorsteinsdottir U, Gudbjartsson DF, Gretarsdottir S, et al. (2006) A variant of the gene encoding leukotriene A4 hydrolase confers ethnicity-specific risk of myocardial infarction. Nat Genet 38:68-74

Helgason A, Palsson S, Gudbjartsson DF, Kristjansson T, Stefansson K (2008) An association between the kinship and fertility of human couples. Science 319:813-816

Helgason A, Palsson S, Thorleifsson G, Grant SF, Emilsson V, Gunnarsdottir S, Adeyemo A, et al. (2007) Refining the impact of TCF7L2 gene variants on type 2 diabetes and adaptive evolution. Nat Genet 39:218-225

Kong A, Thorleifsson G, Stefansson H, Masson G, Helgason A, Gudbjartsson DF, Jonsdottir GM, Gudjonsson SA, Sverrisson S, Thorlacius T, Jonasdottir A, Hardarson GA, Palsson ST, Frigge ML, Gulcher JR, Thorsteinsdottir U, Stefansson K (2008) Sequence Variants in the RNF212 Gene Associate with Genomewide Recombination Rate. Science

Palsdottir A, Helgason A, Palsson S, Bjornsson HT, Bragason BT, Gretarsdottir S, Thorsteinsdottir U, Olafsson E, Stefansson K (2008) A drastic reduction in the life span of cystatin C L68Q carriers due to life-style changes during the last two centuries. PLoS Genet 4:e1000099

Genomics and the Biopolitics of Race and Ethnicity

Richard Tutton

Tutor Biography:

I am a Senior Lecturer at Cesagen, Lancaster University. My academic training was in literary and cultural studies, before my interest turned to studying the social implications of human genetics research in the late 1990s. My research interests have clustered around the collection and banking of human tissue and genetic information for genetics and biomedical research; discourses of donation and participation in these forms of research by public groups; questions of scientific citizenship and expertise; and the implications of science and technology for changing notions of identity; race/ethnicity.

Session Outline:
Convention has it that after World War II the scientific community abandoned the concept of race and began instead to see human differences in terms of populations defined by genetic frequencies and continuous variation. Race came to be recognised as a 'social construct', the product of social ideologies and histories of imperialism, and no longer a scientifically valid concept. Given this telling of the past, how should we then understand contemporary developments in the life sciences and their implications for scientific and social discourses about race and ethnicity? What should we make of patent applications for new drugs that cite race or ethnicity as indicators of differing efficacy, the FDA in 2005 approving the world's first drug to be marketed to only one racial/ethnic group, or geneticists working on the genetics of drug response and disease susceptibility frequently claiming that there are meaningful genetic differences between groups defined by racial and ethnic classifications? Do these developments revive older notions of racial differences that were thought to have been abandoned by the scientific community over fifty years ago? Or do they signal the emergence of new forms of politics and identity-formation that require different ways of conceptualising their implications for society?

The aim of this session is two-fold. The first is to provide an overview of some significant trends in research, governance and marketing of genomics and biomedicine, which will be juxtaposed against long-standing research in public health concerned with health inequalities amongst different racial/ethnic groups. The second aim is to consider how social scientists have responded to and subsequently framed many of these developments so that participants in the session will have a good understanding of the major issues at stake and the different approaches taken by scholars in this area. We will examine the writings of North American and European authors such as Duster, Epstein, Kahn, Fausto-Sterling, Reardon, Rose and Skinner.

Indicative Bibliography:

* indicate texts that students might want to read before participating in this

session.

Bamshad, M., Wooding, S., Salisbury, B. A., & Stephens, J. C. 2004, 'Deconstructing The Relationship between Genetics and Race', *Nature Reviews Genetics*, 5 (8): 598-609.
Bradby, Hannah (1996) 'Genetics and Racism', in T. Marteau and M. Richards (eds) *In The Troubled Helix: Social and Psychological Implications of the New Human Genetics* (Cambridge: Cambridge University Press): 295-316.
Burchard, Esteban, et al. (2003) 'The Importance of Race and Ethnic Background in Biomedical Research and Clinical Practice', *New England Journal of Medicine* 348(12): 1170-1175
*Cooper, Richard, Jay S. Kaufman, & Ryk Ward (2004) 'Race and Genomics', *New England Journal of Medicine* 348(12): 1166-1175.
*Duster, Troy (2005) 'Race and Reification in Science', *Science*, 307, 18 February 2005: 1050-51
Epstein, Steven (2007) *Inclusion: The Politics of Difference in Medical Research*, (London: University of Chicago Press)
Goldstein, D. and E Hirschborn (2004) 'In genetic control of disease, does 'race' matter? Nature Genetics 36 (12): 1243-44
*Kahn, J. D. (2004) 'How a drug becomes "ethnic": law, commerce, and the production of racial categories in medicine,' *Yale Journal of Health Policy, Law, and Ethics*, **4**: 1–46
Marks, Jonathan (1998) *Human Biodiversity: Genes, Race and History* (New York: Aldine de Gruyter)
Rose, Nikolas (2006) *The Politics of Life Itself: Biomedicine, Power and Subjectivity in the Twenty-first Century*, (Princeton: Princeton University Press)
Rose, S and H Rose (2005) 'Why we should give up on race', The Guardian, London and Manchester.
Shim, Janet. K. (2005) 'Constructing "Race" Across the Science-Lay Divide: Racial Formation in the Epidemiology and Experience of Cardiovascular Disease', *Social Studies of Science*, 35(3): 405-436.
*Skinner, Davis (2006) 'Racialized futures**:** biologism and the changing politics of identity', *Social Studies of Science*, 36 (3): 459-488
Smart, A. R. Tutton, P. Martin, G. T. H. Ellison and R. Ashcroft (2008) 'The Standardization of Race and Ethnicity in Biomedical Science Editorials and UK Biobanks,' *Social Studies of Science*, 38 (3): 407-423.
Taylor A.L.; S. Ziesche S and C. Yancy et al. (2004) 'Combination of Isosorbide Dinitrate and Hydralazine in Blacks with Heart Failure', *New England Journal of Medicine* 351: 2049-2057

Globalization of Clinical Trials: Otherness, Subjectivity and the Political

Economy of Biomedicine

Kaushik Sunder Rajan

Tutor Biography*:*
I am Assistant Professor of Anthropology at the University of California, Irvine. I was initially trained as a biochemist, and have a PhD in STS. My dissertation research, published as *Biocapital: The Constitution of Post-Genomic Life*, looked at the political economy of genome science in the United States and India. I am currently researching global clinical trials, looking again at the US and India.

Session Outline:
My own work has less to do with race *per se* and more to do with difference in the context of global biomedicine. I will divide this session into three components. First – drawing upon some of my own research, I address the ontological and epistemological status of two types of subjects that are constitutive to the clinical trials process. The first is the Third World experimental subject, as clinical trials are increasingly globalized for reasons of cost and ease of patient recruitment. The second is the animal model, which is essential for pre-clinical research before an experimental therapy is tested in humans. I am interested less in the ethical dimensions of these experimental subjectivities than I am in how we read them as biomedical bodies of knowledge, and as potential generators of value for global capital. How does a Third World experimental subject become a "good enough" surrogate for the Western patient to whom most experimental drugs are eventually marketed, given the likelihood of different genetic profiles as well as environmental milieus? How does an animal subject become a "good enough" surrogate for the human, when value considerations make it important that pre-clinical studies are robust enough to anticipate the fate of an experimental drug in clinical trials? I address these questions based on research conducted on clinical trials in India, and on the development of transgenic pre-clinical mouse models in the United States. These questions are relevant not just to understanding the epistemology of clinical trials, but also to conceptualizing the ways in which contemporary biomedicine reconfigures ontological categories of humanness through emergent trans-species and global postcolonial encounters.

Second – I will situate some of this in the context of a developing body of ethnographic work around clinical trials that is emerging at the intersection of anthropology and STS. And third – I will talk about how this work on clinical trials collectively forces us to consider biomedicine as a global regime in political economic terms, bringing questions of value, subjectivity and governance to the

fore.
Indicative Bibliography:

Literature on clinical trials

- Cooper, Melinda, Brian Salter, and Amanda Dickins. 2006. 'China and the Global Stem Cell Bioeconomy: An Emerging Political Strategy?' *Regenerative Medicine* 1 (5).
- Dumit, Joseph. Forthcoming. *Drugs for Life*. Durham: Duke University Press.
- Fisher, Jill. 2005. 'Human Subjects in Medical Experiments' in Sal Restivo ed., *Science, Technology, and Society*, Oxford: Oxford University Press.
- Greene, Jeremy. 2008. *Prescribing by Numbers: Drugs and the Definition of Disease.* Baltimore: Johns Hopkins University Press.
- Kuo, Wen-Hua. 2005. *Japan and Taiwan in the Wake of Bio-Globalization: Drugs, Race, and Standards*. MIT Ph.D. dissertation.
- Marks, Harry. 2000. *The Progress of Experiment: Science and Therapeutic Reform in the United States, 1900-1990*. Cambridge, UK: Cambridge University Press.
- Petryna, Adriana. 2005. 'Ethical Variability: Drug Development and Globalizing Clinical Trials' *American Ethnologist* 32 (2), 2005, pp. 183-197
- Petryna, Adriana. 2005. 'Drug Development and the Ethics of the Globalized Clinical Trial', Princeton Institute of Advanced Studies working paper.
- Sunder Rajan, Kaushik. 2007. 'Experimental Values: Indian Clinical Trials and Surplus Health'. *New Left Review* 45: 67-88.
- Timmermans, Stefan, and Marc Berg. 2003. *The Gold Standard: The Challenge of Evidence-Based Medicine*. Philadelphia: Temple University Press.

Literature on political economy of biomedicine

- Biehl, Joao. 2007. *Will to Live: AIDS Therapies and the Politics of Survival.* Princeton: Princeton University Press.
- Cooper, Melinda. 2008. *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era.* Seattle: University of Washington Press.
- Lakoff, Andrew. 2006. *Pharmaceutical Reason: Knowledge and Value in Global Psychiatry*. Cambridge, UK: Cambridge University Press.
- Petryna, Adriana, Andrew Lakoff and Arthur Kleinman, eds. 2006. *Global Pharmaceuticals: Ethics, Markets, Practices.* Durham: Duke University Press.
- Rose, Nikolas. 2006. *The Politics of Life Itself: Biomedicine, Power, and*

Subjectivity in the Twenty-First Century. Princeton: Princeton University Press.
- Sunder Rajan, Kaushik. 2006. *Biocapital: The Constitution of Post-Genomic Life*. Durham: Duke University Press.
- Waldby, Catherine, and Robert Mitchell, eds. 2006. *Tissue Economies: Blood, Organs, and Cell Lines in Late Capitalism*. Durham: Duke University Press.

The science of re-assessing and re-making human/non-human species Boundaries

Alain Prochiantz

Tutor Biography:
I am a Professor at College de France in Paris. My training is in molecular biology, neurosciences and developmental biology. My present research interest is in development and evolution of the nervous system. My laboratory has discovered a novel signaling mechanism that operates through the intercellular transfer of homeoprotein transcription factors and takes place at all developmental stages and in the adult. In addition to the latter scientific work, I have developed an interest for the history of biology. This has led me to write several books and theatre plays not unrelated with developmental and evolutionary issues that will be discussed during the session.

Session outline:
Darwinians as we are, we indeed believe, or rather know, that we are animals by any means. A first part of the session will thus be devoted to our own animality, in particular that of our brain. This discussion will be based on the evolutionary conservation of many genes and mechanisms that participate in the construction of the brain. This discussion must lead to the important issue of the existence of boundaries between human/non-human species. Is the emergence of the human species gradual? Alternatively, is there between our closest primate relatives and us a qualitative and sudden change that makes us animals and non-animals at the same time? The question will be discussed in view of recent findings on the regulation of gene expression. Indeed, this discussion is not without consequences on our position in the universe and on the relationship that we entertain with the rest of the living world.

Indicative Bibliography
1-33
1. Berezikov, E. et al. Diversity of microRNAs in human and chimpanzee

brain. Nat Genet 38, 1375-7 (2006).
2. Bradbury, J. Molecular insights into human brain evolution. PLoS Biol 3, e50 (2005).
3. Brunet, I., Di Nardo, A. A., Sonnier, L., Beurdeley, M. & Prochiantz, A. The topological role of homeoproteins in the developing central nervous system. Trends Neurosci 30, 260-7 (2007).
4. Bystron, I., Blakemore, C. & Rakic, P. Development of the human cerebral cortex: Boulder Committee revisited. Nat Rev Neurosci 9, 110-22 (2008).
5. Canestro, C., Yokoi, H. & Postlethwait, J. H. Evolutionary developmental biology and genomics. Nat Rev Genet 8, 932-42 (2007).
6. Chen, K. & Rajewsky, N. The evolution of gene regulation by transcription factors and microRNAs. Nat Rev Genet 8, 93-103 (2007).
7. Cheng, Z. et al. A genome-wide comparison of recent chimpanzee and human segmental duplications. Nature 437, 88-93 (2005).
8. Cohen, J. Evolutionary biology. Relative differences: the myth of 1%. Science 316, 1836 (2007).
9. Dehaene, S. & Cohen, L. Cultural recycling of cortical maps. Neuron 56, 384-98 (2007).
10. Fablet, M., Rebollo, R., Biemont, C. & Vieira, C. The evolution of retrotransposon regulatory regions and its consequences on the Drosophila melanogaster and Homo sapiens host genomes. Gene 390, 84-91 (2007).
11. Feschotte, C. Transposable elements and the evolution of regulatory networks. Nat Rev Genet 9, 397-405 (2008).
12. Fisher, S. E. & Marcus, G. F. The eloquent ape: genes, brains and the evolution of language. Nat Rev Genet 7, 9-20 (2006).
13. Ghazanfar, A. A. Language evolution: neural differences that make a difference. Nat Neurosci 11, 382-4 (2008).
14. Gilad, Y., Oshlack, A., Smyth, G. K., Speed, T. P. & White, K. P. Expression profiling in primates reveals a rapid evolution of human transcription factors. Nature 440, 242-5 (2006).
15. Hayakawa, T., Altheide, T. K. & Varki, A. Genetic basis of human brain evolution: accelerating along the primate speedway. Dev Cell 8, 2-4 (2005).
16. Holcman, D., Kasatkin, V. & Prochiantz, A. Modeling homeoprotein intercellular transfer unveils a parsimonious mechanism for gradient and boundary formation in early brain development. J Theor Biol 249, 503-17 (2007).
17. Kaas, J. H. Evolution of the neocortex. Curr Biol 16, R910-4 (2006).
18. Kerszberg, M. & Wolpert, L. Specifying positional information in the embryo: looking beyond morphogens. Cell 130, 205-9 (2007).
19. Kiecker, C. & Lumsden, A. Compartments and their boundaries in vertebrate brain development. Nat Rev Neurosci 6, 553-64 (2005).

20. Krubitzer, L. The magnificent compromise: cortical field evolution in mammals. Neuron 56, 201-8 (2007).
21. Kruglyak, L. & Stern, D. L. Evolution. An embarrassment of switches. Science 317, 758-9 (2007).
22. Lebedev, M. A. & Nicolelis, M. A. Brain-machine interfaces: past, present and future. Trends Neurosci 29, 536-46 (2006).
23. Li, W. H. & Saunders, M. A. News and views: the chimpanzee and us. Nature 437, 50-1 (2005).
24. McGregor, A. P. et al. Morphological evolution through multiple cis-regulatory mutations at a single gene. Nature 448, 587-90 (2007).
25. O'Leary, D. D., Chou, S. J. & Sahara, S. Area patterning of the mammalian cortex. Neuron 56, 252-69 (2007).
26. Ponting, C. P. & Lunter, G. Evolutionary biology: human brain gene wins genome race. Nature 443, 149-50 (2006).
27. Premack, D. Human and animal cognition: continuity and discontinuity. Proc Natl Acad Sci U S A 104, 13861-7 (2007).
28. Preuss, T. M., Caceres, M., Oldham, M. C. & Geschwind, D. H. Human brain evolution: insights from microarrays. Nat Rev Genet 5, 850-60 (2004).
29. Ranade, S. S. et al. Analysis of the Otd-dependent transcriptome supports the evolutionary conservation of CRX/OTX/OTD functions in flies and vertebrates. Dev Biol 315, 521-34 (2008).
30. Sasaki, T. et al. Possible involvement of SINEs in mammalian-specific brain formation. Proc Natl Acad Sci U S A 105, 4220-5 (2008).
31. Sikela, J. M. The jewels of our genome: the search for the genomic changes underlying the evolutionarily unique capacities of the human brain. PLoS Genet 2, e80 (2006).
32. Weissenbach, J. Genome sequencing: differences with the relatives. Nature 429, 353-5 (2004).
33. Yeyati, P. L., Bancewicz, R. M., Maule, J. & van Heyningen, V. Hsp90 selectively modulates phenotype in vertebrate development. PLoS Genet 3, e43 (2007).

Constructing a Natural Order and Our Place within It

Jonathan Marks

Tutor Biography:
I am a professor of biological anthropology at the University of North Carolina at Charlotte. My primary area of research is molecular anthropology – or broadly

speaking, the area of overlap between (scientific) genetic data and (humanistic) self-comprehension. My work has been published in scientific and scholarly journals ranging from *Nature* through the *Journal of Human Evolution* to *History and Philosophy of the Life Sciences.* I am the author of *Human Biodiversity* (Aldine/Transaction, 1995), *What It Means to Be 98% Chimpanzee* (University of California Press, 2002), and *Why I am Not a Scientist* (University of California Press, forthcoming).

Session Outline:
Although all cultures have ideas about where and how they "fit in" with the rest of living and non-living things, modern science formally dates the beginning of its confrontation with that problem to the tenth (1758) edition of *System of Nature*, by the Swedish physician-botanist, Carl Linnaeus. Subsequent generations of scientists have vacillated between emphasizing the obvious differences of humans from other animals (for example, calling the apes "Quadrumana" and humans "Bimana"), versus emphasizing our similarities to the apes (often impressionistic, but formally taillessness, a rotating shoulder, and the relationships demonstrable in hemo-genetic comparisons). We are currently experiencing an epistemic pendulum-swing in the latter direction, emphasizing the proximity of humans to apes over the features that distinguish us from apes, and indeed from all other species. The ultimate consequence is that today, the journal Nature uses "hominins" where a decade ago it would have said "hominids" to denote the same group of species.

This session will explore the meaning of the modern scientific classifications of humans in historical, social, and philosophical contexts. What is gained or lost in any particular scientific classification? Should adaptive divergence – arguably Darwin's most significant contribution to biology – be acknowledged in a scientific classification? What is the meaning and relevance of our genetic similarity to apes? How are other taxonomic issues related, such as the status of reptiles, fish, Neanderthals, and the taxonomic status of human populations in relation to one another? What roles are played by tangential science issues, such as primate conservation, creationism, the animal-rights movement, cladistics, and geno-hype?

Indicative Bibliography:
* indicate texts that students might want to read before participating in this session.

Bowker, G. and Star, S. (1999) *Sorting Things Out: Classification and Its Consequences*. Cambridge, MA: MIT Press.
Campbell, B. (1962) The systematics of man. *Nature*, 194:225-232.

Corbey, R. (2005) *The Metaphysics of Apes: Negotiating the Animal-Human Boundary*. New York: Cambridge University Press.
Dupré, J. (2002) *Humans and Other Animals*. New York: Oxford University Press.
Diamond, J. (1992) *The Third Chimpanzee*. New York: HarperCollins.
Enard, W. and Paabo, S. (2004) Comparative primate genomics. *Annual Review of Genomics and Human Genetics*, 5:351-378.
Holliday, T. W. (2003) Species concepts, reticulation, and human evolution. *Current Anthropology*, 44:653-673.
Hull, D. L. (1970) Contemporary systematic philosophies. *Annual Review of Ecology and Systematics*, 1:19-54.
Huxley, J. S. (1955) Evolution, biological and cultural. *Yearbook of Anthropology*, 0:2-25.
Hussey, L. M. (1926) The blood of the primates. *American Mercury*, 9:319-321.
Jensen-Seaman, M. I., Deinard, A. S. and Kidd, K. K. (2001) Modern African ape populations as genetic and demographic models of the last common ancestor of humans, chimpanzees, and gorillas. *Journal of Heredity*, 92:475-480.
*Landau, M. (1984) Human evolution as narrative. *American Scientist*, 72:262-268.
Marks, J. (2002) *What It Means to Be 98% Chimpanzee: Apes, People, and Their Genes*. Berkeley: University of California Press.
*Marks, J. (2007) Anthropological taxonomy as both subject and object: The consequences of descent from Darwin and Durkheim. *Anthropology Today*, 23:7-12.
*Sayers, K. and Lovejoy, C. O. (2008) The chimpanzee has no clothes. *Current Anthropology*, 49:87-114.
Schwartz, J. H., Collard, M. and Cela-Conde, C. J. (2001) Systematics of "Humankind". *Evolutionary Anthropology*, 10:1-3.
Simpson, G. G. (1961) *Principles of Animal Taxonomy*. New York: Columbia University Press.
*Simpson, G. G. (1964) Organisms and molecules in evolution. *Science*, 146:1535-1538.
*Wildman, D. E., Uddin, M., Liu, G., Grossman, L. I. and Goodman, M. (2003) Implications of natural selection in shaping 99.4% nonsynonymous DNA identity between humans and chimpanzees: Enlarging genus *Homo*. *Proceedings of the National Academy of Sciences, USA*, 100:7181-7188.

Day four

Indexing life: the scientific and political production of lineages

Giuseppe Testa

Tutor Biography:
I am a Principal Investigator at the European Institute of Oncology in Milan. My academic training was in Medicine (MD at the University of Perugia), Molecular Biology (PhD at the EMBL), Bioethics and Science and Technology Studies (MA at Manchester University and visiting scholarship in the program on Science, Technology and Society at the Harvard Kennedy School).
My lab investigates the epigenetic mechanisms of lineage commitment using mice and mouse embryonic stem cells as model systems. Over the course of the last ten years I have integrated Bioethics and STS in my scholarly track, joining the Science and Society Program at EMBL and later founding the Dresden Max Planck Forum on Science and Society in Dresden. Together with Giovanni Boniolo we established in 2006 the PhD Program in Foundations of Life Sciences and their Ethical Consequences at the European School of Molecular Medicine (SEMM) in Milan. In 2007 I was appointed on the Ethics and Public Policy Committee of the International Society for Stem Cell Research (ISSCR).
Starting from an the epistemic reframing of genetic agency in the light of molecular epigenetics, my research interests focus on how genes and cell lineages become visible, mobile and political elements in the public sphere. Applying a co-productionist analytical framework, I am after the ways in which epistemic and social understandings are shaping the polity of the biotechnological age

Session Outline:
The last decades have witnessed a remarkable increase in our understanding of the molecular basis of cell fate and in our capacity to manipulate cell lineages in several organisms. Heralded by the birth of Dolly, the option to reverse and engineer lineages has recently found in iPS cells (pluripotent cells derived from skin fibroblast through various types of genetic manipulations) its most poignant example. Partially as a response to the redistribution of body lineages in space and time, practices and discourses in both Science and Society at large have positioned the early phases of human embryonic development at the crossroad of two main trajectories: a generative one, encompassing assisted reproduction in its various applications, and a regenerative one aimed at harnessing and/or remaking lineages to understand and cure diseases or more broadly to improve the human condition.
At the epistemic level, development has become a problem of molecular epigenetic indexing, an updated and more articulated version of the ‘code’ that parses developmental stages into combinations of molecular marks. Large scale

-omic efforts, in the form of transcriptional or chromatin arrays, are contributing to make this developmental 'indexing' comprehensive, capturing in digital maps of genomic landscapes the analogic continuity of life in time. But as lineages within and especially outside of the organism became objects of public concern, a variety of parallel 'indexing' efforts, which we may broadly define as social, accompanied the epistemic inquiry to enable the circulation of the various 'new' lineages in the public sphere. This social indexing incorporates moral, legal and economic rationalities and the aim of this session is to analyze the ways in which these parallel processes of lineage indexing are shaping each other to contribute to an order that is at one and the same time scientific and political. Examples are many. From the organization of stem cell banks to the insertion of 'water-marks' into Venter's organisms to label them as synthetic, from the harnessing of partial trajectories of development to circumvent the moral qualms of embryo usage to the definition of human/animal percentages in chimera research, the epistemic and the social tasks of indexing lineages are becoming increasingly embricated. Epistemic re-definitions of gene functions and the novel technologies that probe them are being used to shape or uphold moral and legal boundaries, while these in turn orient the significance of biological observations and the priority of research directions.
We will trace these parallel developments integrating paradigmatic case studies with strands of inquiry from Epigenetics and Science and Technology Studies. The aim is to provide a broad and articulate assessment of how the question of lineages is being co-shaped by scientific inquiry and social change.

Suggested reading:

- Allis CD, Jenuwein T, Reinberg D (Eds.) *Epigenetics* (Cold Spring Harbor, Cold Spring Harbor Laboratory Press, 2007), especially chapters 1, 2, 3, 11, 12, 20 and 22).
- Jasanoff S, *Designs on Nature* (Princeton University Press 2007), especially chapters 1, 6, 7 and 8.
- Jasanoff S (Ed.), *States of Knowledge: The Co-Production of Science and the Social Order* (Routledge, 2004), chapters 1 and 2
- Kitcher, P *Science, Truth, and Democracy* (Oxford University Press 2003), especially chapters 5 and 6
- Franklyn, S *Dolly Mixtures: The Remaking of Genealogy* (Duke University Press, 2007), especially chapter 1
- Gibson DG et al. *Complete chemical synthesis, assembly, and cloning of a Mycoplasma genitalium genome* Science 2008 Feb 29;319(5867):1215-20.
- Jaenisch R and Young R *Stem cells, the molecular circuitry of pluripotency and nuclear reprogramming* Cell. 2008 Feb 22;132(4):567-82
- Salter, B *Bioethics and the global moral economy: the cultural politics of*

human embryonic stem cell science Science, Technology and Human Values 2007 32(5)
- Hyun I, Taylor P, Testa G, et al. *Ethical standards for human-to-animal chimera experiments in stem cell research* Cell Stem Cell. 2007 Aug 16;1(2):159-63
- Testa G and Harris J. *Ethical aspects of ES cell-derived gametes* Science 2004 Sep 17;305(5691):1719
- Testa G and Harris J *Ethics and synthetic gametes* Bioethics 2005 Apr;19(2):146-66
- The Hinxton Group: An international consortium on stem cells, ethics and law *Consensus Statement: The Science, Ethics and Policy Challenges of Pluripotent Stem Cell-Derived Gametes* April 2008 (http://www.hinxtongroup.org/au_pscdg_cs.html)

Ontological Politics

Sheila Jasanoff, J.D., Ph.D.

Tutor Biography:
Sheila Jasanoff is Pforzheimer Professor of Science and Technology Studies at Harvard University's John F. Kennedy School of Government. She has held academic positions at Cornell, Yale, Cambridge, Oxford, and Kyoto. At Cornell, she founded and chaired the Department of Science and Technology Studies. She has been Karl Deutsch Guest Professor at the Science Center Berlin and Fellow at the Berlin Institute for Advanced Study. Her research concerns the role of science and technology in the law, politics, and public policy of modern democracies, with particular focus on the regulation of biotechnology and the environment in the US, Europe, and India. She is particularly interested in the means by which scientific ideas and artifacts both open up and constrain opportunities for democratic deliberation, and she uses comparative cross-national analysis to illuminate how nation states ratify some forms of public reason as preferable to others. Her books include *Controlling Chemicals* (1985), *The Fifth Branch* (1990), *Science at the Bar* (1995), and *Designs on Nature* (2005). Jasanoff has served on the Board of Directors of the American Association for the Advancement of Science and as President of the Society for Social Studies of Science, as well as on many U.S. and international scientific advisory committees. She holds AB, JD, and PhD degrees from Harvard and an honorary doctorate from the University of Twente.

Session Outline:
What does it mean for the life sciences to be political? Conventional wisdom suggests that it is not basic science but its applications that are political. How,

after all, can developments at the benches of research possibly take on a political character? Isn't it the case that science itself has no politics, but that science becomes political only when its findings are applied to technologies that have impacts on people's lives? Don't laypeople mistakenly see science as political mainly because they misunderstand the nature and purposes of science, and wouldn't healthy doses of science communication greatly reduce the political tensions that surround new, boundary-crossing developments in the life sciences, such as the production of embryos through somatic cell nuclear transfer, the injection of human neuronal cells into mouse brains, or the breeding of cloned animals for food?

This session will query common understandings of the relations between science and politics by teasing out several possible meanings of "politics" in the context of the life sciences, beginning with ideas that the students bring to the course and juxtaposing these with notions derived from Kitcher, Sandel, and Jasanoff among others. It will use the framework of co-production to investigate how moral and political values enter into the production of scientific ideas and objects, as well as how science conditions the ways in which people want to transform their lives. Particular attention will be paid to the interaction between scientific and political cultures in imagining alternative realities. For this purpose, we will draw on comparisons among three Western nations (Britain, Germany, and the US) in accommodating the products of biotechnology into their legal and political cultures. Overall, this session will develop the argument that the life sciences are reshaping ideas of personhood, identity, community, privacy, and liberty, among others, thereby reframing basic notions of constitutional rights.

The session will end with some discussion of what it means to democratize the life sciences, how these sciences should be "steered" by policymakers, and what sorts of procedures would be most appropriate for drawing people into productive debate on novel forms of life.

Using a few news reports as resources "to think with," the group will consider the extent to which critical self-reflection by scientists, citizens, and policymakers is possible, given the deterministic ways in which culture appears to influence what the life sciences invent, as well as the meanings that people assign to those inventions.

Suggested Readings (in addition to those suggested by G. Testa):

Sheila Jasanoff, *Designs on Nature* (Princeton: Princeton University Press, 2005), Chapter 10.

Sheila Jasanoff, “In the Democracies of DNA: Ontological Uncertainty and Political Order in Three States,” *New Genetics and Society* 24(2): 139-155 (2005).

M.J. Sandel, “The Case against Perfection,” *Atlantic*, April 2004: 51-62.

Henry I. Miller, “Auf Wiedersehen, Academic Freedom,” *Wall Street Journal Europe*, June, 24, 2008

Olivia Judson, “Enter, the Cybrids,” *New York Times*, May 20, 2008.

Antony Barnett and Robin McKie, “UK to clone human cells,” *The Observer*, June 13, 2004

Day five

Synthetic biology: some philosophical considerations

Andrés Moya

Tutor biography:
I am professor of Genetics at University of València. I studied simultaneously Biology and Philosophy and got the phD degrees in both. I have written original articles, reviews, book chapters and books about Genetics, Evolution and Philosophy of Biology. My more significant contributions are in the fields of experimental and genomic evolution. I’m particularly interested in the evolution of biological complexity and, under the umbrella of evolutionary theory, on the philosophical implications of reaching the self-conscious state.

Session outline:
Synthetic biology is neither a new science nor a clearly defined research program yet. Although recent years have witnessed great enthusiasms around the field it is simply not true that “synthetic biology” is a new coined term. We must go at the beginning of the past century to find that the French biophysicist Stéphane Leduc used this term in 1912 as a title of one of his books on the synthesis of artificial life whereas the German-American biochemist Jacques Loeb in 1906 defined the synthesis of life as the goal of biology (Peretó and Català, 2007). Moreover, synthetic biology can even be included in an older tradition of thinking that was introduced by Goethe when he pointed out on the intrinsic value of a better understanding of life from an holistic perspective than when it was approached by the more successful analytic one. Biology has been dominated in the last century by the powerful analytic approach and the advent

of genomics, with their avalanche of data that led us to ask again on the possibility of a synthetic biology. The recent history of the discipline showed us that the notion of synthesis is not unique, and at least three different categories with different aims, methodologies and techniques can be distinguished: protocell creation, DNA-based device construction and genome-driven cell engineering (O'Malley et al., 2007). The aim of the protocell approach is to construct viable approximations of cells and to understand fundamental biological principles in general, and the origin of life in particular. The aim of the second approach is to apply the engineering principles to biology and to construct standardized biological devices. The third category of synthetic biology pursues the synthesis of minimal but complete genomes and their insertion in cells to redesign and control metabolic processes.

The aim of this session is two-fold. The first aim is to provide an appropriate historical perspective for a better understanding of this re-emerging field. The second aim is to think about the philosophical consequences of the three above-mentioned categories of synthetic biology.

Indicative bibliography:

Cho, M.K. et al.. 1999. Ethical considerations in synthesizing minimal genome. Science 286:2087-2090.

Church, G.M. 2005. From systems biology to synthetic biology. *Molecular Systems Biology* doi:10:10.1038/msb4100007.

Endy, D. 2005. Foundations for engineering biology. *Nature* 438:449-453.

Galperin, M.Y. 2008. The dawn of synthetic genomics. Environmental Microbiology 10:821-825.

Moya, A., Peretó, J., Gil, R., and Latorre, A. 2008. Learning how t olive together: genomics insights into prokaryote-animal symbiosis. *Nature Reviews Genetics* 9:218-229.

*O'Malley, M., Powell, A., Davies, J.F., and Calvert, J. 2007. Kowledge-making distinctions in synthetic biology. *BioEssays* 30:57-65.

*Peretó, J., and Catalá, J. 2007. The Renaissance of synthetic biology. *Biological Theory 2:128-130.*

Serrano, L. 2007. Synthetic biology: promises and challenges. Molecular Systems Biology 3:158.

Szostak, J.W., Bartel, D.P., and Luisi, P.L. 2001. Synthesizing life. *Nature* 409:387-390.

The Kavli Foundation. 2007. Report on the Kawly Futures Symposium "The merging of bio and nano: towards cyborg cells".

*Tucker, J.B., and Zilinskas, R.A. 2006. The promise and perils of synthetic biology. The New Atlantis Spring: 25-45

*Text of particular interest to be read before the session.

Synthetic Futures – Anticipatory Knowledge and Emerging Technologies of Life

Stephen Hilgartner

Biography*:*
I am associate professor and chair of the Department of Science & Technology Studies at Cornell University. My academic field is science & technology studies (STS), an emerging discipline devoted to studying the social aspects of knowledge, broadly construed to include knowledge packaged in texts, technologies, persons, and practices. I work in social studies and politics of emerging technologies, especially in genomics and the life sciences, and my research has examined such topics as genome laboratories and the construction of property; expert knowledge about risk; and the construction of credible science advice in contentious domains.

Session Outline:
In the new life sciences, and in other areas of emerging technology, claims-making about the future is ubiquitous. The assumption that the technology of tomorrow will be significantly different from that of today is widely shared, and states, corporations, and other bureaucratic actors expend considerable effort attempting to secure knowledge about future technical and social developments. Many forms of anticipatory knowledge—from the numerical outputs of systematic forecasting to the narratives and images of science fiction—are continually created and used to imagine futures of life.

In recent years, STS research has paid considerable attention to investigating how futures are imagined, through what means, and with what consequences. This session has two aims: to review some findings of STS research on anticipatory knowledge in the life sciences and to consider synthetic biology through this lens. To accomplish these goals, we will examine both primary documents, such as “roadmaps” and scientific advisory reports, and secondary literature on future-making, anticipation, and promissory science in biology.

Indicative Bibliography:

*note: this bibliography is illustrative only; specific texts to read prior to participation will be supplied later

Brown, Nik, Brian Rappert, and Andrew Webber, eds. 2000. Contested Futures: A sociology of prospective techno-science. Burlington, USA: Ashgate.
Fortun, Mike. 2001. "Mediated speculations in the genomic futures markets." New Genetics and Society 20(2): 139-156.
Hedgecoe, Adam and Paul Martin. 2003. "The drugs don't work: Expectations and the shaping of pharmacogenetics." Social Studies of Science 33(3): 327-364.
Hilgartner, Stephen. 2007. "Making the bioeconomy measurable: Politics of an emerging anticipatory machinery." BioSocieties 2(3): 382-6.
Kitzinger, Jenny and Clare Williams. 2005. "Forecasting science futures: Legitimising hope and calming fears in the embryo stem cell debate." Social Science & Medicine 61: 731–740.
National Research Council. 1988. Mapping and Sequencing the Human Genome. Washington, D.C.: National Academy Press.
OECD. 2006. "Scoping Document. The Bioeconomy to 2030: Designing a Policy Agenda" (June 2006).
Rabinow, Paul, and Talia Dan-Cohen. 2005. A Machine to Make a Future : Biotech Chronicles. Princeton, N.J.: Princeton University Press.
Sarewitz, Daniel, Roger A. Pielke, Jr., and Radford Byerly, Jr., eds. 2000. Prediction: Science, Decision Making, and the Future of Nature. Washington, DC: Island.
Selin, Cynthia. 2007. "Expectations and the emergence of nanotechnology." Science Technology Human Values 32(2): 196-220.
Sunder Rajan, Kaushik. 2006. Biocapital: The Constitution of Postgenomic Life. Durham: Duke University Press.
van Lente, Harro and Arie Rip. 1998a. "Expectations in technological developments: An example of prospective structures to be filled in by agency," Disco, Cornelis, and Barend van der Meulen. 1998. Getting New Technologies Together: Studies in Making Sociotechnical Order. New York: Walter de Gruyter.

Synthetic Biology: Of Property and Vision

Paul Oldham

Tutor Biography:
I am a Social Anthropologist working at the ESRC Centre for Economic and Social Aspects of Genomics (CESAGen) at Lancaster University. My background is in environment and human rights issues working with indigenous peoples in the Amazon and elsewhere. Much of my work now focuses on international policy debates and in particular on access to genetic resources and benefit-sharing under the Convention on Biological Diversity. As part of that

work I have been carrying out a review of global trends in patent activity for biological and genetic material. Synthetic biology is the final chapter in that research.

Session Outline:
This session will present some of the results of research on the international patent landscape for synthetic biology and will focus on recent patent activity for genome synthesis, genome transplantation, synthetic genomes, whole genome engineering and modular genomes. One of the main challenges involved in considering intellectual property issues is its relative invisibility. The aim of this session is to introduce some of the methodological tools that can be used for empirical analysis of intellectual property issues and discuss their strengths and weaknesses.

In exposing these landscapes the session will also raise some wider questions. Thus, if historically 'biotechnology' has been oriented towards improvements upon natures designs, does synthetic biology through its emphasis upon chemical synthesis, engineering and assembly represent a more radical departure to *making*? If so, what, if any, are the implications of this shift for the human capacity to intervene in evolutionary processes by directing evolution at a variety of levels?

The process of making also involves processes of envisioning both in terms of pursuing and achieving results and in terms of imaging possible futures. It is here that the careful language of science, i.e. Gibson et al 2008, departs into the realm of imaginary visions of possible futures in connection with synthetic genomes. What do these visions and assertions of rights over possible futures mean for the rest of us?

In preparing for this session, participants could usefully read a combination of one or more of the articles indicated below. Participants may wish to review the ETC Group report Extreme Genetic Engineering and the following two patent documents *Installation of genomes or partial genomes into cells or cell-like systems* US20070269862 and *Synthetic Genomes* US20070264688 from the Venter Group and the ETC Group item entitled Extreme Monopoly: Venter's Team Makes Vast Patent Grab on Synthetic Genomes.

Suggested Readings:

*Benner, S. A., and A. M. Sismour. 2005. Synthetic biology. *Nature Reviews Genetics* 6 (7):533-543.

*Endy, D. 2005. Foundations for engineering biology. *Nature* 438 (7067):449-453.
*Forster, A. C., and G. M. Church. 2007. Synthetic biology projects in vitro. *Genome Research* 17 (1):1-6.
Garfinkel, M. S., D. Endy, G. L. Epstein, and R. M. Friedman. 2007. Synthetic genomics - Options for governance. *Biosecurity and Bioterrorism-Biodefense Strategy Practice and Science* 5 (4):359-361.
*Gibson, D. G., G. A. Benders, C. Andrews-Pfannkoch, E. A. Denisova, H. Baden-Tillson, J. Zaveri, T. B. Stockwell, A. Brownley, D. W. Thomas, M. A. Algire, C. Merryman, L. Young, V. N. Noskov, J. I. Glass, J. C. Venter, C. A. Hutchison, and H. O. Smith. 2008. Complete chemical synthesis, assembly, and cloning of a Mycoplasma genitalium genome. *Science* 319 (5867):1215-1220.
Glass, J. I., N. Assad-Garcia, N. Alperovich, S. Yooseph, M. R. Lewis, M. Maruf, C. A. Hutchison, H. O. Smith, and J. C. Venter. 2006. Essential genes of a minimal bacterium. *Proceedings of the National Academy of Sciences of the United States of America* 103 (2):425-430.
Holt, R. A., R. Warren, S. Flibotte, P. I. Missirlis, and D. E. Smailus. 2007. Rebuilding microbial genomes. *Bioessays* 29 (6):580-590.
*Lartigue, C., J. I. Glass, N. Alperovich, R. Pieper, P. P. Parmar, C. A. Hutchison, H. O. Smith, and J. C. Venter. 2007. Genome transplantation in bacteria: Changing one species to another. *Science* 317 (5838):632-638.
O'Malley, M. A., A. Powell, J. F. Davies, and J. Calvert. 2008. Knowledge-making distinctions in synthetic biology. *Bioessays* 30 (1):57-65.

Day six

The Political Economy of the Technosciences of Bios.

Hilary Rose

Tutor Biography:
Emerita professor of social policy at Bradford University and of physik at Gresham College, London. As a sociologist my interest has lain in the intersection between science and technology –today between the global technosciences, culture and society. My long project has been has been how can the technosciences be made accountable and socially responsible - so issues of policy and governance have been a frequent concern. But it has also led me to pursue issues of how science shapes our changing cultural understandings of our gendered and 'raced' human nature, with today's return to the biological reconstruction of 'race' via the molecularistion of bios itself, and

its resistance as expressed in the reaction to Jim Watson's outrageous racist statement.
Within feminist science studies I see my work as trying to take part in the theoretical debates particularly around feminist standpoint theory but also always seeking to maintain conversations with women in science. For this double agenda see my book, *Love, Power and Knowledge* (Polity, 1994). Recently I have been concerned with DNA biobanking and the commodification of both bodies and bioinformation, and in race and genetics. My current interest is in human embryonic stem cell research and the neuro-technosciences.

Session outline:
This session will address four themes: how biology became biotechnology; biotech –hopes, hypes and threats; biotech within globalisation and the possibilities of a socially responsible science.
I discuss globalisation and three transformations of boundaries:
First through space and time - the collapse of geographical distance, instant communication, 24 hr financial markets, new social connections.
Second the weakening or loss of national sovereignty- the free movement of capital but semi –free movement of labour, precarity of employment for most- including the research labs.
Third the blurring of once secure boundaries between culture and nature so that today "nature" is materially and socially constructed in the laboratories - from oncomouse to chimeras. The Chakrabarti case opened the door to patenting life itself.
Then follows a brief account of the transformation of biology from the 1950s, a time of little biology and the double helix, with the molecularisation of the life sciences. By the 1970s genetic engineering and reproductive technologies begin to arrive, accompanied by hope/hype and risk. With the 80s and the move to neoliberalism , the lines between the academic life sciences and industry blur, science and technology fuse into the technosciences with their drivers of venture capital, global corporations, intellectual property, patents and immense profits. The launch of the global Human Genome Project in 1990 was accompanied by unparalleled hype in the *Science* editorial heralding genetic therapy for everything from cancer to homelessness.
Ten years on, with rather little in the way of successful genetic engineering therapies, genetics has become subsumed within genomics along with the proliferation of the OMICS. Meanwhile the technosciences become part of what has been called a new mode of production. My own work on deCode's DNA data base for the entire Icelandic population and a later study of the Swedish Umangenomics form examples of the promises and perils of the technosciences.
Lastly the 'trust gap' between science and society has led to a variety of

initiatives by the EU and national governments to close the gap by forms of citizen participation. These projects can be read either as recruiting the publics to the project of the technosciences or as an attempt to render them socially accountable. How far this can be done when the technosciences are both global and national remains an open question.

Suggested reading:

Troy Duster (2005) Race and Reification in Science. *Science* **307**: 1050-51.

Donna Haraway (1991) Situated Knowledges: the science question in feminism and the privilege of partial perspectives. In *Simians, Cyborgs and Women,* New York, Routledge

Sandra Harding (ed) (2004) *The Feminist Standpoint Theory Reader; intellectual and political controversies,* New York, Routledge

Michael Hardt and Antonio Negri (2004) *Multitude, War and Democracy in the Age of Empire*, Cambridge, Ma, Harvard UP

David Held and Anthony McGrew (2000) *The Global Transformation Reader*, Cambridge, Polity

Ruth Hubbard, MF Henifin and Barbara Fried (eds) (1982) *Biological Woman: the convenient myth*. Cambridge, MA, Schenkman

Alan Irwin and Brian Wynne (eds) (1996) *Misunderstanding Science: the public reconstruction of science and technology*, Cambridge UP

Sheila Jasanoff (ed (2004) *States of Knowledge: the co-production of science and social order.* New York, Routledge

Jonathan Kahn 2004. How a Drug Becomes 'Ethnic': Law, Commerce, and the Production of Racial Categories in Medicine. *Yale J. of Health Policy, Law & Ethics* **4**: 1-46, 22-23.

Richard Lewontin, (2005) The fallacy of racial medicine: confusions about human races. *Social Science Research Council*: http://raceandgenomics.ssrc.org

Helga Nowotny, Peter Scott and Michael Gibbens (2001) *Rethinking Science : knowledge and the public in an age of uncertainty* Cambridge, Polity

Hilary Rose (2004) Hand Brain and Heart: towards new epistemology or the sciences, in Harding, op. cit.

Hilary Rose (2006) From Hype to mothballs in 4 years, troubles in the development of large scale biobanks in Europe, *Community Genetics*, **9** (3) 184-189

Defining Death, Life and Identity through Novel forms of Property

Patrick Taylor

Tutor Biography:
I am a Lecturer at Harvard Medical School, Boston, Massachusetts, and the Deputy General Counsel and Chief Counsel for Research Affairs at Children's Hospital Boston. My academic training was primarily in biology and philosophy followed by law. My academic research interests, and a significant part of professional practice, have focused on research ethics, medical ethics, intellectual property, academic-industry collaborations, conflicts of interest, stem cell research, and privacy.

Session Outline:
The capital economy has changed science, and the pursuit of patents has reframed new living "constructs" as tools and objects of interwoven economic activity and scientific discovery. We will discuss these important points, which occupy much of the current literature on industry, intellectual property, and their effects on biomedical innovation, academic research and the professional self-definition of academic researchers.

But is that the end of the story? We will also look at examples of how death and life have been redefined for functional ends that have supported new forms of entitlement, including ownership of and property in living matter, through a series of fictions about when death occurs and life and identity emerge. Not just death and life, but concepts of identity and property co-evolve, and they do so for complex but identifiable reasons.

The aim of this session is three-fold. First, participants should be able, by end, to work with basic concepts of intellectual property law, and to understand the polarized debate around the impact of intellectual property on science. Second, they should be able to question common assumptions in that debate concerning the fixed nature of property interests, the concrete nature of scientific categories, and the extricability of professional virtues and scientific decisions from their legal and technological matrix. Third, they should be able to continue to deliberate, after the course, on the malleability of both natural and legal categories, and implications for the moral responsibility of scientists in engaging in production of knowledge.

Bibliography:

Texts that students will want to have read before participating in this session:

Angell M. Is academic medicine for sale? N Engl J Med 2000;342:1516-1518.

Bergman KB, Graff GD. The global stem cell patent landscape: implications for efficient technology transfer and commercial development. Nature Biotechnology 2007;25(4):419-425.
Nathan DG, Weatherall DJ. Academic freedom in clinical research. N Engl J Med 2002;347:1368-1371
DeAngelis CD et al. Impugning the integrity of medical science: the adverse effects of industry influence. JAMA 2008;299(15):1833-35.
Martinson BC, Anderson MS, deVries R. Scientists behaving badly (Commentary). Science 2005; 435:737-738
Mello MM, Clarridge BR, Studdert DM. Academic medical centers' standards for clinical trial agreements with industry. N Engl J Med 2005;352:2202-2210.
Steinbrook R. Gag clauses in clinical-trial agreements. N Engl J Med 2005;352:2160-2162
Taylor P. Research sharing, ethics and public benefit. Nature Biotechnology 2007;25(4):398-401
Truog RD. Brain death – too flawed to endure, too ingrained to abandon. Journ Law, Med and Ethics 2007;35(2):273-281.

Sociological reflections on stem cell translational research: Can Bourdieu help us?

Steven Wainwright

Biography:
Steven Wainwright is Professor of Sociology of Medicine, Science & the Arts, and founder and Co-Director of the Centre for Biomedicine & Society (CBAS), School of Social Science, King's College London. His research focuses on two areas: the connections between Medical Sociology & Science Studies (especially new medical technologies); and the Sociology of the Arts (particularly the notion of embodied vulnerability in classical ballet, opera, and Romantic painting). He recently completed an ESRC study on stem cells and the bench-bedside interface (mapping stem cell innovation in action), and he is currently an ESRC Research Fellow, working on a qualitative research study of embryonic stem cells (spaces of stem cell science). Over the next five years he will be working on sociological facets of interdisciplinary research and biomedical ethics in the fields of interspecies embryos and experimental neuroscience through a Wellcome Trust *Biomedical Ethics Strategic Award* which establishes *LABTEC – The London & Brighton Translational Ethics Centre*. He is an Editor of the leading Sociology journal: *Sociology of Health & Illness*.

Session objectives:

1. To explore the nature of translational research;
2. To describe some recent social research papers on embryonic stem cells which draw on a range of established STS concepts;
3. To examine the potential of a Bourdieusian framework for research on 'stem cell translation' in particular, and, more especially, for STS more broadly.

Background:
The prospects for a new era of regenerative medicine built on human embryonic stem cell technologies is invariably based on a linear model which sees stem cell science leading to cell transplant medicine. I outline a four stage model of translational research (from molecules/genetics, to animal models, to experimental medicine, to clinical trials) as a prelude to my review of the complex nature of this rhetorical 'health research pathway'. I discuss the problems within and between basic science and clinical medicine and highlight the social complexities of the 'translational pipeline'. I outline a host of well established STS concepts, for example, on expectations (Hedgecoe), boundary-work (Gieryn), boundary objects (Star & Griesemer), core set (Collins), and geographies of science (Livingstone) that we have employed in our research on stem cells.

However, I am also beginning to argue for the increased use of the ideas of Pierre Bourdieu in the field of STS. Despite the pre-eminent position of Bourdieu in areas such as the sociology of education and cultural sociology there is a relative 'absence of Bourdieu' in science studies. I outline key elements of Bourdieu's conceptual toolkit: habitus, illusio, capital and field. In brief, fields are hierarchies of power within social worlds which produce a set of dispositions (a habitus, where agents reflect the structures they are embedded in), and where individuals and institutions strive to accumulate capital to maintain (and enhance) their position within a field. Capital takes various interrelated forms: economic (money), social (networks), cultural (education), symbolic (status), and so Bourdieu's schema is useful in understanding the complex (and sometimes hidden) production and reproduction of social worlds (eg inequalities in education).

I illustrate the salience of a Bourdieusian approach to science and medicine through a discussion of our research on the field of 'bench to bedside' embryonic stem cell research. In particular, I highlight the tensions in habitus, illusio and different forms of capital within and between both laboratory science and clinical medicine. I adopt Bourdieu's imperative to use and adapt his 'conceptual toolkit' and I introduce five 'new notions': expectational, scientific and clinical capital; and individual and institutional habitus. I conclude with a discussion of the value of a Bourdieusian approach in understanding, and

therefore potentially changing, the production and reproduction of (inequalities in) medicine, science and society.

Suggested reading - key readings are marked *:

Bourdieu, P. (1984) *Distinction: a social critique of the judgement of taste* London: Routledge.
Bourdieu, P. (2004) *Science of science and reflexivity* Cambridge: Polity.
Bourdieu, P. & Wacquant, L. (1992) *An invitation to reflexive sociology* Cambridge: Polity Press.
Brosnan, C.J. (2008) *The sociology of medical education: the struggle for legitimate knowledge in two English medical schools.* Unpublished PhD Thesis, University of Cambridge, UK.
*Burri, R.V. (2008) Doing distinctions: boundary work and symbolic capital in radiology. *Social Studies of Science* 38: 35-62.
Collins, H. (2004) *Gravities shadow: the search for gravitational waves*. Chicago: Chicago University Press.
Gieryn, T.F. (1999) *Cultural boundaries of science: credibility on the line.* Chicago: Chicago University Press.
Hedgecoe, A. (2004) *The politics of personalised medicine: pharmacogenetics in the clinic.* Cambridge: Cambridge University Press.
Livingstone, D.N. (2003) *Putting science in its place: geographies of scientific knowledge.* Chicago: Chicago University Press.
Martin, P. Brown, N. & Kraft, A. (2008) From bedside to bench? Communities of promise, translational research and the making of blood stem cells. *Science as Culture* 17: 1-13.
Michael, M. Wainwright, S.P. Williams, C. Farsides, B. & Cribb, A. (2007).From core set to assemblage: on the dynamics of exclusion and inclusion in the failure to derive beta cells from embryonic stem cells. *Science Studies* 20(1): 5-25.
Scott, C.T. (2006) *Stem cell now: from the experiment that shook the world to the new politics of life.* New York: Pi Press.
Star, S.L. & Griesemer, J. (1989) Institutional ecology, “translations” and boundary objects: amateurs and professionals in Berkeley’s Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* 19: 387-420.
*Wainwright, S.P. Williams, C. & Michael, M. Farsides, B. & Cribb, A. (2006a) From bench to bedside? Biomedical scientists’ expectations of stem cell science as a future therapy for diabetes. *Social Science & Medicine* 63: 2052-2064.
Wainwright, S.P. Williams, C. Michael, M. Farsides, C. & Cribb, A. (2006b) Ethical boundary work in the embryonic stem cell laboratory. *Sociology of Health & Illness* 28**:** 732-748.
Wainwright, S.P. Williams, C. & Turner, B.S. (2006c) Varieties of habitus and the embodiment of ballet. *Qualitative Research* 6: 535-558.

Wainwright, S.P. Williams, C. & Michael, M. Farsides, B. & Cribb, A. (2007) Remaking the body? Scientists' genetic discourses and practices as examples of changing expectations on embryonic stem cell therapy for diabetes. *New Genetics & Society* 26: 251-268.
Wainwright, S.P. & Williams, C. (2008) Spaces of speech and places of performance: an outline of a geography of science approach to embryonic stem cell research and diabetes. *New Genetics & Society* 27: 161-173.
*Wainwright, S.P. Michael, M. & Williams, C. (2008) Shifting paradigms? Reflections on regenerative medicine, embryonic stem cells and pharmaceuticals. *Sociology of Health & Illness* (in press, should be available online in August).
Williams, C. Wainwright, S.P. Ehrich, K. & Michael, M. (2008) Human embryos as boundary objects? Some reflections on the biomedical worlds of embryonic stem cells and pre-implantation genetic diagnosis. *New Genetics & Society* 27: 7-18.

Note: for a list of papers that I use on my MSc module on *Translational Research: Linking Medicine, Science & Society* you can download our MSc handbook from the CBAS homepage:
http://www.kcl.ac.uk/schools/sspp/interdisciplinary/cbas/