Summer School
on
Evolutionary Developmental Biology

conceptual and theoretical aspects of evolutionary developmental biology

organized by Alessandro Minelli, Michael Akam, Gerd B. Müller and Giuseppe Fusco

Venezia, Istituto Veneto di Scienze, Lettere ed Arti

14-17 September 2009

Program

September 14th
8.30-12.00

GERD B. MÜLLER

Introduction to evolutionary developmental biology

The first unit provides an overview of the origins, basic ideas, specific questions, empirical research programs, and theoretical consequences of EvoDevo. The introduction will address the basic tenets of evolutionary theory, the effects of developmental factors in organismal evolution, and the conceptual extensions of evolutionary theory afforded by the results of EvoDevo. The unit will terminate in an overview of new tools for the acquisition of three-dimensional and four-dimensional developmental data that can be used for the computational representation, quantitative analysis, comparison, and modelling of developmental processes. The introduction does not contain practical activities.

13.00-16.30

ALESSANDRO MINELLI and *GIUSEPPE FUSCO*

Post-embryonic development, the forgotten ontogeny

Postembryonic development is not just allometric growth. There is much more to late development than simply going on with processes already put in place during early embryogenesis. Strictly focusing on the earliest part of ontogeny introduces a systematic bias in our understanding of the evolution of development. This unit aims to suggest a new perspective able to extend evo-devo studies to late embryonic and post-embryonic development. Practical activity focuses on strategies of comparative analysis that try to go beyond the fixed frames imposed by established categories and definitions (eg. in ontogeny periodization and body organization) in order to generate unconstrained evo-devo questions.

September 15th
8.30-12.00

EINHARD SCHIERENBERG

Developmental changes during evolution at the cellular level

The way how an organism emerges from a single egg cell varies considerably not only between animal phyla but even between closely related species. After a broad overview of early development in the animal kingdom nematodes will be chosen as significant examples for a comparative analysis of early embryogenesis taking the model system *Caenorhabditis elegans* as a standard. Different pathways and their underlying mechanisms (revealed by various ways of experimental interference) will be discussed as "developmental strategies" shaped by evolutionary history and selection. Practical activity will focus on essential steps of early embryogenesis in nematodes including establishment of polarity, formation of body axes and bilateral symmetry, soma-germline separation and gastrulation.

13.00-16.30

MICHAEL AKAM and *JOHANNES JAEGER*

Gene expression and gene networks: possibilities and limitations of genetic manipulation

Outline will be available soon.

September 16th

8.30-12.00

STUART A. NEWMAN

The role of physics in the origination and development of biological form

The clusters of cells leading to the first complex multicellular organisms were, like all mechanically and chemically active matter, subject to a characteristic set of physical laws. Considering the physical determinants acting on these ancient forms helps explain why animals, for example, look the way they do. In particular, the morphological motifs of animal body plans and organs: multilayered, hollow, elongated, segmented, involuted and appendaged tissue masses, are predictable outcomes of the physics of active "mesoscale" materials. These physical effects were, by default, mediated by ancient gene products that first arose in unicellular lineages. A comparative review of developmental mechanisms will show that "dynamical patterning modules," consisting of elements of the developmental-genetic toolkit and the physical processes they mobilize, remain conserved determinants of embryogenesis in modern animals.

13.00-16.30

JUKKA JERNVALL and *ISAAC SALAZAR-CIUDAD*

Mathematical modelling: pattern formation mechanisms and their role in morphological variation and evolution

These lectures will cover how different mechanisms of pattern formation are responsible for the production of morphological variation. A special emphasis is on morphological variation at the level of populations. We will first review the mechanisms of pattern formation proposed in the literature. From there we will introduce the main mathematical models dealing with pattern formation; including the underlying assumptions and data used to construct and test these models. The direction of morphological change in evolution will be conceptualized as an interplay between natural selection and the variational properties of development.

September 17th

8.30-12.00

MADAN BABU

Computational approaches to investigate transcriptional regulation

Outline will be available soon.

13.00-16.30

RONALD JENNER

Tree thinking - the importance of phylogenetics in evo-devo

This unit will introduce important phylogenetic concepts and methods that belong in every evo-devologist's toolkit. Topics covered include the ingredients of critical tree thinking, the gene tree-species tree dualism, hierarchical phylogenetics and phylostratigraphy, methods of ancestral state reconstruction, the node density effect, molecular clock estimates of divergence times, comparison of molecular and morphological evolutionary rates, the significance of branch lengths and phylogenetic position, the value of model organisms for comparative and evolutionary research, and the relevance of fossils. The material will be presented in the form of lectures and through computer demonstrations.