

Cycle G: Gene Expression and Epigenetics

Coordinator: Susan Gasser

G1: Dynamics and Maintenance of the genome:

DNA replication, repair, recombination – 19520

(2 hrs/week; 2 CP; Spring 2020)

S. Gasser, **P. Schär**

With many genomes having been sequenced, our understanding of the basic enzymology that ensures its replication and faithful transmission from mother to daughter cells now takes center stage. The lectures will cover mechanisms, regulation and biological significance of DNA metabolism in all forms. This will include general aspects of genome organization and dynamics, the enzymology, control and coordination of DNA replication, and the formation and repair of the various forms of DNA damage that occur continuously in our cells. In addition to the molecular and mechanistic aspects, the course will illustrate the significance of genome instability and maintenance in development, carcinogenesis, premature ageing and other forms of genetic degenerative conditions.

G2: Transcription, Regulation and Gene Expression in Eukaryotes – 13709

(2 hrs/week; 2 CP; Spring 2020)

J. Betschinger, J. Chao, L. Giorgetti, **P. Matthias**

This course deals with transcriptional regulation and gene expression, in particular in eukaryotes. The emphasis will be put on understanding the regulatory interplay between transcription factors and their crucial role in translating environmental and developmental cues into coordinated activation of the genome.

Topics that will be discussed include: Regulatory DNA sequences: promoters, enhancers, locus control regions; General transcription machinery; Transcription factors, cell-specific and ubiquitous; Mechanistic aspects of transcription activation; Chromatin, histone modifications, DNA methylation; Genome 3D organization and its impact on gene expression; Gene regulatory networks; Enhancers and Super-enhancers as integrators of gene activity; Transcription factors as master controllers of cellular differentiation; Transcription factors in health and disease; Functional dissection of transcription control by genome-wide screens; Quantitative analysis of transcription control.

G3: Frontiers in RNA Biology – 13186

(2 hrs/week; 2 CP; Fall 2020)

M. Bühler, H. Grosshans

The discovery that RNA is not only a carrier of genetic information or a structural scaffold in ribonucleoprotein particles but can also act as a catalyst in many different cellular processes, greatly stimulated research on the structure, processing and function of RNA. The lecture will cover the following topics: chemistry and structure of RNA; major classes of cellular RNAs (mRNAs, tRNAs, rRNAs, snRNAs, and the newly discovered small regulatory ~20-nt RNAs); chemistry and structure of RNA; pre-mRNA processing with emphasis on splicing and polyadenylation; biogenesis of tRNA and rRNA; biochemistry and function of RNA interference (RNAi) and microRNAs; RNA trafficking in the cell, RNA quality control and RNA degradation; and regulated mRNA translation during development. Also covered are RNA-protein interactions and major classes of ribonucleoprotein particles and the evolution of RNAs.

G4: Chromatin and Epigenetics – 17913

(2 hrs/week; 2 CP; Spring 2021)

S. Gasser, R. Paro, **D. Schübeler**

This course will cover all aspects of heritable patterning of gene expression and the biological importance of "epigenomes". The modification of nucleosomes and of DNA, and the assembly of chromatin into higher order structures will be discussed. Mechanisms of inheritance will be presented as well as imprinting, X inactivation, and the role of RNA in establishing silent chromatin. Finally, the course will cover the impact of chromatin structure on differentiation, cell plasticity and development.

G5: Translational Control and Post-Translational Protein Modification – 18367

(2 hrs/week; 2 CP; Fall 2019)

M. Hall, A. Schmidt, N. Thomä

This course will describe the components of the translational apparatus and their putative roles in each of the three steps of protein synthesis: initiation, elongation, and termination. The first part of the course will draw information from the current literature to cover specific cases of translational control. The translational control section will cover a wide spectrum of topics including frame shifting, attenuation, phosphorylation, and transformation. The second part of the course will emphasize the role of translational control in the regulation of cell growth, with particular emphasis on the TOR signaling network. Once synthesized, proteins often require posttranslational modifications either to achieve their full biological activity or to regulate their activity. In these lectures we will discuss the various forms of posttranslational modifications of proteins and the consequences of these modifications for protein function. The lectures will give an up-to-date overview of protein splicing, poly-protein processing, different forms of modifications of amino acids, protein folding and protein transport phenomena requiring proteolysis.