Attachment 2:

Course Description

(1) Nutrient Sensing in the Brain

Metabolic syndrome, obesity and type 2 diabetes are among the leading cause of morbidity and mortality globally. The majority of previous work focuses on the peripheral pathogenesis of these disorders, bu little is known on the central molecular mechanism and neurocircuits underlying these processes. In class, Prof. Sabrina Diano will explain in detail the role of metaolic hormones, such as Leptin and Ghrelin in energy and glucose homeostasis. Afterwards, Prof. Sabrina Diano will explain how to explore the brain mechanisms regulating energy and glucose homeostasis, utilizing interdisciplinary approaches, including molecular biology, anatomy, biochemistry, behavior, electrophysiology, and chemogenetics, in rodent models. In addition, we will discuss nutrient sensing by the brain aim to identify inter- and intra-cellular mechanisms that enable brain cells to regulate energy and glucose metabolism and how derangements of these mechanisms induce the development of metabolic disorders. Finally, Prof. Sabrina Diano will summarize the hypothalamic regulation of energy and glucose homeostasis, using recently published work from Diano's lab as examples, especially the role of reactive oxygen species as metabolic signals and mitochondrial dynamics in energy sensing..

(2) Metabolic control of cell fate commitment

Maintenance of stem cell properties and directed differentiation is critical for long-term tissue homeostasis. Under physiological conditions, directed differentiation of stem cells contributes to tissue repair and regeneration. Under pathological conditions, abnormal stem cell self-renewal and differentiation can lead to diseases such as cancer. Metabolism of glucose, fatty acids and amino acids can alter the energy state of stem cells, and the resulting metabolites are important components of epigenetic modulations, such as DNA methylation and histone acetylation, which determine stem cell maintenance and differentiation. However, the coordination and transition between different metabolic pathways in stem cell stemness and differentiation remains unclear. Prof. Sofia-Iris Bibli will review recent advances in metabolic and epigenetic regulation in stem cell biology and present recent findings from her laboratory on the metabolic regulation of cell fate commitment during embryonic development.

(3) Cysteine metabolism in obesity and cancer

Cysteine is a Sulphur-containing amino acid that is essential for cellular functions such as protein synthesis, detoxification and metabolism. In obesity, elevated cysteine levels are associated with increased fat mass and metabolic dysregulation. Cysteine promotes adipogenesis and influences energy expenditure, thereby affecting overall metabolic health. In cancer, cancer cells often upregulate cysteine metabolism to increase proliferation and resist chemotherapy. Cysteine supports tumor growth and survival by maintaining redox balance and supporting biosynthetic pathways. Prof. Andreas Papapetropoulos will review and summarize the role of cysteine metabolism in the development of obesity and cancer, and explore potential therapeutic strategies targeting cysteine metabolism for these critical health issues based on the latest findings from his laboratory.

(4) Stem Cell Biology, Eukaryotic Genetics

The course will start with the basic concepts of stem cell biology and, through the analysis of the concepts, will lead to the key advances in the understanding of stem cells over the last three decades in eukaryotes through genetic approaches, especially using Drosophila genetics. In class, Prof. Benjamin Ohlstein will explain in detail the emergence of the concept of the stem cell niche and the important role it plays in stem cell maintenance. Afterwards, Prof. Ohlstein will explain the stem cell lineage tracing methodology and the research ideas behind it, utilizing the stem cell research paradigm in the gut epidermis, enabling an understanding of stem cell lineage specifications. In addition, we will discuss the development and regeneration of stem cells in tissues, thus linking stem cell biology to clinical medicine. Finally, Prof. Ohlstein will explain the important role of Notch signaling pathway in stem cell differentiation and the effect of gastric acid on intestinal stem cells and intestinal health, using recently published work from Prof. Ohlstein's lab as examples.

(5) Interorgan communication and metabolic regulation

Different metabolic organs in the body, such as the liver, adipose tissue, and muscle, possess highly specialized metabolic regulatory functions. Interorgan communication serves as a critical mechanism for mobilizing all body organs to collectively respond to environmental and physiological changes. Recent researches indicate that individual organ(s) can directly influence the physiological functions of others through secreted factors (like secreted proteins, metabolites, and extracellular vesicles) or hormones. Dysregulation of interorgan communication directly contributes to the occurrence and progression of various metabolic disorders, including aging, obesity, diabetes, and cancer cachexia. In this session, Prof. Wei Roc Song will review the discovery history

of key metabolic hormones, discuss the identification of metabolic tissues or organs and pivotal signaling pathways, and explore recent advancements and future directions in the field, including his laboratory's contributions to understanding interorgan communication in a broad range of metabolic diseases.

(6) Basic concepts of innate immunity and host-microbe interactions

While largely neglected over decades during which adaptive immunity captured most of the attention, innate immune mechanisms have now become central to our understanding of immunology. Innate immunity provides the first barrier to infection in vertebrates, and it is the sole mechanism of host defense in invertebrates and plants. Innate immunity also plays a critical role in maintaining homeostasis, shaping the microbiota, and in disease contexts such as cancer, neurodegeneration, metabolic syndromes, and aging. The emergence of the field of innate immunity has led to an expanded view of the immune system, which is no longer restricted to vertebrates and instead concerns all metazoans, plants, and even prokaryotes. In this talk, Prof. Zongzhao Zhai will recall the history of the core concepts of innate immune recognition that led to the Nobel Prize in Physiology or Medicine 2011, and discuss the basic principles and physiological consequences of host-microbe interactions especially in the intestine.