Recommended knowledge in Cell Biology

1) Cell and cellular organelles (structure, function, visualization, isolation)

2) Methods in cell biology (Visualization, cell fractionation, isolation)

3) Intracellular compartments and protein trafficking

4) Intracellular Vesicle traffic, secretion and endocytosis

5) Protein modification (phosphorylation, glycosylation, ubiquitylation)

References:

Molecular Biology of the Cell, 5th Edition, Alberts et al., 2008
or
Molecular Cell Biology, 6th edition, Lodish et al., 2008

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Recommended knowledge for the Immunology section of the master course

Basic concepts and topics to understand and know before starting the master course:		Learning material
1) Function of the immune system 2) Hematopoiesis 3) Myeloid and lymhpoid cell lineages and their functions 4) Lymphoid organ architecture and function 5) Innate immune system and inflammation 6) Adaptive immune system 7) Antigen receptors: generation, diversity, clonal selection, tolerance 8) Antigen processing and presentation, MHC molecules 9) Dendritic cells, antigen-presenting cells 10) Antigen recognition and immune response 11) T cell subsets and function 12) Antibodies 13) Effector mechanisms of adaptive immunity 14) Immunological memory, principle of vaccination 15) Harmful immune responses: Allergy, autoimmunity and graft rejection		**Textbook 'Janeway's Immunobiology' Chapter 1: Basic concepts in immunology, p. 1-36** **and / or** **Refresher training program on the e-learning website of this master program ('Basic concepts in Immunology')**

Reference:

- *Janeway's Immunobiology, Kenneth Murphy et al., Garland Science, 8th edition (2011)* This textbook will also be the main reference for the immunology course in the 1st and 2nd master semester.
- Refresher training program: open to all registered students (http://unil.bio-med.ch/); includes images and animations

Prof. Werner Held and Prof. Sanjiv Luther

Recommended knowledge for the Cancer section of the master course

Basic concepts and topics to understand and know before starting the master course:		Review:
1) The 'nature' of cancer 2) Multistep tumorigenesis 3) Cellular oncogenes 4) Tumor suppressors		**The Hallmarks of Cancer, by D.Hanahan and R.A.Weinberg. *Cell 100: p. 57 70 (2000) (14 page review)***

		and / or **Refresher training program on the e-learning website of this master program ('Hallmarks of cancer')**

Reference:

- Review: downloadable at (http://download.cell.com/pdf/PIIS0092867400816839.pdf) or on the master website (http://unil.bio-med.ch)

- Refresher program available on the master website (http://unil.bio-med.ch), including images and animations

For further reading: we recommend the Textbook "The Biology of Cancer" (Robert A. Weinberg), Garland Publishing Inc, 2nd edition 2013, that will be the main reference for the 1st and 2nd semester course.

Prof. Daniel Speiser and Prof. Fabio Martinon

From early september onward all registered students will also be granted access to **the e-learning website dedicated to the immunology & cancer courses of the master program.** You will be asked in september to do an **online-test** (not graded and anonymous for the teachers!) with 29 basic questions in immunology and 23 in cancer to test your knowledge and encourage you to fill your gaps yourself before starting the master course.

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Master in Medical Biology

Recommended knowledge in Metabolism

The following metabolic pathway should be known beforehand:

- Glycolysis
- Neoglucogenesis
- Glycogen synthesis
- Fatty acids and triglyceride synthesis
- Krebs cycle
- Protein translation

The basic regulation of receptor tyrosine kinases, G protein-coupled receptors, small GTP-binding proteins should also be known.

References

Biochemistry:
Devlin T.M, "BIOCHEMISTRY" (2010) John Wiley & Sons, Inc.

Signaling:
Handbook of Cell Signaling (Cell Biology) (Hardback) Edited by Ralph A. Bradshaw, Edited by Edward A. Dennis

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Recommended knowledge cardiovascular diseases

PHYSIOLOGY OF THE CARDIOVASCULAR SYSTEM

Heart:
-anatomy

-electrical activity:

- **the heart conduction system**
- **cardiac action potential**
- **electrocardiogram**
- **-excitation-contraction coupling**

-cardiac cycle

-cardiac output

- **-effect of sympathetic/parasympathetic system**
- **Frank-Starling law**

Vascular system:

General concepts: pressure, resistance, Poiseuille equation

- **Arteries, arterioles**
  -arterial pressure, compliance, systolic and diastolic pressure, effect of the sympathetic system
- **veins**
  -venous pressure and blood volume, venous return

- **regulation of systemic blood pressure, baroreflexes**

References:

Medical Physiology, Boron et Boulpaep, Chapters 17-25

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Recommended Requirements Neurosciences

Tissues Biology: the Nervous Tissue and the Nervous System

Goals

The goal of this course is to allow students to understand how animal cells organize themselves to form tissues and to familiarize the students with the structural and functional properties that are specific to each tissue. The student will need to have understood and be able to explain:

- The notions of tissue and organ
- The notions of cell and extracellular matrix
- The criteria for classification and the properties of the studied tissues
- The relations existing between cell structure and function
- The notion of structural or functional defect at the cellular level as possible cause of disease

Content

1. Function and organization of the Nervous System
2. Neurons
    a. Historical perspective
    b. General properties
    c. Ultrastructural characteristics:
        i. Cell body
        ii. Dendrites
        iii. Axon
        iv. Synapse (transmission dynamics at chemical synapses)
        v. Cytoskeleton
3. Glial cells
    a. Glial cells of the Peripheral Nervous System (PNS):
        i. Schwann cells
        ii. Satellite cells
    b. Glial cell of the Central Nervous System (CNS):
        i. Oligodendrocytes
        ii. Astrocytes
        iii. Microglia
        iv. Ependymal cells
4. Nervous Tissue organization in the PNS:
    a. Peripheral nerves
    b. Ganglia
    c. Somatic and autonomous PNS
5. Nervous Tissue organization in the CNS:
    a. Cerebral cortex, cerebellar cortex, spinal cord
    b. Meninges and cerebral spinal fluid
6. Comparative Neurobiology

Reference Books:

1. Junqueira, L.C., Carneiro, J., Kelley, R.O. “Histology” 2nd Edition PICCIN ISBN-10: 8829916056; ISBN-13: 978-8829916054

2. Boron, W.F., Boulpaep, E.L. "Medical Physiology" 1st ed (2002) W.B. Saunders Company ISBN: 1416023283.
3. Ross, M.H., Pawlina, W "Histology: a text and atlas with correlated cell and molecular biology" 5th ed. LIPPINCOTT WILLIAMS & WILKINS, Philadelphia ISBN: 0-7817-5056-3

Introduction to Neurosciences

Goals
The goal of this course is to provide an ensemble view of the organization and function of the Nervous System, at both the cellular and system levels.

Contents
1. General Introduction (A. Volterra)
    a. What do Neurosciences study?
    b. Electrical excitability: the basis of cell-cell communication
    c. Neuronal communication at synapses
    d. Development and organization of the Nervous System
    e. Perception of the external world
    f. Voluntary and involuntary actions
    g. Learning and memory
    h. From brain to soul
    i. Neurosciences at the interface with other disciplines
2. Electrical Excitability (A. Lüthi)
    a. Electrophysiology of the cell membrane
    b. Principles of electrostatics
    c. Notions of electrochemical gradients
    d. Nernst equation, Goldman-Hodgkin-Katz equation
    e. Electrochemical equilibrium and membrane potential
    f. Resting membrane potential
    g. Electrical model of the cell membrane
    h. Depolarization and hyperpolarization of the membrane
    i. Electrotonic propagation of a depolarization
    j. Principles of the "voltage-clamp" technique
    k. Principles of the "patch-clamp" technique
    l. The main ion channels (Na+, K+, Cl-, Ca2+)
    m. Neuronal excitability
    n. Genesis of the action potential, ionic and molecular bases
    o. Structure and function of voltage-dependent ion channels
    p. Continuous and saltatory action potential propagation
    q. Role of myelin
    r. Formalism Hodgkin-Huxley
3. Synaptic transmission (A. Volterra)
    a. The synapse
        i. Morphological types of synapses
        ii. Electrical and chemical synapses
        iii. Dynamics of chemical transmission
    b. Release of neurotransmitters
        i. Constitutive and regulated secretion

        ii. Synaptic vesicles
        iii. Molecular bases of exocytosis and endocytosis: SNARE hypothesis, Ca2+, calcium sensor
    c. Neurotransmitters
        i. Small molecule transmitters and neuropeptides
        ii. Transmitter cycle: synthesis, stocking, release, inactivation
        iii. Principal small molecule transmitter systems: glutamate, GABA, acetylcholine, catecholamines, serotonin, atypical transmitters
        iv. Co-release of transmitters
    d. Neurotransmitter receptors
        i. Ionotropic receptors
        ii. Metabotropic receptors
    e. Integration of synaptic signals
        i. EPSP: propagation, summation, transformation in action potential
        ii. IPSP
        iii. Integration of excitatory and inhibitory signals
        iv. Neuromodulation
        v. Synaptic and neuronal circuits
    f. Intracellular signal transduction
        i. Main principles: diversification, amplification, interaction
4. Development and organisation of the Nervous System (F. Tschudi-Monnet)
    a. Embryonic development: neural tube and neural crest
        i. Neural tube: Central Nervous System
        ii. Neural crest: Peripheral Nervous System
        iii. Polarity: dorsal-ventral axis (separation of sensory and motor modalities)
        iv. Induction role of cord and molecules involved in gene regulation (e.g., retinoic acid, FGF, TGF, sonic hedgehog (shh))
        v. Caudal-rostral axis: developmental gradient of convergence and complexity
        vi. Early regional divisions: homeobox genes
    b. Nervous System development (Brain: 3 vesicles: pros-, mes-, rhomb-, spinal cord)
    c. Differentiation of prosencephalon
        i. Optic vesicle: retina, optic nerve
        ii. Telencephalon: cortex, fibres network: corpus callosum, internal capsule
        iii. Diencephalon: thalamus, hypothalamus
    d. Differentiation of mesencephalon
        i. Tectum: inferior and superior colliculus
        ii. Tegmentum: substantia nigra, red nucleus
    e. Differentiation of rombencephalon
        i. Cerebellum
        ii. Pons
        iii. Medulla
    f. Differentiation of spinal cord
        i. Sensory horns
        ii. Motor horns
    g. Lateralization
        i. In the spinal cord

    ii. In the brain (decussation)
  h. Summary, Adaptation/evolution in mammalian species
  i. Differentiation of neural crest cells
    i. PNS: somatic system (spinal ganglion); autonomic system (sympathetic and parasympathetic ganglia)
    ii. Spinal ganglion formation: an example of the interface between PNS and CNS
    iii. Axonal growth
  j. Cerebral cortex organization
    i. Stratified aspect
    ii. Progenitors in the ventricular zone, asymmetric division
    iii. Precursor: neurons and glia
    iv. Migration: 1: Radial glia: projection neurons; Tangential: interneurons
    v. Functional organization of the different layers
    vi. Cytoarchitectonic Broadmann map
    vii. 3 types of cortex (archicortex (hippocampus), paleocortex (olfactory cortex), neocortex)
    viii. Neocortex evolution in mammalian species
5. Perception of the external world (F. Tschudi-Monnet)
  a. Sensory transduction as the basis of different sensory modalities (somesthesia, vision, audition, chemical senses)
  b. Receptor potential, generator, action potential
  c. Adequate stimulus
  d. Relation between stimulus intensity and action potential frequency
  e. Functional aspects of sensory receptors in the skin and locomotor system
    i. Stimulus specificity
    ii. Activation threshold
    iii. Adaptation speed
    iv. Receptor field
    v. Primary sensory afferents, different types of fibre, different conduction speeds, spinal cord entry – general view
    vi. Segment organization of the spinal cord, dermatomes
    vii. Dorsal column and lateral lemniscus pathways (touch, proprioception)
    viii. Spinal-thalamic pathways (pain, temperature)
    ix. Primary and secondary somato-sensory cortex
    x. Organization in cortical areas
    xi. Somatotopy
    xii. From sensation to perception
    xiii. Plasticity of sensory cortical maps during development and in the adult
6. Voluntary/ Involuntary action (A. Lüthi)
  a. Spinal circuits and motor control
  b. Spinal cord morphology
  c. Motor circuits and reflexes for movement control and posture
  d. Stretching reflex with alpha and gamma motor neurons
  e. Tendon reflex
  f. Coordination between different muscles
  g. Descending control of spinal cord circuits
  h. General view
  i. Descending projections from medulla (rubrospinal, vestibuospinal, tectospinal, reticulospinal pathways; proactive and retroactive maintenance of posture)

j. Descending projections from cerebral cortex (motor areas, somatotopic organization, primary motor areas, corticospinal and corticobulbar pathways)
k. What does the motor map show?
l. Supplementary motor areas (premotor area, supplementary, cortico-cortico projections)
m. Basal ganglia and cerebellum
    i. Motor system with the two main modulatory systems
    ii. Basal ganglia: nuclei composing the basal ganglia, connections between basal ganglia and neurotransmitters involved; principles of functioning; direct and indirect pathway, pathologic neurodegeneration in basal ganglia; Parkinson's and Huntigton's diseases
n. Cerebellum
    i. Macroscopic morphological regions
    ii. Afferent and efferent fibres
    iii. Neuronal circuits
    iv. The three functional divisions
    v. Electrophysiology of cerebellum during movements

7. Learning and memory (A. Volterra)
    a. Types of memory:
        i. Declarative memory
        ii. Non declarative memory (procedural memory, associative and non associative learning)
        iii. Short-term and long-term memory
        iv. Forgetting and amnesia
    b. Stocking memory in the brain
        i. Median temporal lobe and declarative memory
        ii. Hippocampus and spatial memory
        iii. Striatum and procedural memory of motor abilities
        iv. Prefrontal cortex and working memory
    c. Cellular and molecular mechanisms of memory: synaptic plasticity
        i. Mechanisms of associative and non associative learning in an invertebrate, Aplysia
        ii. Habituation of gill withdrawal reflex
        iii. Short- and long-term sensitization
        iv. Classical conditioning
    d. Mechanisms of associative learning in rodents
        i. Long-term potentiation (LTP) in the hippocampus
        ii. Long-term depression (LTD) in the hippocampus
        iii. Synaptic plasticity: the cellular basis of memory?
    e. Brain aging and memory
        i. Physiological brain aging
        ii. Senile dementia and Alzheimer's disease
8. From brain to soul (P. Clarke)
    a. The man who took his wife for a hat
        i. The visual system in two words
        ii. The structures analyzing shapes in primary visual cortex
        iii. The "blindsight" following a visual cortex lesion
        iv. The "what" and "where" in the visual system
        v. The man from Lausanne who was colour blind only in one hemisphere
        vi. The lady who does not see the movement

vii. Propagnosia and the fusiform gyrus

b. Desire and auto-control
    i. The centres for reward in rodents and men
    ii. The tumour that induced to be a paedophile
    iii. Brain and criminality
c. Hemi-negligence and the right parietal lobe
    i. All to the left! Types of hemi-negligence (vision, audition, touch, movement)
    ii. Half of the watch and of Milan's cathedral
    iii. We do see it but we deny it
    iv. Attention problems for the different parts of the space
d. The brain-machine and the philosophy

Reference Books:

1. Boron and Boulpaep: Medical Physiology
2. Kandel et al., Principles of Neural Science – V Edition, McGraw-Hill, 2012

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