CELL BIOLOGY TOPIC LIST

Academic year 2012/2013 EM I First semester

1. Light and electron microscopical histotechniques

1. 1. The histotechnical steps of the routine light microscopical preparation. Specimen blocks, flat mounts and whole mounts, smears. Microscopical viewing of living cells. Difficulties of the used technique.

1. 2. Types of staining procedures. Histochemistry, enzymehistochemistry (with examples). 'Native stain' = no staining.

1. 3. Electron microscopical histotechnique. Differences and similarities when comparing to light microscopy together with the possible underlying reasons. Special electron microscopical techniques.

2. Immunohistochemistry

2. 1. The steps and significance of the immunohistochemical procedure. Effects of temperature, pH and fixation. Epitopes. Monoclonal and polyclonal immune sera (antibodies). Visualization of the immune complex.

2. 2. Specificity, cross-reactivity, false positive and false negative results, controls. Masking, detection, blocking. Combined labelling using two or more markers. Selecting the most suitable experimental subjects. The significance of confocal microscopy.

2. 3 Immunohistochemical methods for electron microscopy (i.e. post-embedding immunohistochemistry). Main differences when comared to the light microscopical (pre-embedding) procedure.

2. 4. In situ hybridization. The possible combinations with other methods. Advantages and disadvantages.

2. 5. Autoradiography. The possible combinations with other methods. Advantages and disadvantages.

3. The structure and function of the cell membrane

3. 1. Structure of the whole membrane. The significance of lipid polarity. Main types of the lipid components. Flip-flop, rafts, lateral diffusion. Asymmetry. The specific research methods of the membrane structure. The structure and significance of the gylcocalyx.

3. 2. Protein components of the cell membrane. Integral and peripheral proteins, transmembrane, extra-and intracellular types together with their importance. Function of membrane proteins. Aquaporins, orthogonally arranged particles. 'Multidrug resistance protein'.

3. 3. Transport mechanisms through membranes. The basic differences between active and passive transports, primary and secondary active transports, channels &

carriers (carrier, transporter). What are the differences and similarities between the facilitated diffusion, simple diffusion and active transport? Uniport, cotransport, symport, antiport. Describe Na-K-ATP-ase pump relative to the previous processes.

3. 4. The major means and significance of the exo- and endocytotic transports. Facultative and regulated forms. The significance of the cellular membrane cycles together with the importance of their constant renewal. Why is a balanced exo-and endocytotic process is important?

4. Intracellular membranous organelles

4. 1. Differences between the rough and smooth endoplasmic reticula (structure, function). The significance of 'Detoxification'. How is a protein produced in the interior of the reticulum, what happens there? Translocators.

4. 2. The significance and possible ways of protein molecule signalling. The role of protein conformation. Chaperones (heat-shock proteins). Proteasomes.

4. 3. The structure, parts and functions of the Golgi apparatus and its relationship with other membranous organelles.

4. 4. The lysosomal system. Relationship with other membranous organelles and the cytosolic proteins. Fate of the endocytosed substances. Autophagocytosis.

4. 5. Vesicular transport. Cooperation and connections between membrane systems. Which cellular organelles produce lipo- and glycoproteins? Cytoplasmic membrane formation. Intracellular membrane formation. The fate of proteins produced within the rER. The fate of proteins produced by the free ribosomes.

5. Further cytoplasmic cellular organelles

5. 1. Protoplasm, cytoplasm, cytosol, nucleoplasm. Cell fractionation, ultracentrifugation, gradients, characterization and use of cell fractions.

5. 2. Structure, main functions and origin of mitochondria. The significance of mitochondrial DNA genealogy. Porins, cardiolipin. Peroxisome, peroxides, peroxidases.

5. 3. Comparison between prokaryotes and eukaryotes. Evolutionary advantages of the latter, the theory of their formation. Endosymbiosis.

6. The nucleus

6. 1. Composition of the nuclear membrane, connections to other membranous organelles. Lamins. Structure of the nuclear pores, transport processes. Nucleoporins, importins, exportins.

6. 2. The organization and shaping of the chromatin substance, forms of chromatin. Constitutive and facultative heterochromatin. Territorial arrangement. Role of histones (in keywords) , other proteins and nucleosomes. Nucleoplasm, interchromatic substance, matrix, nucleoskeleton. The structure, function and organization of the nucleolus.

7. Cell surface specializations, cell-cell adhesions

7. 1. Cuticle, brush border, kinocilium, stereocilium. Function and EM & LM composition of the basal striations (together with their molecular aspects).

7. 2. Classification of cell adhesion molecules and their connections. Homophilic, heterophilic contacts, direct, indirect, and cis/trans bindings, etc.. Lectins. The specificity of cell-cell adhesions.

7. 3. Functional classification of cellular adhesion structures detected by the electron microscope. Molecular basis of the E.M. structure. Role of catenins, plakins, vinculins, etc. Compare desmosomes and zonula (fascia, punctum) adherens. Significance of the interdigitated junctions. Gap junction; structure and function. Connexon, connexins. Heterophil, heteromer types.

8. Intercellular substance (ICS), ground substance (GS)
The cell - 'ICS (GS)' relationship

8. 1. Summary of the components and relations/connections of the intercellular substance. Comparison with the glycocalyx. Glycosaminoglycans, their design principles, types and examples. Proteoglycans. Fibronectin and related compounds. Matrix metalloproteidases, significance of the ground substance restructuring.

8. 2. Laminin receptors. Integrins. Describe their features, and the connections formed by them. The dystroglycan-dystrophin complex, their relationship with the cytoskeleton or membrane skeleton. Compare them to cell-cell adhesions. Vinculin, talin, the role of alpha-actinin. The role of molecular RGD component.

8. 3. LM & EM morphology and the molecular composition of the basement membrane and the basal lamina. Laminins. The role and LM & EM morphology of basal striations.

8. 4. The role of intercellular contacts in development and tissue formation. The cell adhesion as a stimulus. Focal adhesion complex. Cell adhesions and cell division. Cell adhesions and migration. Cell adhesions and cell recognitions. Cell adhesions and cell shape. Role of the glycocalyx in the above mentioned procedures.

8. 5. Cell polarity, apical and basolateral membranes, lateral diffusion, the role of tight junctions and the basal lamina.

9. Cellular skeleton, cell motility

9. 1. Summary of the cytoskeletal elements together with their functions. The common (similar) features of their composition. Significance of associated proteins. Plectin. Motor proteins.

9. 2. Microtubules. The structure and function of the centriole. MTOC. MAPs. Dinein, kinesin.

9. 3. Intermediate filaments. Classification. Specificity. IFAPs. Roles and their relationship to the cell membrane. Plectin.

9. 4. The organisation patterns (placement) of actin. Stress fibers. Associated proteins and their functions (examples). Types of myosin. The membrane skeleton together with its functions.

9. 5. The molecular basis of ameboid movement. Receptors, cell adhesions, role of adherence (anchorage). Lamellipodium, filopodia. The role of the matrix metalloproteases.

9. 6. The general function of the actin-myosin system. Troponin, tropomyosin, desmin, titin, nebulin, actinin, myomesin. Role of dystrophin. Calcium stores and their significance.

10. Cell division

10. 1. The general description and phases of the cell cycle, main types. Control points. Cyclins, Cdk's. Early changes in the chromatin and nuclear membrane. The structure and formation of chromosomes. Molecular diagnostic of chromosomes, high-resolution banding.

10. 2. The stages of mitosis. The cytocentrum and the mitotic spindle. Cell division defects.

10. 3. The division of the cytoplasm. The recovery (reforming) of the cell nucleus. Amitosis, syncytium, plasmodium (examples). The essence of meiosis.

10. 4. Chromosomal sets, description of the genome, haplo-, diplo-polyploidia. Point, chromosomal and genomic mutations.

10. 5. The regulation of cell division. Telomere, telomerase, transformed cells, immortalized cells, proto-oncogene, oncogene, tumor suppressor gene. External influence upon the dividing cells. Growth factors, adherence, focal adhesion complex, contact inhibition.

11. Developmental biology

11. 1. Stem cell, progenitor cell, precursor cell. Clone, cell line, spare cells. Role of markers. The ability to divide. Postmitotic cells, the 'birth' of cells. Toti-, pluri-, (multi, oligo-), bi- and unipotent cells (loss of cell potency). Determination in the absolute or relative terms. Differentiation, de-differentiation, regeneration.

11. 2. Significance of induction. Inducive 'signals'. Endocrine, paracrine, juxtacrine, matricicrine, autocrine, introacrine effects. Why could the same induction result in different, or no, response in different cells? Induction 'window'. Primary organization center, secondary organizers, Induction chain. How does this affect the appearance of certain conserved (primordial) structures during embryonic development?

11. 3. Regulatory signals of development, receptors and the cooperation of regulatory genes. Early genes. Homeobox genes: Hox and Pax genes, etc. their influence upon the life of cells. Explain the basis for divergent development of two cells sharing an identical genetic fingerprint. Distribution of cytoplasmic factors, topical differences, lateral inhibition.

11. 4. The role of uneven growth in morphogenesis (examples). Comparison of apoptosis and necrosis. Role of apoptosis in development.