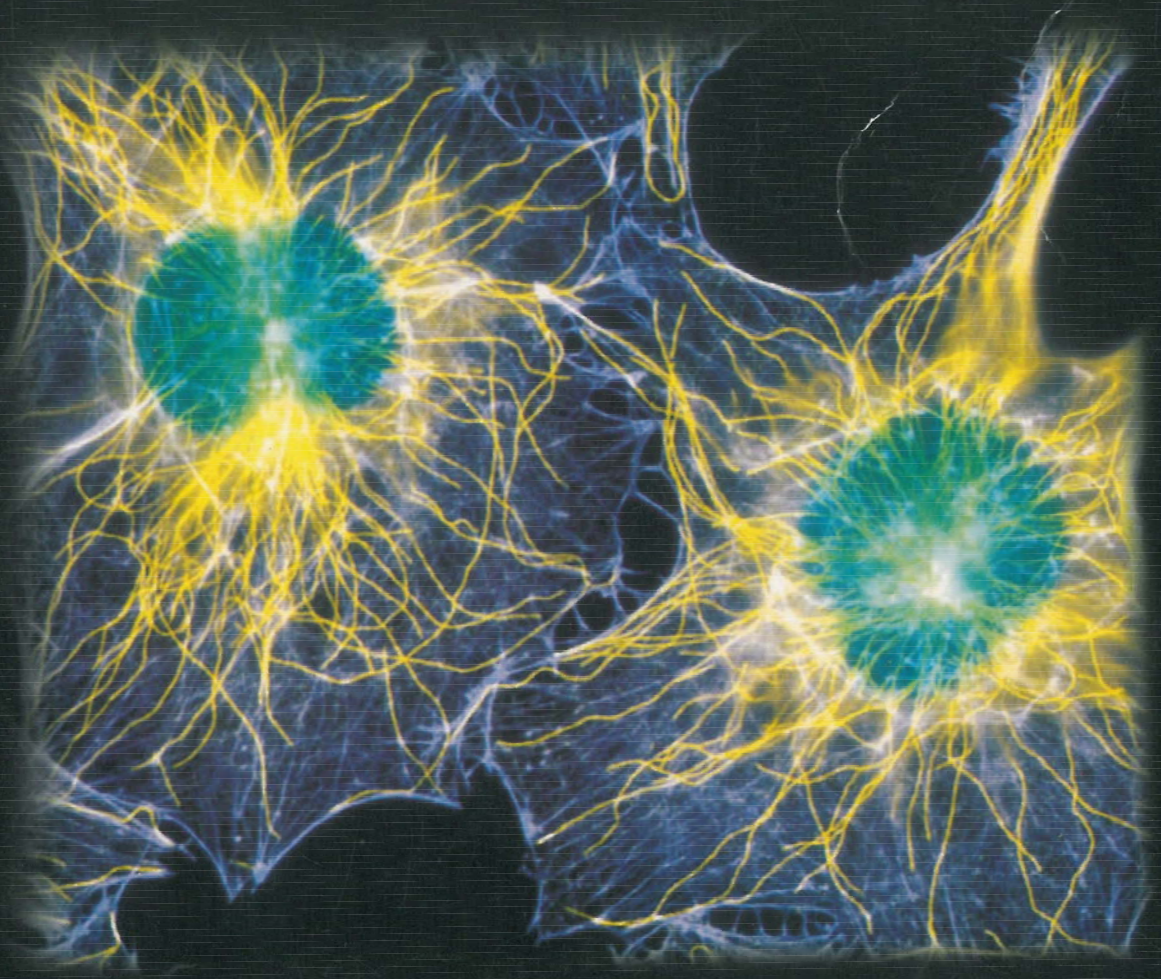
E. Ivanov, MD, PhD

MANUAL

Cytology, Histology and Embryology
Practical Exercises



MEDICAL UNIVERSITY OF PLEVEN,
FACULTY OF MEDICINE
2008

MANUAL

Cytology, Histology and Embryology
Practical Exercises

Under the editorial guidance of E. Ivanov, MD, PhD, Chairman at the Department of Anatomy, Histology and Cytology

Pleven 2008

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for Cytology, Histology and Embryology
Practical Exercises

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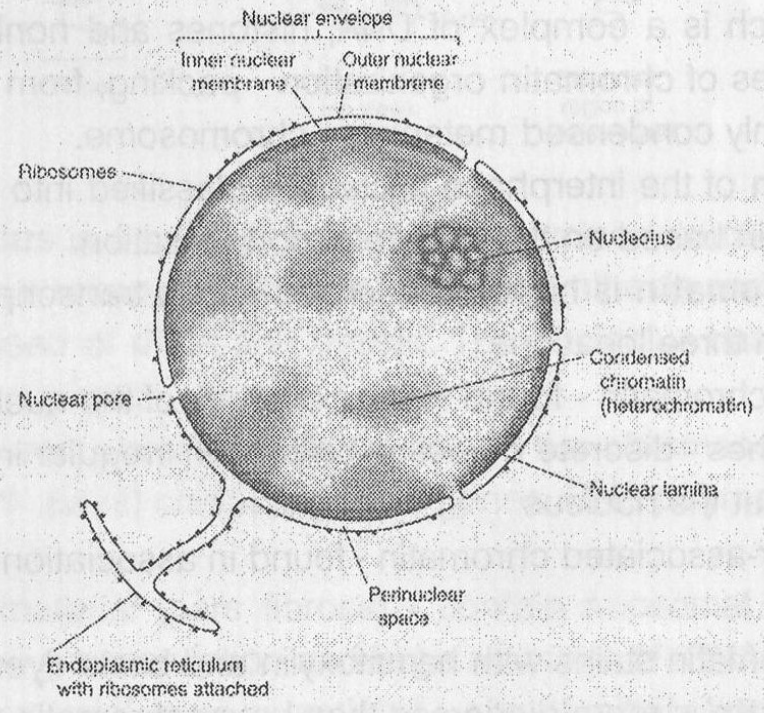
Topic 4. INTERNAL CELL MORPHOLOGY: NUCLEUS, CYTOCENTER

NUCLEUS

The nucleus is a membrane-limited compartment that contains the genome in eukaryotic cells. It contains genetic information together with the machinery for DNA replication and RNA transcription and processing.

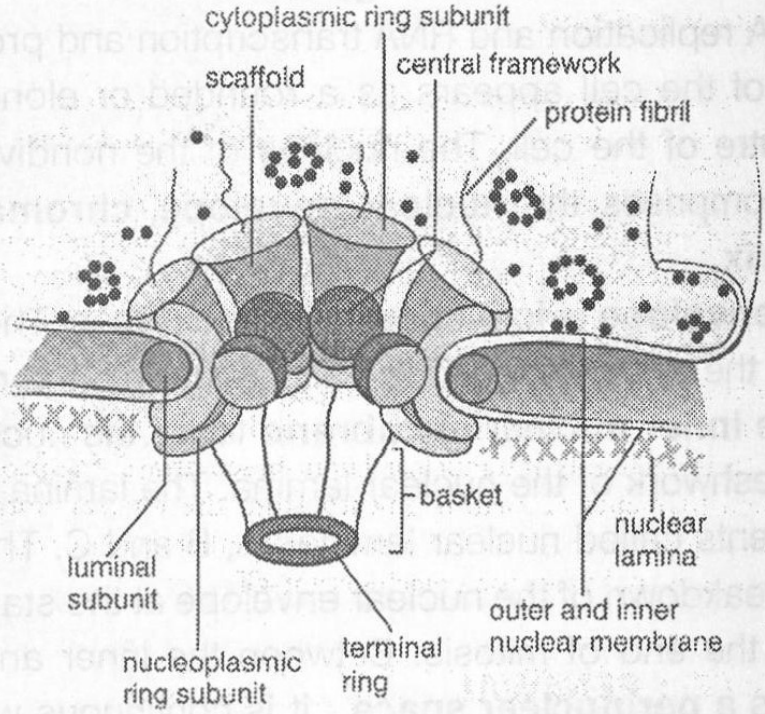
The nucleus of the cell appears as a rounded or elongated structure, usually in the centre of the cell. The nucleus of the nondividing, called an interphase cell, comprises the **nuclear envelope, chromatin, nucleolus and nuclear matrix.**

The **nuclear envelope** is formed by two membranes. The **outer nuclear membrane** faces the cytoplasm and is continuous with the rough endoplasmic reticulum. The **inner nuclear membrane** faces the nucleoplasm and is covered by the meshwork of the nuclear lamina. The lamina is composed of intermediate filaments called nuclear laminas A, B and C. They play a major role in the rapid breakdown of the nuclear envelope at the start of mitosis and its reassembly at the end of mitosis. Between the inner and outer nuclear membrane there is a **perinuclear space** - it is continuous with the cisternal space of the endoplasmic reticulum.



Around the nuclear envelope, at sites where the inner and outer membranes fuse, there are circular opening, the **nuclear pores** that provide pathways between the nucleus and the cytoplasm. Each pore contains 8 protein

subunits arranged in an octagonal central framework at the periphery of the pore. Eight short protein fibrils protrude from the cytoplasmic rings into the cytoplasm. The nuclear ring anchors a basket assembled from eight thin filaments joined distally by a protein terminal ring. The cylindrical central framework encircles the central pore, which acts as a close-fitting diaphragm.



The double-stranded DNA in the mitotic eukaryotic cells is organized into linearly arranged units called **chromosomes.** Chromosomes are made of chromatin, which is a complex of DNA, histones and nonhistone proteins. There are stages of chromatin organization - packing, from the DNA double helix to the highly condensed metaphase chromosome.

Chromatin of the interphase nucleus is classified into heterochromatin and euchromatin based on the degree of condensation.

Heterochromatin is highly condensed and is transcriptionally inactive. It is disposed in three locations:

- Marginal chromatin - found in the periphery of the nucleus
- Karyosomes - discrete bodies of chromatin irregular in size and shape found throughout the nucleus
- Nucleolar-associated chromatin - found in association with the nucleolus.

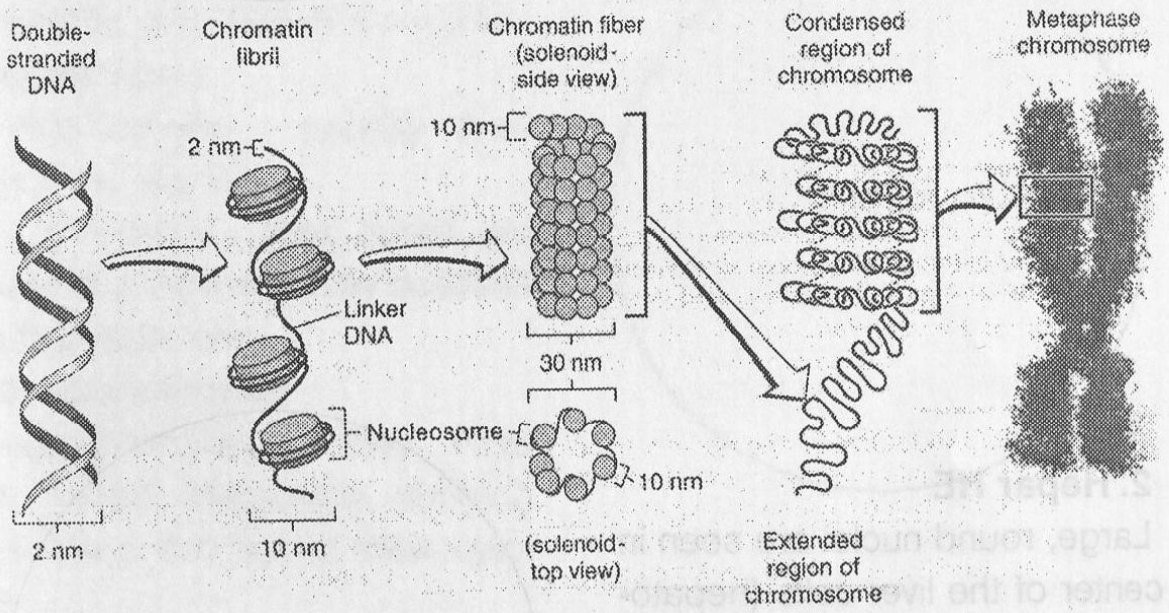
Heterochromatin stains with hematoxylin and basic dyes.

Euchromatin is more dispersed than heterochromatin and is transcriptionally active (chromatin is stretched out so that the genetic information in the DNA can be read and transcribed). It is present within the nucleoplasm in the "clear" areas between and around the heterochromatin.

The smallest units of chromatin are macromolecular complexes of DNA and histones called nucleosomes.

Nucleosomes are 10-nm-diameter particles that represent the first level of chromatin folding. They are formed by the coiling of the DNA molecule around a protein core (8 histone molecules). Thus DNA is shortened seven-fold.

Chromatin fibril (30 nm) consists of turns, each composed of 6 nucleosomes. They are approximately 40-fold shorter than unfolded DNA. **Loop domains** are further organized in long stretches of chromatin fibrils which are anchored into nuclear matrix (nonhistone proteins). During cell division **chromatin fiber,** formed from chromatin loop domains, undergo condensation to form **chromosomes**.



The **nucleolus** is a nonmembranous intranuclear structure present only in the interphase nucleus. It is the site of rRNA synthesis and ribosome subunit. It is composed of rRNA and protein. The nucleolus has three morphologically distinct regions:

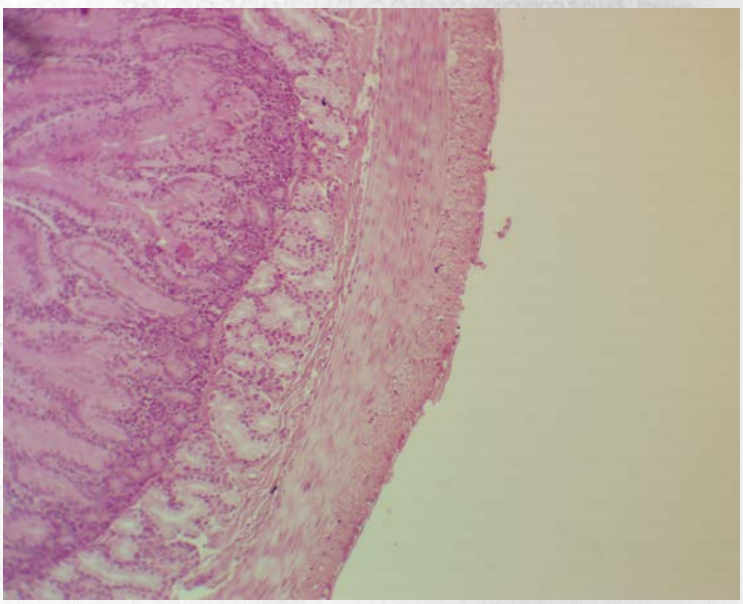
- Fibrillar centers containing DNA loops of five chromosomes (13th, 14th, 15th, 21st and 22nd pairs) containing rRNA genes, RNA polymerase I and transcription factors
- Fibrillar material (pars fibrosa) - contain ribosomal genes that are actively undergoing transcription and large amounts of rRNA
- Granular material (pars granulosa) - site of initial ribosomal assembly containing densely packed preribosomal particles

The nuclear matrix is a fibrous network that contains nuclear proteins, DNA, RNA.

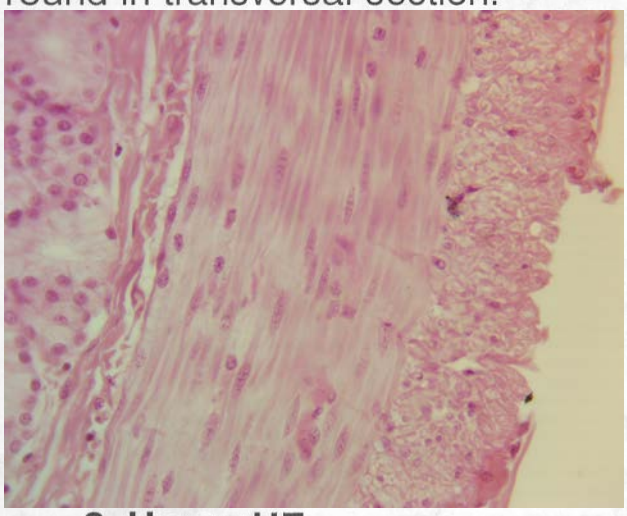
SLIDES

1. Intestinum tenue - HE

Nuclei of different shapes can be observed in the cells of the small intestine. In the lower part of the columnar epithelial cells, elongated nuclei are found. In the spindle-shaped smooth muscle cells of the muscle layer in longitudinal section ovoid nuclei are seen. They appear round in transversal section.



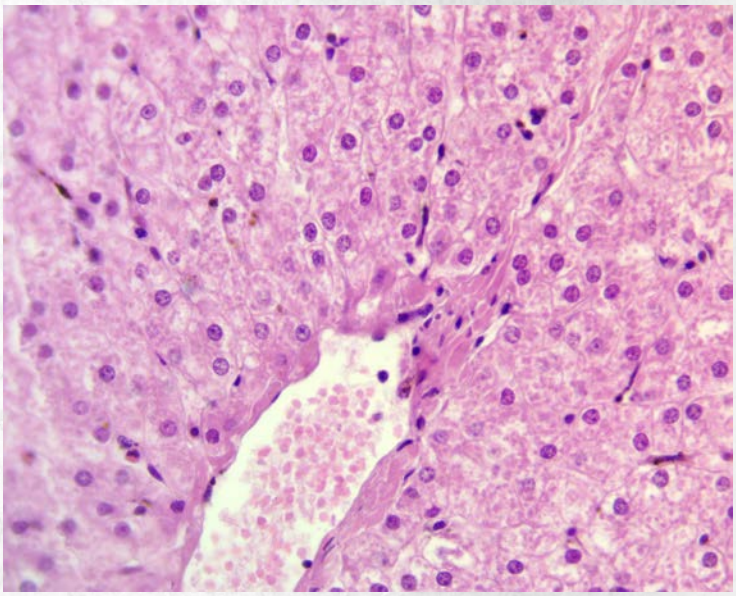
Duodenum x100



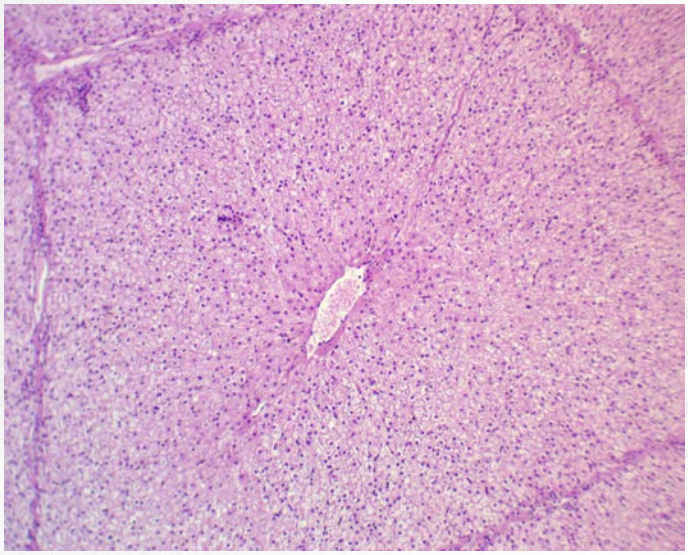
Duodenum x400

2. Hepar HE

Large, round nuclei are seen in the center of the liver cells (hepatocytes). Some of the hepatocytes are binuclear.



Hepar x400



Hepar x100

3. Blood film - Wright-Giemsa

The following types of cells can be found in the blood smear:

A. Red cells (erythrocytes) - Small, biconcave disks without nuclei

B. White cells (leukocytes) -

There are several types of leukocytes

1. Granulocytes

• Neutrophils - their nuclei are segmented - with two or more interconnected lobes

• Eosinophils - usually their nuclei show two lobes

• Basophils - their nuclei are irregular in shape and may possess more than one lobe

2. Agranulocytes

• Lymphocytes - they have large, round intensively staining nuclei and a thin rim of clear cytoplasm

• Monocytes - the largest leucocytes. The nucleus has a characteristic indentation on one side ("kidney - shaped nucleus")

C. Platelets (thrombocytes) - small cytoplasmic fragments (do not possess nuclei)