

**Introduction to concepts of pathology.  
Characteristics and classification of  
diseases.**

**Introduction to general pathology**

Markéta Hermanová

# Pathology

## ■ General pathology: Scientific study of disease

causes (etiology)

mechanisms of development (pathogenesis)

structural changes in diseases (morphology)

clinical consequences of changes

## ■ Pathology in clinical practice (diagnostic pathology)

- diagnosis of the disease based on the examination of surgically removed tissue specimens (histopathology, examination of biopsies) and cytological specimens (cytology): 98 %
- autopsies (necropsies – postmortem examinations): 2 %\*

\*in Czech Republic majority of autopsies performed in forensic medicine/pathology dpt,  
only minority of autopsies performed in dpt of pathology/anatomical pathology

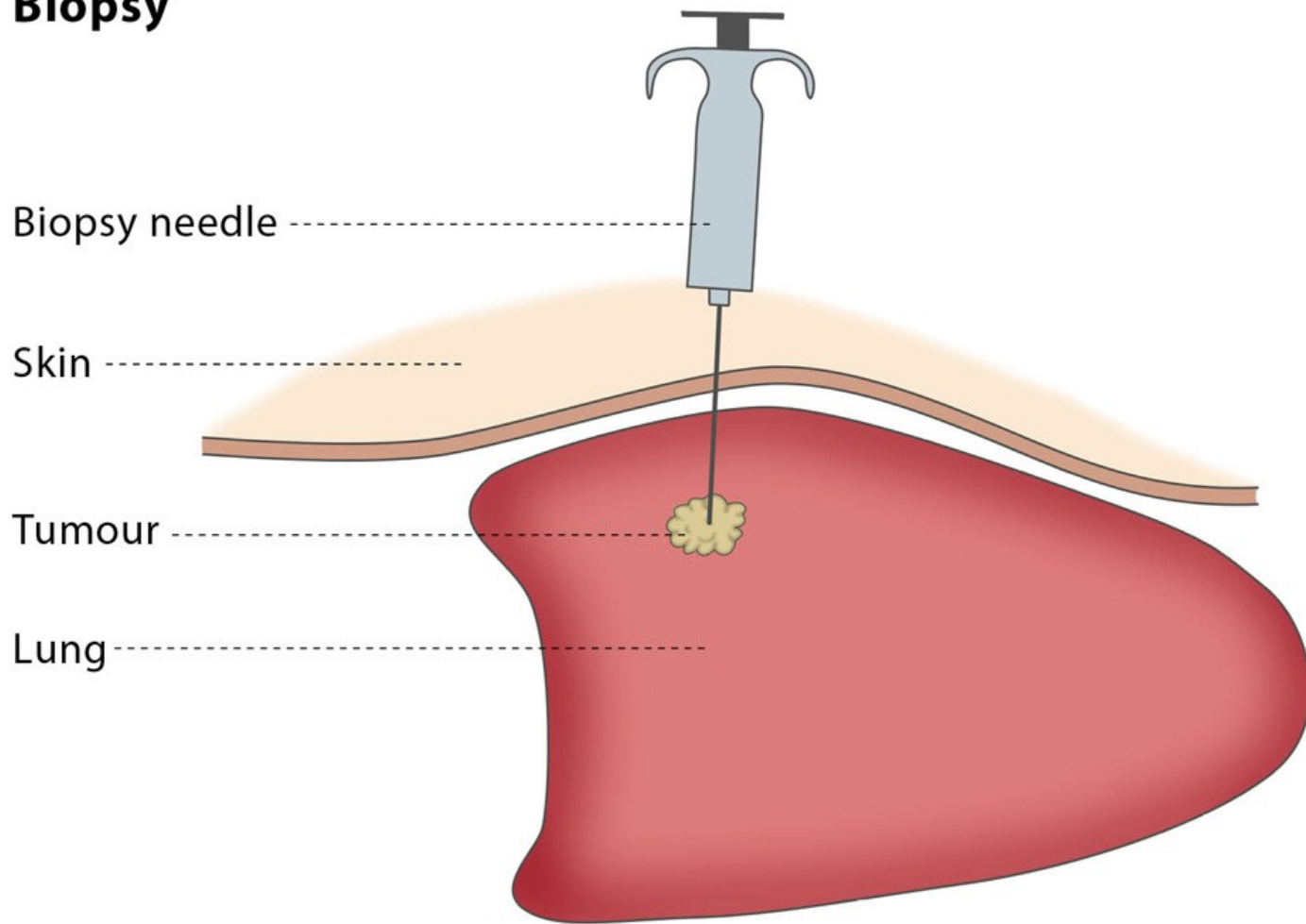
# Who is a pathologist?

- Physicians specialized in the diagnosis and characterization of disease based on examination of tissues (biopsies) and cytological specimens (pleural and pericardial fluid, ascites (from peritoneal cavity), urine, cervical smears, blood, .....)
- Special focus on histopathological diagnosis of oncological diseases
- Clinico-pathological cooperation

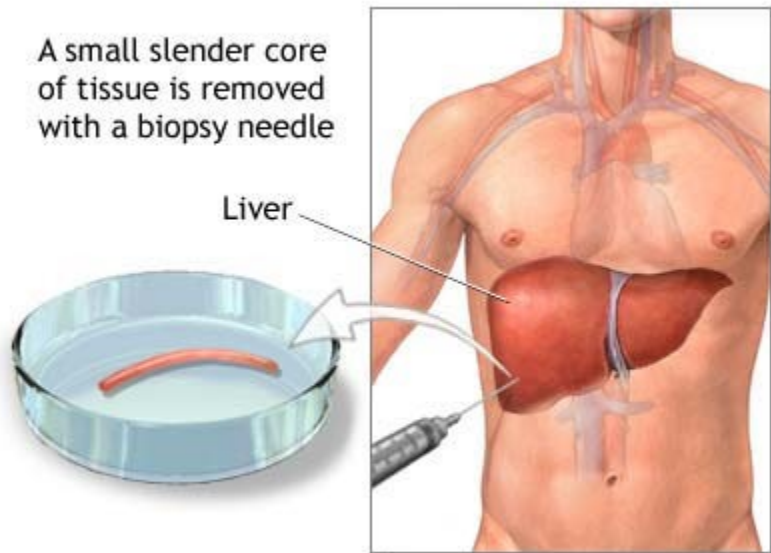
# Tissue biopsy: how to obtain the tissue for histopathological examination?

- Curettage
- Fluid aspiration
- Fine needle aspiration
- Core needle biopsy
- Dermal punch
- Endoscopy
- Stereotactic biopsy
- Surgical excision and resection

# Biopsy

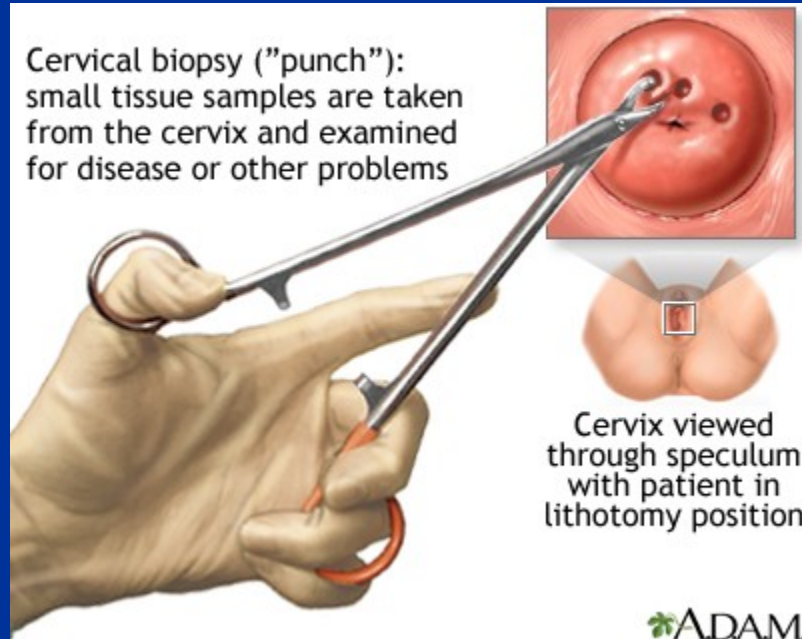


A small slender core of tissue is removed with a biopsy needle

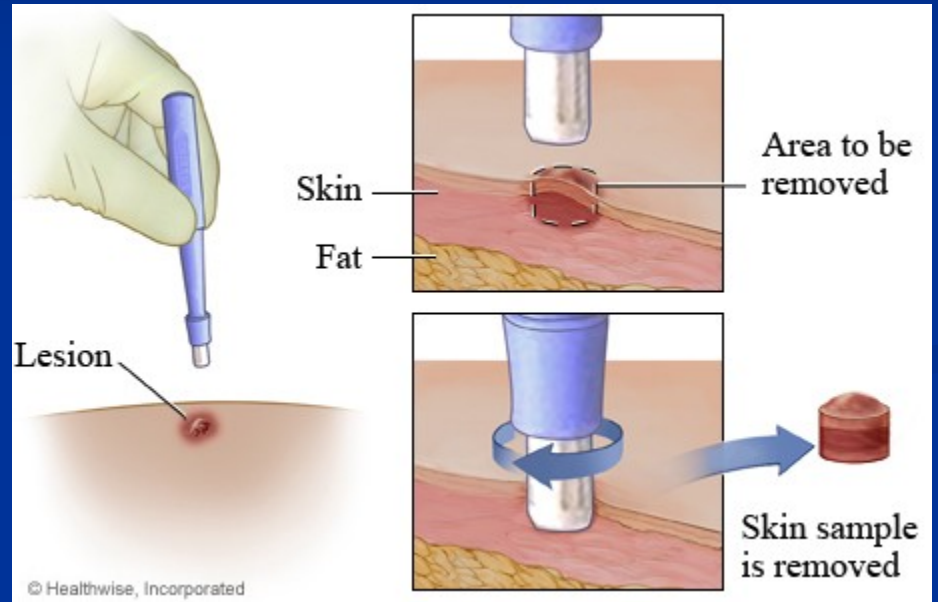


ADAM.

Cervical biopsy ("punch"): small tissue samples are taken from the cervix and examined for disease or other problems



ADAM.



# Resection specimen - rectum



Formalin-fixed tissue

# Evaluation of surgical resection specimens: brain resection specimen

Gross inspection, measuring, cutting representative tissue slices, perpendicular to the cortical surface



Temporal pole resection specimen

Amygdalohippocampal complex

10% neutral buffered formalin, 24 hours, formalin fixed paraffin embedded tissues, paraffin sections  
Remaining unfixed tissue slices snap frozen in liquid nitrogen – molecular biology and genetics



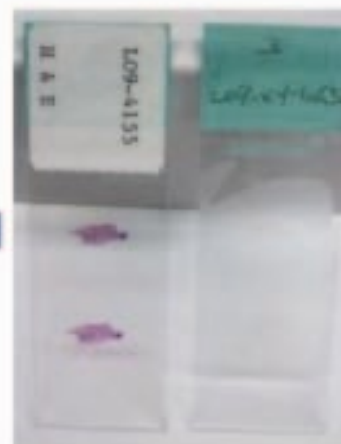
**Fixation**



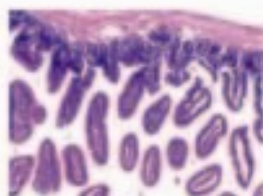
**Paraffin Processing**



**Embedding Tissues in Paraffin Blocks**



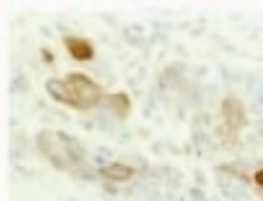
**H&E**



**Special Staining**



**IHC**



**Staining**

# Techniques of pathology

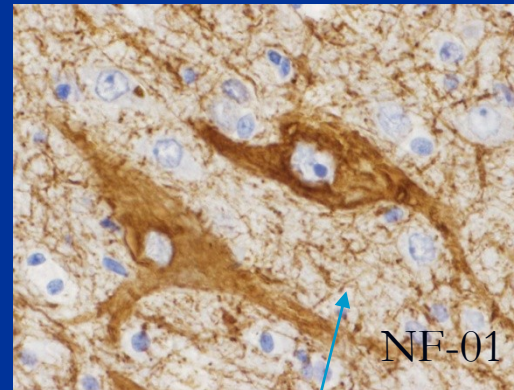
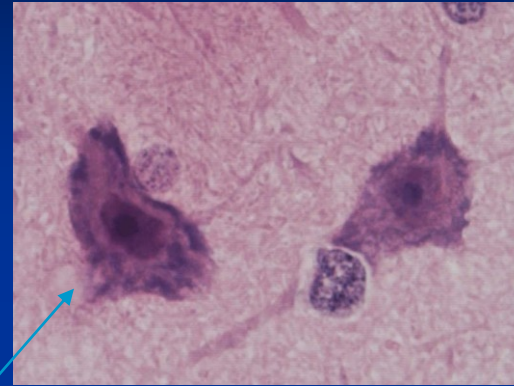
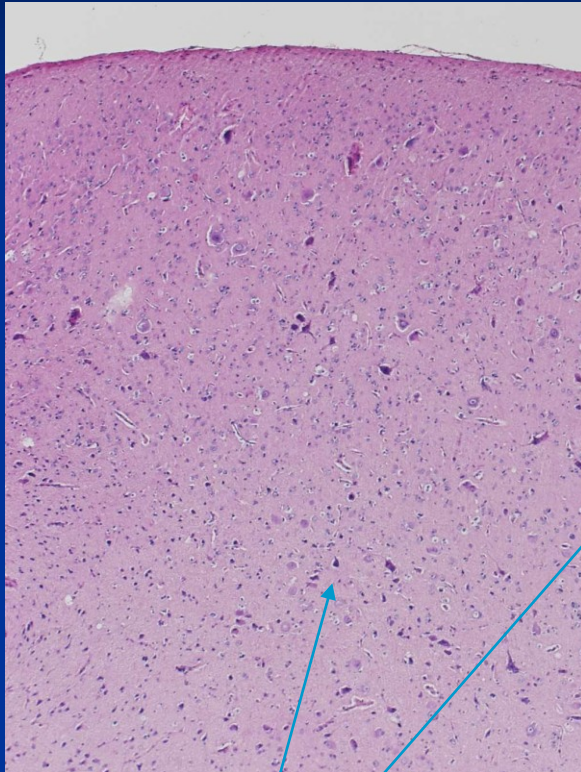
- Gross pathology
- **Light microscopy**
- Enzyme histochemistry
- Immunohistochemistry and immunofluorescence
- Electron microscopy
- Molecular pathology and genetics

+ biochemical, haematological and microbiological techniques, cell cultures (in clinical pathology)



# Focal cortical dysplasia: maldevelopment of cortex

## histopathological examination



Common staining methods: hematoxylin-eosin

Immunohistochemistry:

detecting antigens (e.g. proteins) in a tissue section using antibodies with subsequent visualisation of this binding (Ag/Ab)

# Autopsy

(= necropsy, postmortem examination)

- Determining the *cause of death*
- Audit of the *accuracy of clinical diagnosis*
- *Education* of undergraduates and postgraduates
- *Research* into the causes and mechanisms of the disease
- Gathering accurate *statistics* about disease incidence

# Learning pathology

## ■ General pathology

- The mechanisms and characteristics of the principal types of disease processes (e.g. inflammation, tumours, degenerations,...)

## ■ Systemic pathology

- The descriptions of specific diseases affecting individual organs or organ systems (e.g. GIT, respiratory tract, brain, muscles...)

# Who is your teacher?

■ **Prof. MUDr. Markéta Hermanová, Ph.D.**

[marketa.hermanova@fnusa.cz](mailto:marketa.hermanova@fnusa.cz)

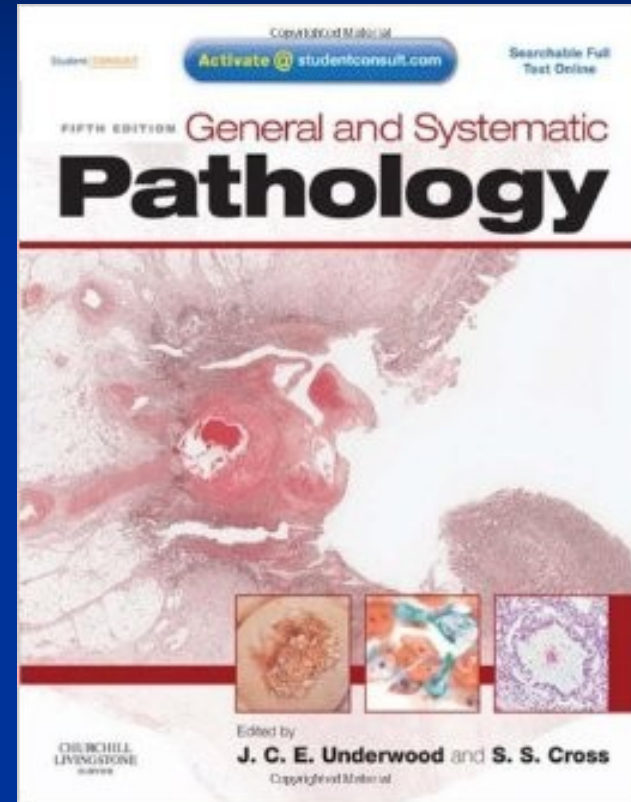
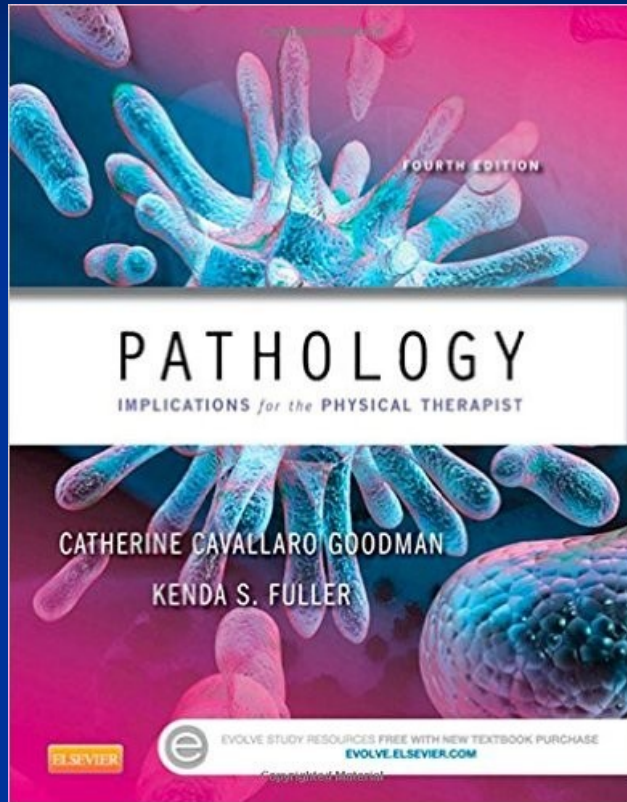
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■ **MUDr. Vítá Žampachová**

[vita.zampachova@fnusa.cz](mailto:vita.zampachova@fnusa.cz)

+420543183231

# Recommended literature for the exam



...and especially content of lectures!  
...the questions for the exam will strictly follow the lectures..

# Characteristics of the disease

- Aetiology (cause: genetic, multifactorial, environmental)
- Pathogenesis (mechanism: inflammation, degeneration, carcinogenesis, immune reaction)
- Pathological and clinical manifestation (morphological, functional, clinical)
- Complications and sequelae
- Prognosis (or outcome)
- Epidemiology (or incidence, population distribution)



# Nomenclature of the disease

## ■ Primary and secondary

- **primary:** without evident antecedent cause (=essential, idiopathic, cryptogenic)
- **secondary:** complication or manifestation of some underlying disease
- primary and secondary also used to distinguish between initial and subsequent stages of a disease

## ■ Acute, subacute and chronic

- describing the dynamics of the disease

## ■ Benign and malignant

- describing their likely outcome
- benign tumors vs malignant tumors
- benign hypertension vs malignant hypertension

# Prefixes

| Prefix | Meaning                          | Example         |
|--------|----------------------------------|-----------------|
| Ana-   | Absence                          | Anaplasia       |
| Dys-   | Disordered                       | Dysplasia       |
| Hyper- | Excess over normal               | Hyperthyroidism |
| Hypo-  | Deficiency below normal          | Hypothyroidism  |
| Meta-  | Change from one state to another | Metaplasia      |
| Neo-   | New                              | Neoplasia       |

# Suffixes

| suffix   | meaning  | example            |
|----------|--|--------------------|
| -itis    | Inflammatory process                             | Appendicitis       |
| -oma     | Tumour   | Carcinoma, adenoma |
| -osis    | State or condition, not necessarily pathological | Osteoarthritis     |
| -oid     | Bearing the resemblance                          | Rheumatoid         |
| -penia   | Lack of  | Thrombocytopenia   |
| -cytosis | Increased number of cells                        | Leukocytosis       |
| -ectasis | Dilatation                                       | Bronchiectasis     |
| -plasia  | Disorder of growth                               | Hyperplasia        |
| -opathy  | Abnormal state lacking specific characteristics  | Lymphadenopathy    |

# General classification of diseases

| Mode of acquisition | Pathogenetic classification | Subclassification            | Example                                |
|---------------------|-----------------------------|------------------------------|--|
| <b>Congenital</b>   | <b>Genetic</b>              | Inherited                    | Cystic fibrosis                        |
|                     |                             | Spontaneous                  | Down's syndrome                        |
|                     | <b>Nongenetic</b>           | Environmental                | Rubella-assoc. malformation            |
|                     |                             | Accidental                   | Cerebral palsy due to hypoxia at birth |
| <b>Acquired</b>     | <b>Inflammation</b>         | Acute                        | Acute appendicitis                     |
|                     |                             | Chronic                      | Tuberculosis                           |
|                     | <b>Growth disorders</b>     | Neoplastic                   | Lung cancer                            |
|                     |                             | Nonneoplastic                | Benign prostatic hyperplasia           |
|                     | <b>Injury</b>               | Kinetic energy               | Bone fracture                          |
|                     |                             | Chemicals, etc.              | Aspirin induced gastric ulcer          |
|                     | <b>Haemodynamic</b>         | Shock                        | Haemorrhagic shock                     |
|                     |                             | Occlusive lesions            | Ischaemic heart disease                |
|                     | <b>Disordered immunity</b>  | Immunodeficiency             | AIDS                                   |
|                     |                             | Autoimmune diseases, allergy | Grave's thyroiditis                    |
|                     | <b>Metabolic</b>            |                              | Diabetes mellitus                      |
|                     | <b>Degenerative</b>         |                              | Osteoarthritis                         |

# Causes of disease

## ■ Genetic

- Inherited or prenatally acquired defects of genes

## ■ Multifactorial

- Interaction between genetic and environmental factors

## ■ Environmental

- No genetic component to risk of disease

| Genetic factors                                    | Environmental factors  |
|--|--|
| <p data-bbox="388 475 720 549">Cystic fibrosis</p> | <p data-bbox="799 619 1020 694">Diabetes</p> <p data-bbox="861 791 1182 865">Breast cancer</p> <p data-bbox="1056 983 1559 1058">Traumatic head injury</p> |



# Mechanisms of cell death

- Necrosis
- Apoptosis



# Necrosis

- Death of the tissue (in a living organism)
- Induces inflammation and repair
- Causes include ischaemia, metabolic, trauma

**Infarction = ischaemic necrosis.**

**Ischaemia = lack of blood perfusion followed by hypoxia**

# Morphological types of necrosis

## ■ Coagulative

- In solid internal organs, with protein predominance (heart, kidneys, liver)
- Caused by ischaemia (lack of blood supply)

## ■ Colliquative

- in brain (generally in organs with lipid predominance), usually caused in ischaemia

## ■ Caseous

- In tuberculosis and some fungal infections

# Morphological types of necrosis

## ■ Gangrene

- Necrosis with putrefaction (caused by some bacteria (clostridia))

## ■ Fat necrosis

- Direct trauma of adipose tissue
- Enzymatic lysis of fat due to release of lipase (in acute pancreatitis)

## coagulative necrosis – myocardial infarction



# NECROSIS - healing

- **inflammatory reaction** = inflammatory infiltrate  
(neutrophils, histiocytes..... lymphocytes) + afterwards  
**nonspecific granulation tissue** (fibroblasts, angiogenesis) → →  
maturation of the fibrous tissue →
- **scar** (within 6 weeks) + possible secondary alterations  
(dystrophic calcification, e.g.)
- **pseudocyst** (colliquation of a necrotic tissue)

# Apoptosis

- Programmed cell death
- Energy-dependent process for elimination/deletion of unwanted cells
- Both physiological and pathological
- Involved in morphogenesis
- Reduced apoptosis in neoplasias/tumors
- Increased apoptosis results in excessive cell loss (e.g. in atrophy)
- No inflammatory response to apoptosis

# **APOPTOSIS in physiological situations**

- **embryogenesis** (morphogenetic, histogenetic, phylogenetic)
- **hormone-dependent involution**
  - endometrial cell breakdown during the menstrual cycle
  - prostatic involution after castration
- defence mechanisms during **immune response**
  - death of neutrophils in an acute inflammatory response
  - elimination of self-reactive T-lymphocytes during their maturation in the thymus, e.g.
- **elimination of damaged cells**
- during **aging**

# APOPTOSIS in pathological conditions

- **pathological inhibition of apoptosis**
  - tumors
    - *follicular lymphoma*
    - *mammary, prostatic, e.g. , carcinomas with mutation in p53 gene)*
  - autoimmune diseases
    - *SLE*
  - infections
    - *herpes simplex virus*
    - *poxviruses*
    - *TBC*



# APOPTOSIS in pathological conditions

- **pathological induction of apoptosis**
  - AIDS
  - neurodegenerative diseases
    - *m. Alzheimer, m. Parkinson, ALS*
  - myelodysplastic syndrome
    - *aplastic anemia*
  - ischemic injury
    - *acute myocardial infarction*

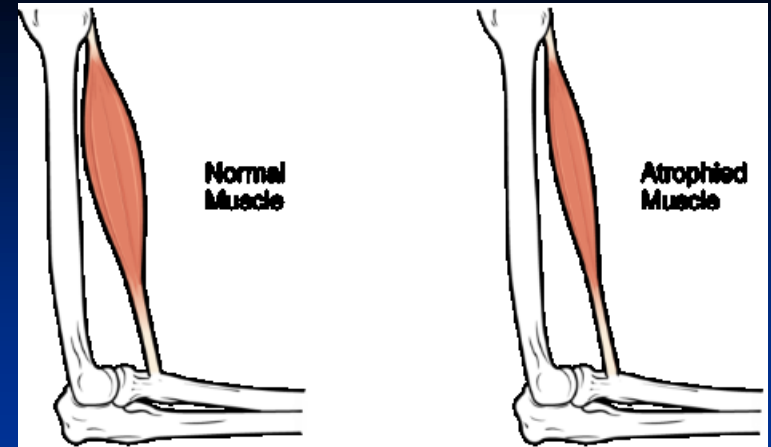
# Atrophy

- Decrease in size of a normally evolved organ
- Reduction of cell size (simple atrophy) or cell number (numeric atrophy) or both
- May be mediated by apoptosis
- May be physiological (e.g. post-menopausal atrophy of uterus)
- Pathological atrophy due to decreased function, loss of innervation, reduced blood or oxygen supply, nutritional impairment or hormonal insufficiency,....

# ATROPHY

## Etiology:

- × physiologic involution (thymus)
- × lack of nutrition ->> cachexia
- × pressure atrophy (compressed tissue)
- × loss of function (immobilisation of a limb)
- × loss of blood supply
- × loss of innervation
- × loss of endocrine stimulation
- × hormone-induced atrophy (in the skin after topically applied corticosteroids)
- × idiopathic



# Hypoplasia, aplasia

- Failure of the development of an organ
- Failure of morphogenesis

