

Progressive changes

Progressive changes are processes aimed at replacing damaged tissue or adapting it to changing conditions.

Replacement of damaged tissue

- *regeneration* (restitution) – replacement with completely equivalent tissue (morphologically and functionally);
- *reparation* (substitution) – replacement with functionally inferior tissue (most often with tissue).

Adapting to changing conditions

- *hypertrophy* (increase in cell volume) + *hyperplasia* (increase in number of cells);
- *metaplasia* – replacement of differentiated tissue with another, also differentiated tissue, which does not usually occur in the given location.

Regeneration

Definition: restoration of dead tissue with new, *functionally and morphologically equivalent tissue*

According to the ability of regeneration, we divide tissues into:

1. **permanent**, incapable of regeneration (cardiomyocytes, neurons, lens cells) – their damage and inability to regenerate (myocardial infarction, cerebrovascular accident) are the most common cause of death

myocardium and CNS – myocardium heals with scar and CNS with postmalacia pseudocyst and gliosis

2. **stable**, signs of mitotic activity are shown by less than 1.5% of cells, with limited regenerative capacity, their regeneration is accelerated in case of damage (liver, kidneys, endothelium, fibroblasts, smooth muscle)

glandular epithelia - the liver, the lining of the kidney tubules, regenerate for a long time and only under certain conditions

3. **labile**, constantly regenerating - more than 1.5% of cells show mitotic activity (hematopoietic bone marrow, surface epithelium - skin, urogenital tract, cornea and intestinal mucosa, etc.), their constant renewal is necessary for life

regeneration of *covering epithelia* - by re-epithelialization from the cambium layer or from the surrounding area, in the case of a deeper defect, granulation tissue is formed first

the exception is *the intestine*: even a deeper defect heals only by re-epithelialization, because the cambium layer (Lieberkühn's crypts) is very deep and usually a part remains preserved, which is why scars do not remain in the intestine after, for example, inflammation

they do not regenerate the adnexa, which is why the scar is dry, without hair

the epithelium of the oral cavity regenerates quickly (if something does not heal, it is either a tumor or the patient has an immune disorder)

Necessary conditions for regeneration of the epithelium are:

- **an intact basement membrane** or reticular fiber system as a growth guide
- **preservation of the cambium layer** (e.g. stratum basale epidermis, cells of periportal fields of liver lobules)

In the early stage of regeneration, the regenerated epithelium is made up of irregular cells with basophilic cytoplasm and frequent nuclear abnormalities (nuclear polymorphism, mitoses, multinucleation...).

The main stimuli for regeneration are apparently given by the decrease in growth inhibitors (so-called chalons) and the loss of contact inhibition of growth. The extent of regeneration has certain limits - for example, in the case of an extensive defect of the epidermis, the formation of fibrous granulation tissue overtakes epithelization, so to heal the defect, it is necessary to transplant "seedlings" of the epidermis to serve as epithelization centers.

Reparation

Definition: *less valuable replacement* of lost tissue, mostly by ligaments (refers to e.g. wound healing, fractures, organization of hematoma, thrombus, necrosis, healing of foreign material)

- Wound healing **per primam** – healing without infection, without a major inflammatory reaction, clean incisions (surgical cut - sharp edges are closely abutting each other and are firmly sewn with stitches).
- Healing **per seconds** – extensive wounds, ulcerous defects, infections, loss injuries, hematoma or remnants of necrotic tissue in the wound. It heals longer, with a more pronounced inflammatory reaction, a lot of granulation tissue is associated with the formation of more extensive scars (contraction of an extensive scar with the participation of myofibroblasts can then cause deformation of the scar and the surrounding tissue)
- Hematoma organization – granulation tissue grows into the fibrin , resulting in a scar and hemosiderin pigmentation. In the brain and pancreas , the hematoma liquefies, resulting in a posthemorrhagic pseudocyst.
- Organization of the thrombus -granulation tissue grows into the fibrin , resulting in a fibrous thickening of the intima or a fibrous bridge.
- **Fracture healing** - hematoma , granulation tissue, fibrous muscle, which turns into primitive skeletal muscle. Remodeling creates a definitive bone muscle.
- **Healing of brain tissue and nerve defects** - smaller brain tissue defects heal with a glial scar, larger ones with a postmalacia pseudocyst, regeneration and restoration of function is possible for peripheral nerves under favorable conditions (connection of stumps)
- **Incubation of foreign bodies** - when the body is infected, it excretes. When it is sterile, a specific granulation tissue is formed around it - **Schloffer's tumor** .

Hyperplasia

Hyperplasia is the proliferation of cells. It leads to enlargement of tissues or organs. It appears (not only) in tissues with greater mitotic activity (glands, skin, mucous membranes).

Physiologically, it is present during pregnancy, when uterine hyperplasia occurs. Also, the proliferation of the mammary gland epithelium during puberty due to hormonal stimulation is physiological. When part of the liver is removed, it is regenerated by *compensatory hyperplasia* . Replication turnover increases up to 10x in hepatocytes.

Pathological hyperplasia of the uterus occurs with excessive production of estrogens . Benign prostatic hyperplasia occurs in men. The cause is an increase in the number of androgen receptors on the surface of the prostate in older age. Pathological hyperplasia is a **risk factor** for tumor formation.



Bone muscle healing fracture

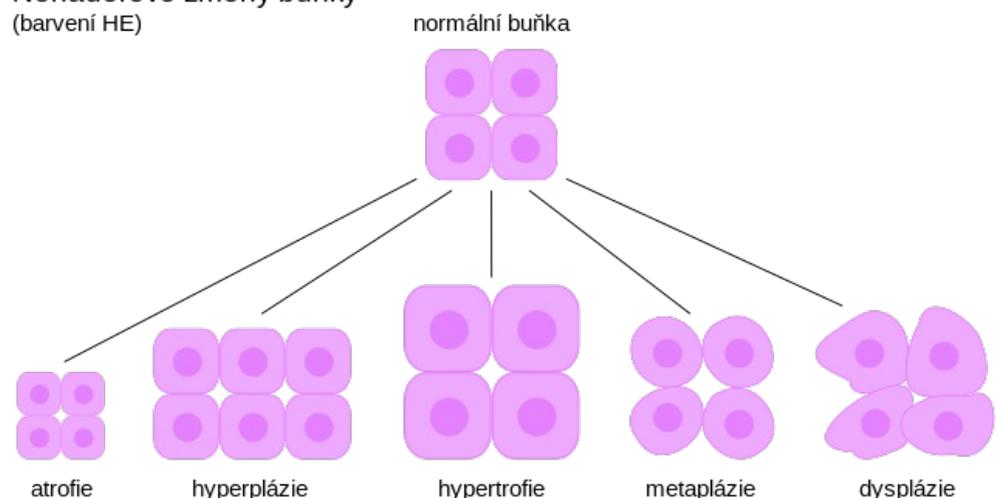
Hyperplasia together with hypertrophy (increase in cell volume) and hyperregeneration can be among the atypical progressive tissue changes. Examples of hyperplasia are nodular hyperplasia of the adrenal cortex, hyperplasia of the islets of Langerhans, hyperplasia of the gastric mucosa.

Division:

1. *Pseudoepitheliomatous* - in the squamous epithelium during chronic inflammatory irritation of the skin and mucous membranes, the process heals itself after the cause is removed.
2. *Pseudosarcomatous* - belongs to the so-called fibromatoses, e.g. proliferative fasciitis after trauma.
3. *Nodular* - e.g. in the prostate (in older men with hormonal imbalance) or in the thyroid gland .
4. *Diffuse* - eg adrenal or parathyroid glands .

Hyperregeneration - e.g. in **amputation neuroma** (at the site of nerve damage, a pseudotumor composed of Schwann cells, collagen fibrils and nerve fibers), similar to Morton's neuroma on the interdigital plantar nerves, which additionally contains thick-walled arterioles with frequent thrombosis , its cause is repeated traumatization.

Nenádorové změny buňky (barvení HE)



Non-cancerous cell changes

Hypertrophy

Definition: enlargement of cells and organs, occurs in tissues with limited mitotic activity (heart, muscles).

Hypertrophic tissue works **energy-efficiently** , its performance per mass unit

is lower than that of normal tissue, and more waste substances are also produced during its activity (e.g. waste products of purine metabolism).

Working

It occurs during long-term work load, e.g. skeletal muscle in athletes. This also includes *compensatory hypertrophy*, such as hypertrophy (concentric, later eccentric) of the heart chamber in hypertension in large (*cor hypertonicum*) or small (*cor pulmonale*) circulation, valvular defects, etc., or trabecular hypertrophy of the urinary bladder in the case of obstruction of the urethra by hyperplastic prostate or thickening of the intestinal muscle above the stenosis.

Nervously conditioned

It arises when the innervation of some sections of the GIT (cardia and lower part of the esophagus, rectum and ace-shaped colon) is disturbed, which leads to spasm (permanent contraction of the muscle due to the impossibility of relaxation) and its hypertrophy, the section orally from the narrowed part expands with accumulated contents, often in this expanded section, the muscle still hypertrophies in a compensatory way, examples are achalasia of the esophagus, Hirschprung's disease (megacolon congenitum) and pyloric stenosis.

Hormonally conditioned

It is usually hyperplasia:

- physiologically in women in the uterus and mammary gland during pregnancy,
- in men, hyperplasia of the prostate ,
- hyperplastic goiter,
- acromegaly (hypertrophy and hyperplasia of the end parts of the skeleton due to increased production of somatotropic hormone in the pituitary gland),
- gynecomastia (hyperplasia of the mammary gland in men, e.g. with an excess of estrogens).

Vascular

It can be post-inflammatory hypertrophy of the epithelium (increased blood flow to the inflamed tissue) or gigantomelia (enlargement of the limb due to congenital arteriovenous shunts that significantly increase blood flow in the affected circulation) or, for example, club fingers .

Metaplasia

The term **metaplasia** means the transformation *of one differentiated tissue into another differentiated tissue* (ligament transforms into bone, cylindrical epithelium into squamous).

Direct

- **change of differentiation without loss of original differentiation**
- e.g.: transformation of ligament into fibrous bone

Prosoplasia

- **differentiation beyond the physiological limit**
- e.g.: transformation of the squamous non-keratinized epithelium of the oral cavity into squamous cornified epithelium during chronic irritation or inflammation (leukoplakia)

Indirect

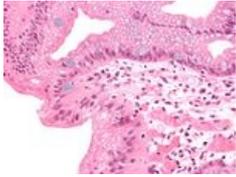
- **removal of the original epithelium and regeneration from the indifferent layer**
- e.g.: transformation of the cylindrical epithelium of the bronchi into squamous cornified epithelium as a result of smoking (reversible)

Intestinal

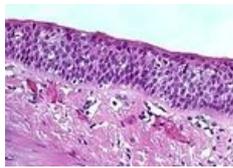
- cells of the stomach lining turn into cells of the small intestine (intestinal metaplasia of the stomach)

Extramedullary

- when the bone marrow is damaged, focal erythropoiesis occurs in the liver , spleen and lymph nodes (myeloid metaplasia)



Barrett's esophagus



Metaplasia of bronchial epithelium into squamous epithelium

Dysplasia

Definition: irregularity in shape, size and arrangement of cells, usually precancerous, caused by chronic irritation, hormonal, viral infections.

Examples:

- Epithelium of the cervix (CIN).
- Adenoma polyp in the intestine.
- Actinic keratosis on the skin.

Links

related articles

- Regeneration
- Reparation
- Metaplasia
- Hyperplasia
- Hypertrophy

Source

- PASTOR, Jan. *Langenbeck's medical web page* [online]. ©2004. [feeling. 6/10/2010]. <<http://langenbeck.webs.com>^[1]>.
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- MACÁK, Jiří. *General pathology*. 1st edition. Olomouc: Palacký University, Faculty of Medicine, 2002. 189 pp. ISBN 80-244-0436-2 .

1. <http://langenbeck.webs.com>