(I.) Red blood cell count. Estimation of haemoglobin concentration. Calculated parameters of red blood cells (II.) Estimation of blood group by slide method

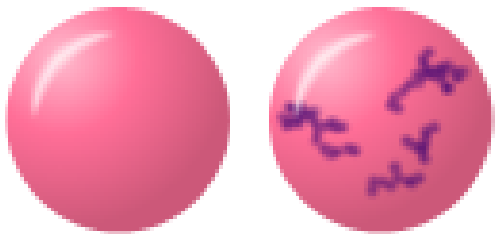
Physiology I – practicals

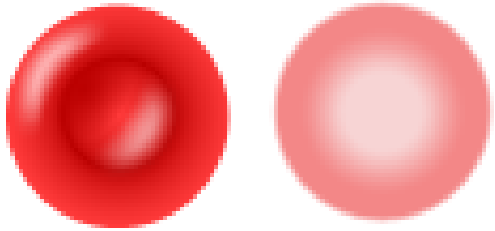
Red Blood Cell (RBC) – erytrocyte

- Anucleated cell, the most abundant blood cell
- Shape:
  - Biconcave disc
    - surface increased by 30%
    - spectrin
    - deformation inside the capillaries
- Functions:
  - Transport of oxygen (haemoglobin)
  - Role in acidobasic balance and CO_2 transport
- Size:
  - Normocyte: 7.5 µm
  - Microcyte: ≤ 7 µm
  - Macrocyte: ≥ 9 µm
  - Megalocyte: ≥ 20 µm

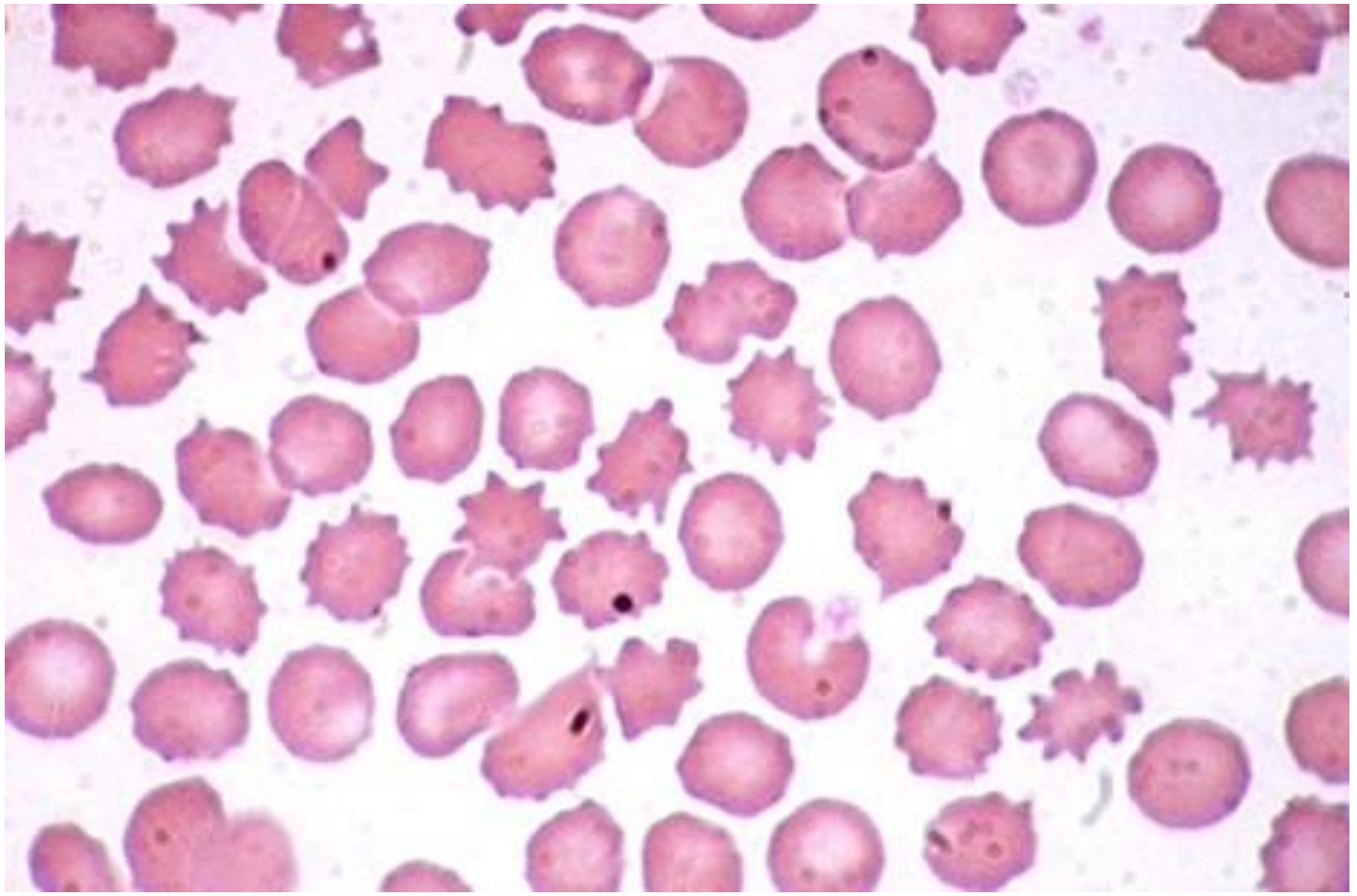
Reticulocyte

- Immature RBC
- In peripheral blood: 1% ± 0.5% of RBC
  - reticulocytosis: increased ratio of reticulocytes in peripheral blood
- No nucleus, but residues of membrane organelles in cytoplasm (substantia granulo-filamentosa)
- Within 48 hrs. maturation to RBC

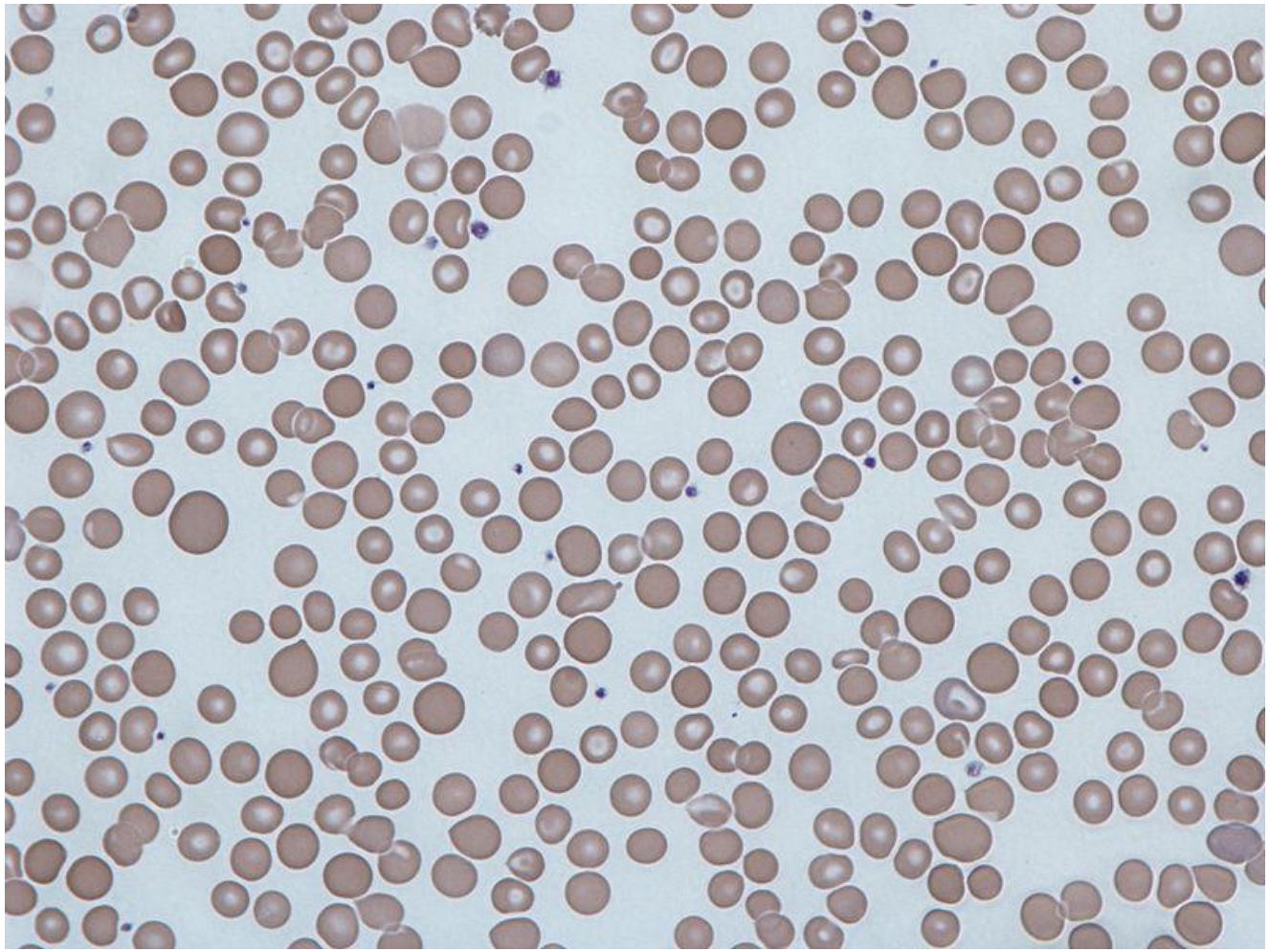




Alteration of shape: poicylocytosis



Anisocytosis: varying size of RBCs



RBC count

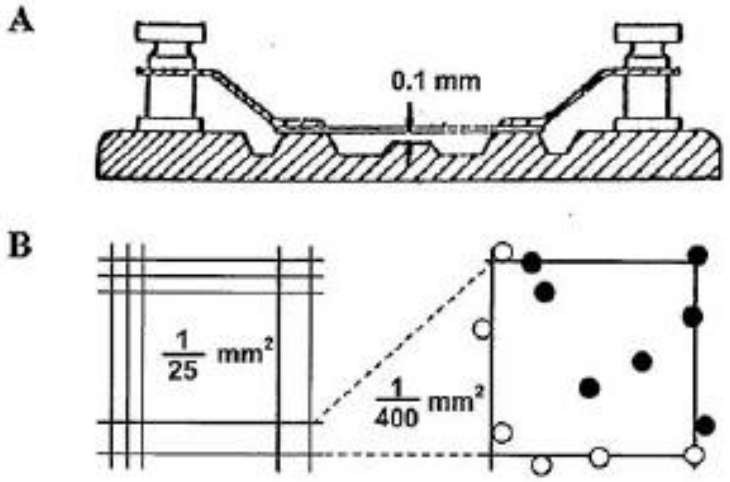
- Number of RBC
  - Men: 4.3-5.3 * 10^{12} / l
  - Women: 3.8-4.8 * 10^{12} / l
  - Newborns: 4.4-7.0 *10^{12} / l

- Intersexual differences:
  - Men: testosteron (male sex hormone) stimulates releasing of erythropoetin
  - Women in fertile period: relative erythrocytopenia due to menstruation

Alterations of RBC count

- polyglobulia – increased number of RBCs
- erythrocytopaenia – decreased number of RBCs

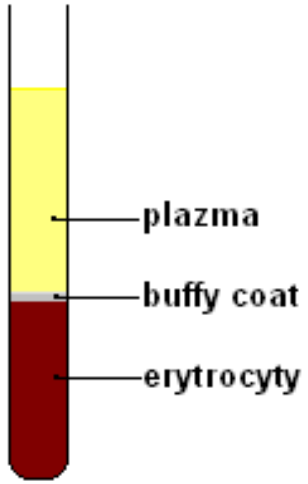
Estimation of RBC count



- Automatic methods

- Classical method: Bürker´s chamber + Hayem´s solution

Haematocrit



- Volume percentage of blood cells in blood sample (erythrocyte volume fraction)
- Centrifugation of **anti-coagulated** blood
  - Plasma
  - Buffy coat
  - RBC

- Hct (hematocrit)
  - Men: 42-52%
  - Women: 37-47%

Hemoglobin

- Hemoglobin concentration (HGB)
  - Men: 140-180 g/l
  - Women: 120-160 g/l
  - Newborns: 160-240 g/l

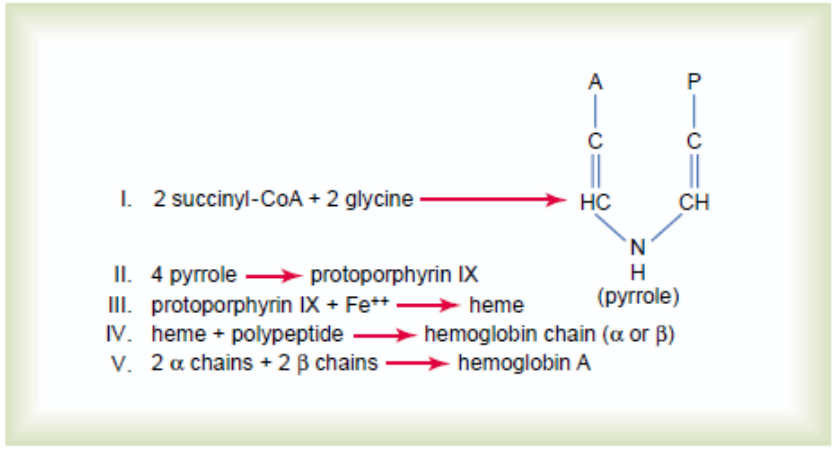


Figure 32–5

Formation of hemoglobin.

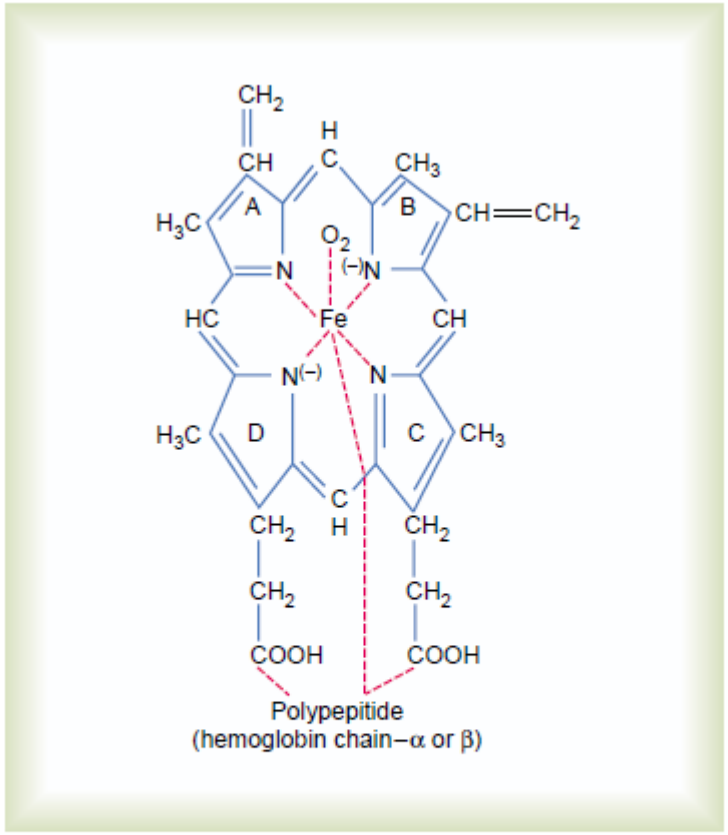


Figure 32–6

Basic structure of the hemoglobin molecule, showing one of the four heme chains that bind together to form the hemoglobin molecule.

Estimation of HGB

- Spectrophotometric method:
  - lysis of RBC by transforming solution + stabilisation of haemoglobin (Hb-cyanide)
  - Measurement of light absorption

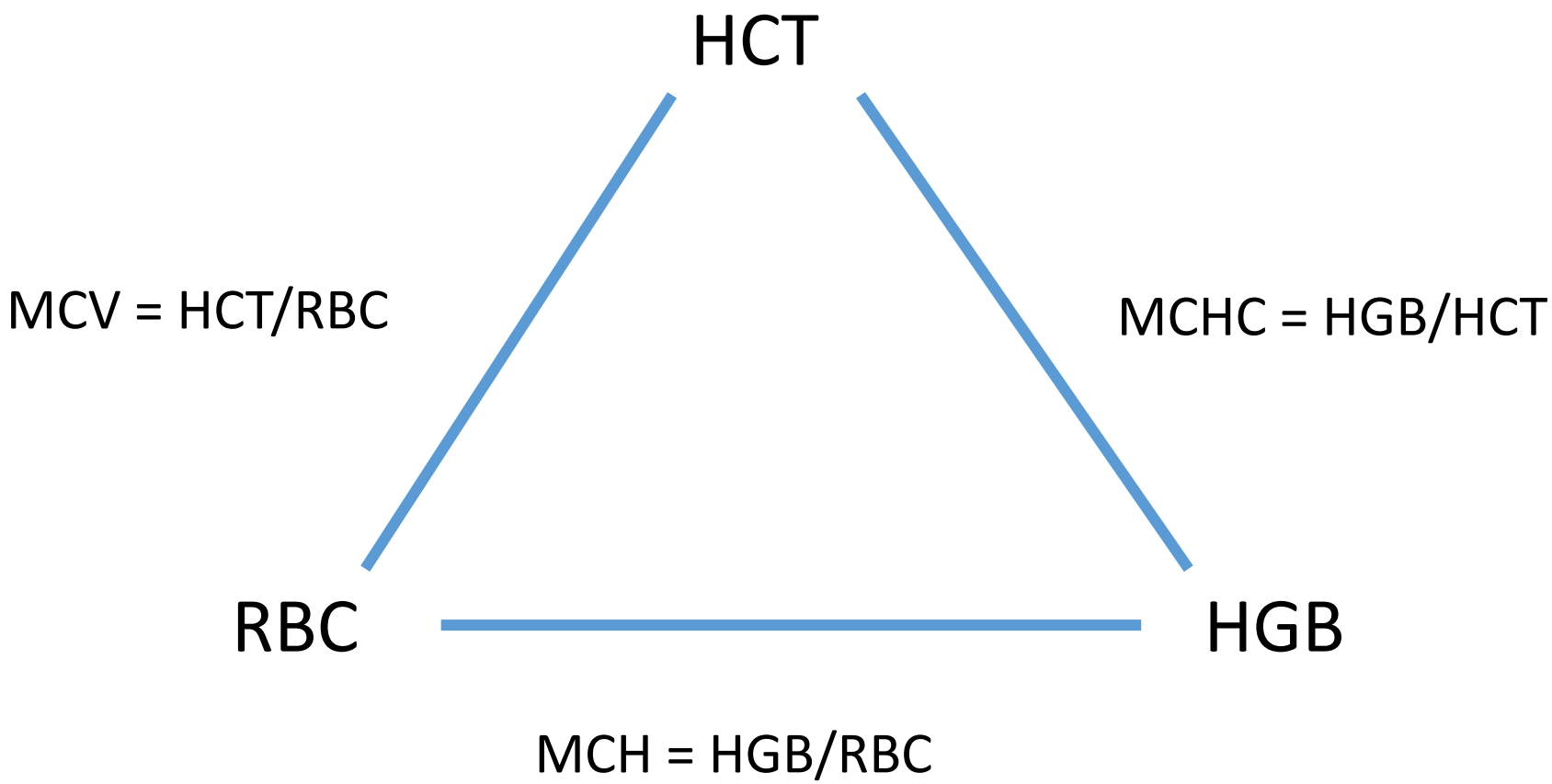
Haemoglobin - derivatives

- **Oxyhaemoglobin** – haemoglobin + O_2
- **Carboxyhaemoglobin** – haemoglobin + CO
- **Carbaminohaemoglobin** – haemoglobin + CO_2
- **Methemoglobin** = haemiglobin with oxidized Fe (Fe^{3+})

Calculated parameters of RBCs

- Average volume of RBC (**MCV**, mean corpuscular volume)
  - MCV = HCT/RBC (hematocrit/ red blood count) = 80-95 fl
- Average weight of Hb in RBC (**MCH**, mean corpuscular hemoglobin)
  - MCH = HGB/RBC (haemoglobin/ red blood count) = 28-32 pg
- Average concentration of Hb in RBC (**MCHC**, mean corpuscular hemoglobin concentration)
  - MCHC = HGB/HCT (hemoglobin/ hematokrit) = 310-360 g/l
- Red cell distribution width (**RDW**) = 11,5-14,5%
  - Variation of RBCs size
  - ↑RDW – anisocytosis

Calculated parameters of RBCs



Anaemia

- **Decreased concentration of Hb** in blood

- Symptoms
  - Pale mucose membrane
  - Fatigue
  - Tachycardia
  - Dyspnoe

Sideropenic anaemia

- Deficiency of Fe^{2+} → decreased production of RBCs→ hypoxia stimulates releasing of erythropoietin → increased production of RBCs with lack of Hb

- **Microcytic hypochromic anaemia**

Pernicious anaemia

- Deficiency of B_{12} of folic acid
- **Macrocytic, hyperchromic anaemia**

Krevní skupiny

- Ery na svém povrchu nesou různé antigeny, podle kterých je dělíme do krevních skupin. Tyto krevní znaky se dědí a jsou neměnné během celého života

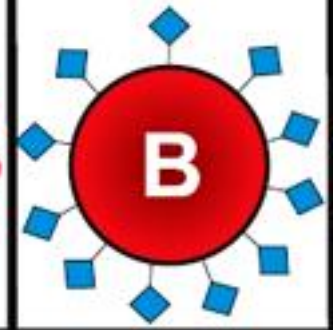
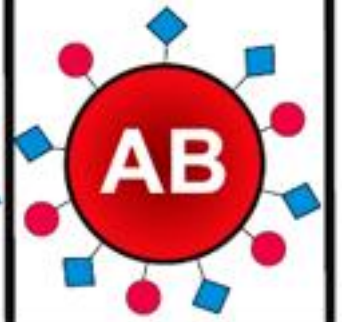
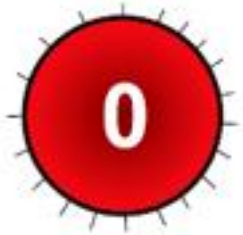
- Např. systémy: ABO, Rh, MNs (průkaz otcovství), Kell, Lewis

AB0 systém

- Aglutinogeny – glykoproteiny:
  - 0 – pouze struktura H, alela ii, 33%
  - A – na strukturu H navázaný N-acetylgalaktosamin, alely AA, Ai, 45%
  - B – na strukturu H navázaná galaktóza, alely BB, Bi, 16%
  - AB – nese antigeny A + B, alela AB, 6%
  - Nevyskytují se jen na erytrocytech.

- Aglutininy – protilátky IgM:
  - 0 – anti-A + anti-B
  - A – anti-B
  - B – anti-A
  - AB – nemá
  - Jejich tvorba je zahájena po příjmu potravy a probíhá po celý život. Nemohou procházet placentární bariérou (kde je přenašeč pouze pro IgG).

AB0 systém

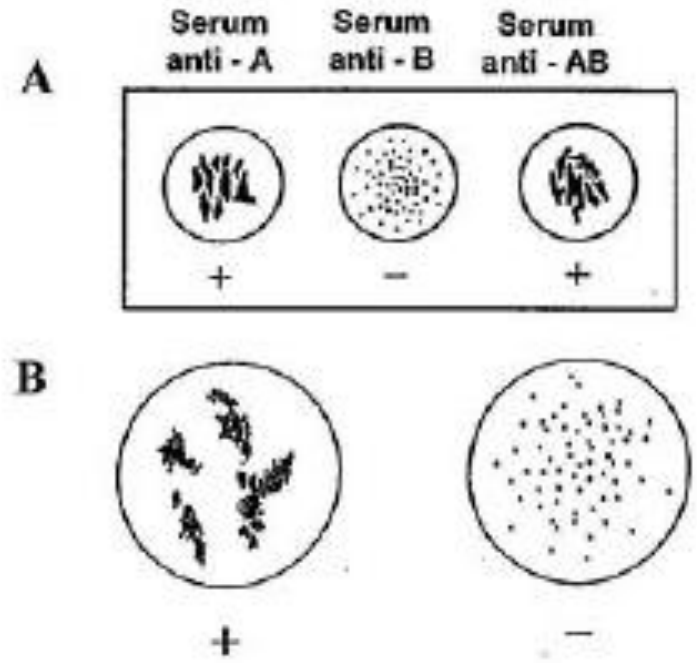
	SKUPINA A	SKUPINA B	SKUPINA AB	SKUPINA 0
erytrocyty				
protilátky	 Anti-B	 Anti-A	žádné	 Anti-A Anti-B
antigeny	 A antigen	 B antigen	 A a B antigeny	žádné

AB0 systém: dědičnost

- Alely: A, B, i
- A a B se dědí kodominantně, projeví se obě alely
- alela i je vůči nim recesivní

Určení krevních skupin sklíčkovou metodou

- Sklíčková metoda – na podložní sklíčko kápneme krev a standardní séra skupiny A, B a 0. Dle aglutinace určíme krevní skupinu.



Rh faktor

- Objeven u opice Makak rhesus
- Antigeny C,c,D,d,E,e
  - Je-li přítomno D → Rh^+, dominantní
  - Rh^- jsou recesivní homozygoti
- Protilátky IgG se tvoří až po setkání a antigenem D
  - Procházejí placentou
  - Možnost imunizace:
    - Transfuze inkompatibilní krve
    - Delivery (miscarrige, abortion) Rh^+ child Rh^- mother, u dalšího těhotenství může nastat **fetální erytroblastóza** – dochází k prostupu anti-Rh protilátek placentou a k hemolýze fetálních erytroblastů→ hydrops fetalis
      - Prevence: podání anti-Rh séra matce do 2 hodin po porodu

Zdroje obrázků

- Slide 3 - https://en.wikipedia.org/wiki/Reticulocyte [cited 30.8.2015]
- Slide 4 - http://medicaltreasure.com/poikilocytosis/ [cited 30.8.2015]
- Slide 5 - https://commons.wikimedia.org/wiki/File:Anisocytosis.jpg [cited 30.8.2015]
- Slide 7, 21 – Praktická cvičení z fyziologie, Masarykova univerzita 2011
- Slide 8 - http://www.wikiskripta.eu/index.php/Hematokrit [cited 30.8.2015]
- Slide 9 – Ganong‘s Review of medical physiology, Ganong, Mc Grow hill, 2010
- Slide 19 - http://www.wikiskripta.eu/index.php/Soubor:Krevni_skupiny.png [cited 30.8.2015]