Pathophysiology of the Blood System.

Case 1.

A 36-year-old woman was admitted to hospital with complaints of acute weakness, increased body temperature, chills, pains in the loin, dyspnea at rest, pains in the heart area and palpitations. *On examination:* The patient is pale, the skin has a lemon-yellow tint; the spleen is enlarged and painful on palpation.

Blood test: hemoglobin (Hb) – 60 g/l; erythrocytes – 1.8 x 10^{12}/l; hematocrit (Ht) – 0.16 l/l; reticulocytes – 28%; reticulocytes index (RI) – 5.3; thrombocytes – 180 x 10^9 /l; leukocytes – 14.5 x 10^9/l. Leukocyte formula (%): basophils – 1; eosinophils – 4; neutrophils: metamyelocytes -2, band neutrophils – 11, segmented neutrophils – 62; lymphocytes – 17; monocytes – 3. *In the blood smear*: anisocytosis, poikilocytosis, polychromasia, single oxyphilic and polychromatophilic normocytes. Erythrocyte sedimentation rate – 40 mm/h. Iron level in the blood serum – 45 mCmol/l, bilirubin – 85 mCmol/l. Osmotic resistance of erythrocytes (ORE): minimal – 0.56%, maximal – 0.32% NaCl. Coombs test is positive. MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin), MCHC (mean corpuscular hemoglobin concentration) are normal.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology is characterized by this hemogram?
3. Explain the pathogenesis of this pathology and classify it according to its main features (pathogenesis, functional state of the bone marrow, type of hemopoiesis, erythrocyte size and hemoglobin content in the erythrocytes).
4. Explain the mechanism of the symptoms and hemogram changes.
5. What does Coombs test mean?

Case 2

Patient K., 20 years old, was admitted to hospital with complaints of weakness, increased fatigability, headaches, dyspnea and palpitation on slight exertion. He is known to have been having these symptoms since his childhood. His mother's father suffered from anemia.

Blood test: Hb – 70g/l; erythrocytes – 3.5 x 10^{12}/l; Ht – 0.32 l/l; reticulocytes – 0.4 %; RI – 0.13; thrombocytes – 295 x 10^9/l; leukocytes – 3.9 x 10^9/l; ESR – 38 mm/h. Leukocyte formula (%): basophils – 0, eosinophils – 1, neutrophils: metamyelocytes – 0, bands – 4, segmented neutrophils – 44, lymphocytes – 46, monocytes – 5. *In the blood smear:* anisocytosis, poikilocytosis, microcytosis, anisochromasia. There is an increased content of sideroblasts (ring-form) in the bone marrow. Serum iron content – 64 mCmol/l; latent iron-binding capacity is decreased; serum bilirubin – 14 mCmol/l. MCV, MCH, MCHC are decreased.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology is characterized by these symptoms and hemogram? Classify it according to its main features.
3. Explain the etiology and pathogenesis of this disease.

4. What complications can this pathology lead to? What measures should be taken for their prevention?

Case 3.

Patient S., 16 years old, was admitted to hospital with complaints of weakness, dizziness, increased body temperature, painful swallowing. From his history it is known that he has inhaled benzene vapor for three months with narcotic purposes. On examination he was found to have pale skin, numerous pinpoint and spot hemorrhages, necrotic ulcers of the faucial and oral mucosa. The liver and spleen are not enlarged.

Blood test: hemoglobin – 60 g/l; erythrocytes – 2.0 x 10^{12}/l; reticulocytes – 0.1%; RI – 0; Ht – 18.4 l/l; thrombocytes – 30 x 10^{9}/l; leukocytes – 2.5 x 10^{9}/l; ESR – 44 mm/h. Leukocyte formula (%): basophils – 0, eosinophils – 2, neutrophils: metamyelocytes – 0, bands – 1, segmented neutrophils – 25, lymphocytes – 69, monocytes – 3. *In the blood smear:* anisocytosis, poikilocytosis, MCV, MCH, MCHC are within the norm. Bone marrow puncture does not show any signs of hemoblastosis. Serum iron content – 40 mCmol/l; bilirubin – 10 mCmol/l.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology is characterized by these symptoms and hemogram? Classify this pathology according to its main features.
3. Determine the absolute neutrophil and lymphocyte count in the blood and assess these values.
4. Explain the etiology and pathogenesis of the disease and the mechanism of the symptoms.

Case 4

A child, 1 year old, was referred to the in-patient department with a diagnosis: anemia. *History data:* the child is preterm; since the age of 3 weeks he has been on artificial feeding; has had frequent colds. The child has a body mass deficit, decreased appetite, dryness of the skin, hair loss, angular stomatitis, pallor of the skin and mucosa.

Blood test: Hb – 60 g/l; erythrocytes – 3 x 10^{12}/l; hematocrit – 0.3 l/l; thrombocytes – 170 x 10^{9}/l; leukocytes – 6.4 x 10^{9}/l; reticulocytes – 2.5%; RI – 0.9; ESR – 22 mm/h. Leukocyte formula (%): basophils – 0, eosinophils – 2, neutrophils: metamyelocytes – 0, bands – 4, segmented – 32, lymphocytes – 53, monocytes – 9. *In the blood smear:* anisocytosis (microcytosis), poikilocytosis, anisochromasia. MCV, MCH, MCHC are decreased. Serum iron content – 5.8 mCmol/l; bilirubin – 15 mCmol/l.

1. Determine the color index and the functional state of the bone marrow.
2. What type of anemia are these symptoms and this hemogram typical of? Justify your conclusion.
3. Classify this anemia according to its main features.
4. Explain the pathogenesis of anemia and the symptoms of the disease.

5. How do total iron-binding capacity and latent iron-binding capacity of blood serum, coefficient of transferrin saturation by iron and content of sideroblasts in the red bone marrow change in this anemia?

Case 5

Patient U., 49 years old was admitted to hospital with complaints of progressing weakness, palpitations, dizziness, dyspnea at rest, pain and burning sensation in the tongue, dyspepsia, numbness of the limbs, derangement of motor coordination.
Examination revealed pallor of the skin with a lemon-yellow tint, bright-crimson tongue with flattened papillae. Fibrogastroduodenoscopy showed signs of atrophy gastritis.
Blood test: hemoglobin – 60 g/l; erythrocytes – 1.5 x 10^{12}/l; hematocrit – 0.14 l/l; reticulocytes – 0.4%; RI – 0.05; thrombocytes – 110 x 10^{9}/ l; leukocytes – 3.8 x 10^{9}/l. Leukocyte formula (%): basophils -0, eosinophils -1, neutrophils: metamyelocytes – 0, bands – 1, segmented – 40, lymphocytes – 53, monocytes -5.
In the blood smear: anisocytosis, poikilocytosis, anisochromasia, megalocytes; erythrocytes with Jolly's bodies and Cabot's rings – single ones in the visual field; polysegmented neutrophils – single ones in the visual field. Price – Jones curve is shifted to the right. MCV and MCH are higher than the norm. Serum iron content – 41 mCmol/l; bilirubin – 43 mCmol/h; osmotic resistance of erythrocytes (ORE): min. – 0.54%, max. – 0.34% NaCl. ESR – 28 mm/h.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology are these symptoms and this hemogram typical of?
3. Classify this pathology according to its main features.
4. What main syndromes are typical of this disease? Explain their pathogenesis.
5. How can you explain the changes in iron and bilirubin content in the blood serum and in ORE?

Case 6

Patient M., aged 39, was admitted to hospital with complaints of weakness, increased fatigability, dizziness, hair loss, brittleness and stratification of the nails, derangement of taste, decreased appetite, pains in the epigastrium exacerbated by fasting, especially in spring and autumn. He suffers from a duodenal ulcer.
Blood test: hemoglobin –70 g/l; erythrocytes – 3.5 x 10^{12}/l; hematocrit – 0.32 l/l; reticulocytes – 1.2%; RI – 0.35; thrombocytes – 360 x 10^{9}/ l; leukocytes – 4.4 x 10^{9}/l. Leukocyte formula (%): basophils -0, eosinophils -3, neutrophils: metamyelocytes – 0, bands – 2, segmented – 65, lymphocytes – 26, monocytes -4.
In the blood smear: anisocytosis, poikilocytosis; Price – Jones curve is shifted to the left. ESR – 19 mm/h. MCV, MCH, MCHC are decreased. Serum iron content – 5.8 mCmol/l; bilirubin – 18 mCmol/l.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology are these symptoms and this hemogram typical of?
3. Classify this pathology according to its main features.

4. Explain the etiology and pathogenesis of this pathology and its main symptoms.
5. Point out possible changes in total iron-binding capacity and latent iron-binding capacity of the blood serum and sideroblast content in the red bone marrow in this pathology.

Case7

Patient V., 47 years old, a worker at an accumulator factory, was admitted to hospital with complaints of weakness, quick fatigability, frequent headaches, memory worsening, dyspnea and pains in the abdomen and lower limbs. Examination showed ashen pallor of her skin, a grey-lilac border of the gums. Neurological examination revealed symptoms of polyneuritis.

Blood test: hemoglobin –70 g/l; erythrocytes – 3.5 x 10^{12}/l; hematocrit – 0.32 l/l; reticulocytes – 6 %; RI – 2.4; thrombocytes – 210 x 10^{9}/ l; leukocytes – 6.8 x 10^{9}/l. ESR – 18 mm/h. Leukocyte formula (%): basophils -0, eosinophils -3, neutrophils: metamyelocytes – 0, bands – 4, segmented – 56, lymphocytes – 30, monocytes -7. *In the blood smear:* anisocytosis, poikilocytosis, anisochromasia, basophilic stippling of erythrocytes. MCV, MCH, MCHC are decreased. Serum iron content – 56 mCmol/l, bilirubin – 26 mCmol/l. In the bone marrow there are numerous sideroblasts (ring-form). *In the urine*: the content of aminolevulinic acid is 30 times as high as the upper border of the norm, increased content of coproporphyrin and free protoporphyrin.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology are these symptoms and this hemogram typical of?
3. Classify the disease according to its main features.
4. Explain the pathogenesis of the disease and its main symptoms.
5. What are sideroblasts?

Case 8

A 53-year-old woman was admitted to hospital with complaints of progressive weakness, palpitations, dyspnea at rest, dizziness, decreased appetite, pain and burning sensation in the tongue when eating spicy and sour food. Examination showed marked pallor of the skin and icteric sclera. Neurological examination did not reveal any pathology. Two years prior to this hospitalization the patient underwent a jejunectomy.

Blood test: hemoglobin –70 g/l; erythrocytes – 1.75 x 10^{12}/l; thrombocytes – 140 x 10^{9}/ l; reticulocytes – 1 %; RI – 0.23; leukocytes – 3.9 x 10^{9}/l. ESR – 27 mm/h. Leukocyte formula (%): basophils -0, eosinophils -2, neutrophils: metamyelocytes – 0, bands – 1, segmented – 43, lymphocytes – 50, monocytes – 4. *In the blood smear:* anisocytosis, poikilocytosis, anisochromasia, megalocytes, single oxyphilic megaloblasts and polysegmented neutrophils. MCV, MCH are increased. Serum iron – 46 mCmol/l, indirect bilirubin – 39 mCmol/l. Osmotic resistance of erythrocytes (ORE): min. – 0.58%, max. – 0.34% NaCl.

1. Determine the color index and the functional state of the bone marrow.

2. What blood pathology are these symptoms and this hemogram typical of?
3. Classify this pathology according to its main features.
4. Explain the pathogenesis of the disease and its main clinical syndromes.
5. What other pathology of the blood system should this disease be distinguished from? Justify your answer.

Case 9

Patient G., 34 years old, was admitted to hospital in a poor condition after a car accident. On admission: the patient is stuporous, indifferent to his surroundings; the skin is pale, the pulse is thready, BP – 65/30 mm Hg. After an anti-shock therapy the patient's condition improved; BP rose up to 115/70 mm Hg. The treatment was given under a constant control of his blood system condition.

Results of one of the blood tests in the process of treatment: hemoglobin –66 g/l; erythrocytes – 2.5 x 10^{12}/l; hematocrit – 0.23 l/l; reticulocytes – 8.5 %; RI – 2.12; thrombocytes – 380 x 10^{9}/ l leukocytes – 14 x 10^{9}/l. ESR – 20 mm/h. Leukocyte formula (%): basophils -0, eosinophils -2, neutrophils: metamyelocytes – 2, bands – 12, segmented – 60, lymphocytes – 20, monocytes – 4. *In the blood smear:* polychromasia, single oxyphilic normocytes. Serum iron – 12.5 mCmol/l; bilirubin – 19 mCmol/l. Osmotic resistance of erythrocytes: min. – 0.44%, max. – 0.32% NaCl.

1. Determine the color index.
2. What blood pathology are these symptoms and hemogram typical of?
3. Classify the disease according to its main features.
4. Explain the pathogenesis of the disease and stages of its development.
5. Point out (approximately) on what day after hospitalization the repeated blood test was made.

Case 10

Student U., 18 years old, at a medical check-up complained of increased fatigability, irritability, sleepiness, worsening of memory. She had her blood test made the day before an examination in normal anatomy.

Blood test: hemoglobin –135 g/l; erythrocytes – 4.5 x 10^{12}/l; hematocrit – 0.40 l/l reticulocytes – 0.8 %; thrombocytes – 200 x 10^{9}/ l; leukocytes – 8 x 10^{9}/l. ESR – 10 mm/h. Leukocyte formula (%): basophils -0, eosinophils -0, neutrophils: metamyelocytes – 0, bands – 6, segmented – 78, lymphocytes – 10, monocytes – 6. *In the blood smear:* single polychromatophilic erythrocytes. MCV, MCH, MCHC are within the norm. Serum iron content – 14 mCmol/l; bilirubin – 14 mCmol/l. ORE: min. – 0.44%, max. – 0.34% of NaCl solution.

1. Determine the color index and absolute neutrophil and lymphocyte count.
2. Assess these values.
3. Explain a possible mechanism of the changes in the hemogram.

Case 11

Patient U., 60 years old, was admitted to hospital with complaints of general weakness, excessive sweating, body temperature increase up to 37 -38 ˚C, dyspnea,

abdominal pains, dyspepsia. Physical examination revealed pallor of the skin with a lemon-yellow tint, icteric sclera, considerable enlargement of peripheral lymph nodes and the spleen, moderate enlargement of the liver.

Blood test: hemoglobin –80 g/l; erythrocytes – 2.4 x 10^{12}/l; hematocrit – 0.22 l/l; reticulocytes – 3 %; RI – 0.7; thrombocytes – 104 x 10^{9}/ l leukocytes – 80 x 10^{9}/l. ESR – 27 mm/h. Leukocyte formula (%): basophils -0, eosinophils -0, neutrophils: metamyelocytes – 0, bands – 1, segmented – 6, lymphocytes – 92, monocytes – 1. *In the blood smear:* anisocytosis, poikilocytosis, single prolymphocytes and Botkin- Gumprecht shadows. On the myelogram – 37% of lymphocytes. Serum iron content – 40 mCmol/l; bilirubin – 68.4 mCmol/l. Coombs reaction is positive. Phenotyping of lymphoid cells with monoclonal antibodies revealed markers CD19, CD20. Cytogenetic investigation revealed trisomy of chromosome 12.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology is this hemogram typical of? Justify your answer.
3. Determine the absolute neutrophil and lymphocyte count in the blood and assess these values.
4. Explain the mechanism of the symptoms and changes in the hemogram.
5. Assess a prognosis for this patient.

Case 12

Patient E., 5 years old, complains of weakness, dizziness, pains in the lower limbs, mild abdominal pain, dry cough. On examination: multiple pinpoint and spot hemorrhages on the skin. The liver, spleen and lymph nodes are enlarged.

Blood test: hemoglobin –90 g/l; erythrocytes – 3.0 x 10^{12}/l; hematocrit – 0.27 l/l; reticulocytes – 0.6 %; RI – 0.2; thrombocytes – 30 x 10^{9}/ l leukocytes – 17 x 10^{9}/l. Leukocyte formula (%): blast cells – 75, basophils -0, eosinophils -2, neutrophils: metamyelocytes – 0, bands – 1, segmented – 5, lymphocytes – 15, monocytes – 2. ESR – 25 mm/h. *Histochemical analysis* of blast cells showed negative reaction to myeloperoxidase and lipids, positive PAS-reaction (periodic acid – Schiff reaction) (polysaccharides in the form of separate granules), positive reaction to TdT (terminal desoxynucleotidiltransferase). Immunophenotyping revealed markers CD10 and CD19.

1. Determine the color index, the functional state of the bone marrow and assess the absolute lymphocyte count in the blood.
2. What blood pathology is characterized by this hemogram? Justify your answer.
3. Explain the pathogenesis of this pathology.
4. Explain the pathogenesis of the symptoms, changes in the hemogram and hemorrhagic syndrome.

Case 13

Patient M., 45 years old, was admitted to hospital with complaints of weakness, excessive sweating, pains in the left side of the abdomen, palpitations, dyspnea, periodic rise of temperature to 37.5 – 39 ˚C, pain in the bones, easy bruising.

Examination revealed hepatomegaly, splenomegaly, enlarged painful lymph nodes.

Blood test: hemoglobin –70 g/l; erythrocytes – 3.0 x 10^{12}/l; hematocrit – 0.28 l/l; reticulocytes – 0.4 %; RI – 0.1; thrombocytes – 80 x 10^9/ l leukocytes – 450 x 10^9/l. *In the blood smear*: anisocytosis, poikilocytosis, anisochromasia.
Leukocyte formula (%): basophils -7, eosinophils -8, myeloblasts – 4, promyelocytes – 7, myelocytes – 17, metamyelocytes – 24, band neutrophils – 19, segmented neutrophils– 13, lymphocytes – 1, monocytes – 0.

1. Determine the color index and assess the absolute neutrophil, basophile, eosinophil and lymphocyte count in the blood.
2. What blood pathology is characterized by this hemogram? Justify your answer.
3. Explain the mechanism of the symptoms and changed in the hemogram.
4. Name possible etiological factors of this disease.
5. What chromosome abnormality can be found in the majority of patients with this disease?

Case 14

Patient A., 28 years old, was admitted to hospital with complaints of weakness, increase in body temperature, chills and painful swallowing. She fell ill suddenly. Examination revealed signs of ulcerous necrotic tonsillitis and stomatitis, enlargement and tenderness of the submandibular lymph nodes. From the patient's history it is known that she often takes biceptol.
Blood test: hemoglobin –126 g/l; erythrocytes – 4.2 x 10^{12}/l; hematocrit – 0.39 l/l; reticulocytes – 0.6 %; thrombocytes – 195 x 10^9/ l leukocytes – 1.3 x 10^9/l. Leukocyte formula (%): basophils -0, eosinophils -0, neutrophils: metamyelocytes – 0, bands – 2, segmented – 13, lymphocytes – 80, monocytes – 5. The proportion of fat and cell elements in the bone marrow is normal.

1. Determine the color index and assess the absolute neutrophil and lymphocyte count in the blood.
2. What blood pathology is characterized by this hemogram? Explain its pathogenesis.
3. What is the origin of the symptoms?
4. What similar pathology should this hematological disorder be distinguished from?

Case 15

Patient O., a 27-year-old woman, was admitted to hospital with complaints of weakness, dyspnea, dry cough, rise of temperature, chills, pain in the oral cavity, ulceration of the oral mucosa. Examination revealed ulcerous stomatitis and pneumonia which was almost asymptomatic. The liver and the spleen are not enlarged.
Blood test: hemoglobin –96 g/l; erythrocytes – 3.2 x 10^{12}/l; hematocrit – 0.29 l/l; reticulocytes – 0.3 %; RI – 0.1 thrombocytes – 49 x 10^9/ l leukocytes – 1.5 x 10^9/l. Leukocyte formula (%): basophils -0, eosinophils -0, neutrophils: metamyelocytes – 0, bands – 0, segmented – 22, lymphocytes – 75, monocytes – 3. ESR – 28 mm/h.

In the blood smear: moderate anisocytosis, poikilocytosis, neutrophils with pycnosis of the nuclei and toxic stippling of the cytoplasm. There are no signs of lymphoid metaplasia in the bone marrow punctate. Serum iron – 41 mCmol/l.

1. Determine the color index and the functional state of the bone marrow.
2. What blood pathology is this hemogram typical of?
3. State possible causes of the disease. Explain the mechanism of the symptoms and changes in the patient's hemogram.
4. What complication can develop in this patient and why?

Case 16

Patient B., 23 years old, was admitted to hospital with complains of weakness, increased fatigability, pains in the bones, dyspnea, increased temperature and chills, painful swallowing. Examination revealed signs of ulcerous necrotic tonsillitis, enlargement of the liver, spleen and regional lymph nodes.

Blood test: hemoglobin – 70 g/l; erythrocytes – 2.6 x 10^{12}/l; hematocrit – 0.24 l/l; reticulocytes – 0.4 %; RI – 0.1; thrombocytes – 40 x 10^{9}/ l; leukocytes – 25 x 10^{9}/l. ESR – 34 mm/h. Leukocyte formula (%): blast cells – 78, basophils -0, eosinophils – 1, neutrophils: myelocytes – 0, metamyelocytes – 0, bands – 0, segmented – 10, lymphocytes – 10, monocytes – 1.

In the blood smear: anisocytosis, poikilocytosis. Cytochemical analysis of blast cells revealed: positive reaction to myeloperoxidase and lipids; negative reaction to TdT (terminal desoxynucleotide-transferase). Immunophenotyping revealed antigen markers CD33, CD13. In the bone marrow punctate > 30% of blast cells.

1. Determine the color index and assess the absolute neutrophil and lymphocyte count in the blood.
2. What disease is characterized by these clinical features and this hemogram? Justify your answer.
3. Explain the pathogenesis of the disease, its main symptoms and changes in the hemogram.
4. Point out the principles of treatment.

Case 17

Patient G., a 17-year- old girl, presented with complaints of general weakness, malaise, increased body temperature, chills, muscle and joint aches, painful swallowing. Examination revealed enlargement and hyperemia of the tonsils, presence of purulent exudates in the tonsil lacunae. The neck lymph nodes are moderately enlarged, painful on palpation.

Blood test: hemoglobin –150 g/l; erythrocytes – 4.5 x 10^{12}/l; reticulocytes – 0.7 %; thrombocytes – 245 x 10^{9}/ l; leukocytes – 16 x 10^{9}/l. ESR – 24 mm/h. Leukocyte formula (%): basophils -0, eosinophils -2, neutrophils: metamyelocytes – 8, bands – 20, segmented – 56, lymphocytes – 11, monocytes – 3.

1. Determine the color index and assess the absolute neutrophil and lymphocyte count in the blood.
2. Write a conclusion about changes in the hemogram.
3. Explain the pathogenesis of the disease symptoms and changes in the hemogram.