

# Laboratory assessment of the pancreas and the gastro-intestinal tract

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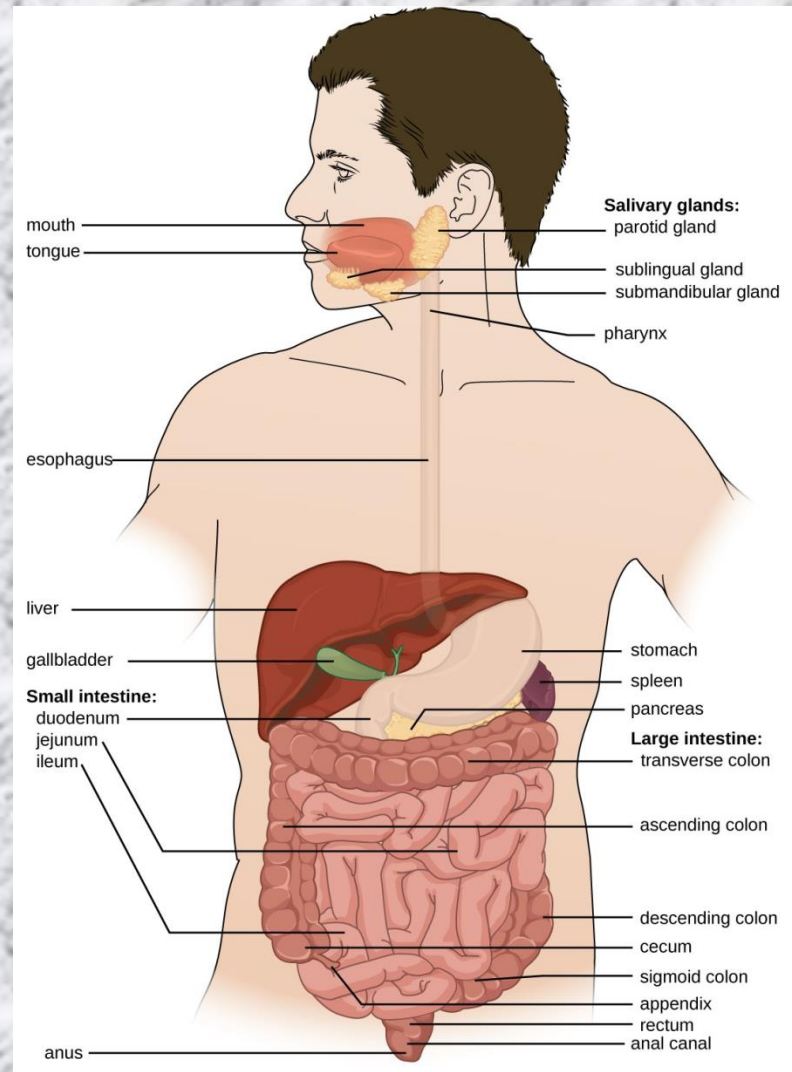
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# Laboratory assessment of the pancreas and the gastro-intestinal tract

## Highlights:

Laboratory markers of:

- pancreas
- peptic ulcer
- bowel inflammation, including
  - IBD and appendicitis
- malabsorption
- malignant disorders



# Disorders of the pancreas

- Acute pancreatitis
- Chronic pancreatitis
- Obstruction
- Cystic fibrosis
- pancreatic cancer



Source: <https://www.clinicaladvisor.com/home/topics/hepatology-information-center/acute-pancreatitis-may-reveal-pancreatic-cancer-at-earlier-stage/>

# Disorders of the pancreas/ acute pancreatitis

## **Causes:**

1. Metabolic
  - alcohol abuse
  - hyperlipidemia
2. Obstruction
  - cholelithiasis
  - abdominal trauma
  - cancer
  - iatrogen (ERCP, surgery)
3. Infection – Inflammation
  - mumps
  - coxsackie
4. Vascular

## **Pathomechanism:**

cellular damage →  
release of activated enzymes →  
Pancreatic and surrounding tissue  
proteo- and lipolysis →  
Inflammation

# Disorders of the pancreas/ acute pancreatitis

## Laboratory markers:

serum amylase

serum lipase

urinary amylase

immunoreactive trypsin

serum elastase

## Additional markers:

Lactate dehydrogenase

Alanine Aminotransferase (ALT –GPT)

HS-CRP

WBC count

Decreased serum Calcium

Metabolic Acidosis and  $\text{HCO}_3^-$  deficiency

Hypo or hyperglycemia

Kidney damage (proteinuria, serum urea ↑)

# Disorders of the pancreas/ acute pancreatitis

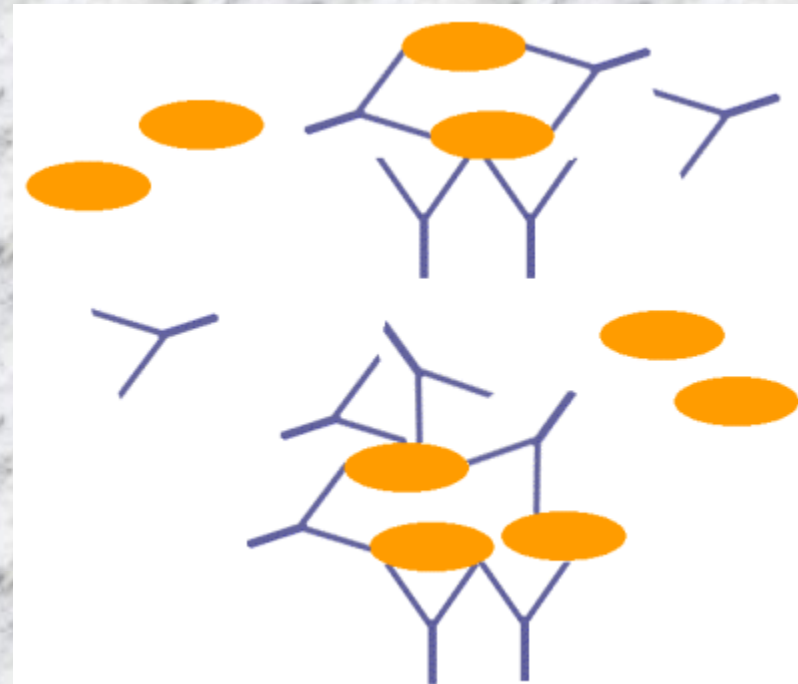
## Serum amylase:

- 45 kD (filtrates through the glomeruli)
- produced by **pancreas, saliva glands**, gonads, small intestine, striated muscle, fat tissue and lung
- physiological role: digesting starch (hydrolysis of Alpha-1,4 glycosid bonds)
- Excreted into the GI tract, but a small amount is leaking (from the pancreatic cells!) into the circulation also under physiological condition
- Physiological serum concentration: < 100 U/L
- Elevates (> 5X) in acute pancreatitis, perforated peptic ulcer, ovarium cancer, extrauterin gravidity
- Elevates moderately (< 5X): acute inflammation of the abdomen, kidney damage, diabetic ketoacidosis, saliva gland disorders

# Disorders of the pancreas/ acute pancreatitis

## Macroamylasemia

- usually is a laboratory finding, not a clinical symptom
- in a few cases, it might be associated with autoimmune diseases such as coeliac disease or autoimmune thyroiditis
- Caused by formation of a complex of normal amylase and either immunoglobulin A or G
- This large complex (hence the name ,macro') is unable to filter through the glomeruli and have a longer serum half-life
- **Lab findings:** Serum amylase is elevated, while urinary amylase is decreased. Serum amylase levels decrease after polyethylene glycol (PEG) precipitation
- Presents a differential-diagnostic challenge, especially if the patient is also presented with recurring abdominal pain of unknown origin



# Disorders of the pancreas/ acute pancreatitis

## **Serum lipase:**

- more specific than amylase
- reaches peak levels after 24-48 hours (amylase: 12-24 hours), but has a longer serum half-life (1-2 weeks vs 3-4 days for amylase)
- helps to differentiate between salivary and pancreatic disorders

## Sensitivity of laboratory markers for pancreatitis:

- amylase ~ 80%
- amylase & lipase: 94%

## **Serum Calcium:**

- decreases due to saponification (digestion of fat tissues by lipase → free fatty acids → precipitates with Ca)

## **Bicarbonate:**

- the pancreas produces and releases up to 2 liters of exocrin fluid, which contains ~ 140 mM of bicarbonate (nota bene: bicarbonate cc. in the blood ~ 24mM)
- Pancreatic tissue damage means less bicarbonate production, thus the balance is tipped toward acidosis



Date of birth: 1951.08.13

Sex: NÖ

Sampling time : 2017.05.24 04:44

Test	Results		Reference range	Unit
Sodium	151	!	136-145	mmol/l
Potassium	4,42		3,50-5,10	mmol/l
Calcium	1,41	!	2,15-2,55	mmol/l
Plasma Glucose	13,43	!	3,90-7,00	mmol/l
Total bilirubin	16,7		2,5-21,0	umol/l
Urea	8,41	!	2,14-8,21	mmol/l
Creatinine	148	!	44-80	umol/l
Triglycerid	30,70	!	0,00-1,70	mmol/l
TSH	1,050		0,270-4,200	mU/l
LDH	1425	!	240-480	U/l
GOT	71	!	<44	U/l
GPT	11		<50	U/l
Alkaline phosphatase	29	!	35-105	U/l
Gamma-GT	132	!	0-40	U/l
Amylase	1360	!	28-100	U/l
Lipase	2470	!	<60	U/l
Total protein	41,2	!	66,0-87,0	g/l
Ultrasensitive CRP	299,80	!	<5,00	mg/l
Complete blood count				
White blood cells	6,290		4,000-10,000	Giga/l
Neutrophil%	58,0		34,0-71,1	%
Lymphocyte %	35,8		19,3-51,7	%
Monocyte %	5,2		4,7-12,5	%
Eosinophil %	0,2		0,0-5,8	%
Basophil %	0,8		0,0-1,2	%
Red blood cell	5,19		3,90-5,30	T/l
Hemoglobin	171	!	120-157	g/l
Hematokrit	45,9	!	34,1-44,9	%
MCV	88,6		80,0-95,0	fl
MCH	33,0		26,0-33,0	pg
MCHC	373	!	310-360	g/l
RDW	13,2		11,6-14,4	%CV
Platelet	275,0		140,0-440,0	Giga/l
MPV	9,79		9,40-12,40	fl

Date of birth: 1947.12.18

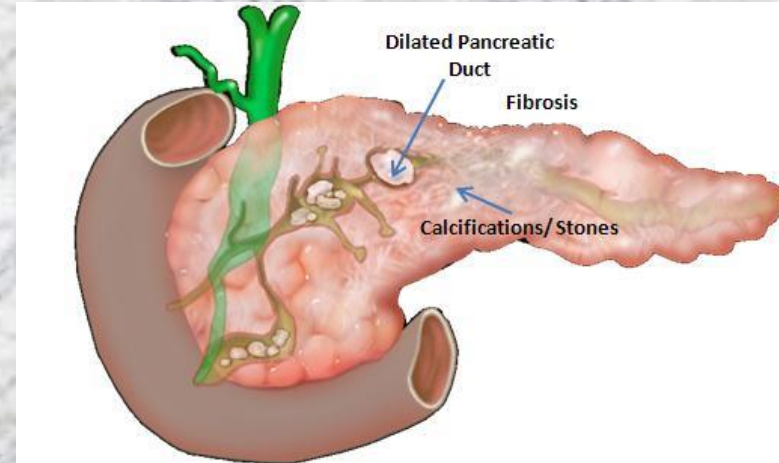
Sex: Male

Sampling time : 2013.03.23 05:57

Test	Results		Reference range	Unit
Sodium	137		136-146	mmol/l
Potassium	5,40	!	3,80-5,20	mmol/l
Calcium	1,76	!	2,10-2,60	mmol/l
Total bilirubin	26,7	!	5,0-20,0	umol/l
Urea	21,67	!	2,00-9,00	mmol/l
Creatinine	251	!	62-106	umol/l
LDH	14110	!	<450	U/l
GOT	6789	!	<44	U/l
GPT	2621	!	<50	U/l
Alkaline phosphatase	63		40-130	U/l
Gamma-GT	73	!	<70	U/l
Amylase	1577	!	28-100	U/l
Lipase	2270	!	<60	U/l
Total protein	62,2	!	66,0-83,0	g/l
Albumin	32,8	!	35,0-53,0	g/l
Ultrasensitive CRP	285,30	!	<5,00	mg/l
Procalcitonin	14,18	!	<0,50	ng/ml
Complete blood count				
White blood cells	10,600	!	4,000-10,000	Giga/l
Neutrophil%	82,0	!	34,0-67,9	%
Lymphocyte %	8,4	!	21,8-53,1	%
Monocyte %	9,0		5,3-12,2	%
Eosinophil %	0,0		0,0-7,0	%
Basophil %	0,5		0,0-1,2	%
Red blood cell	4,21	!	4,50-6,00	T/l
Hemoglobin	136	!	137-175	g/l
Hematokrit	40,3		40,1-51,0	%
MCV	95,8	!	80,0-95,0	fl
MCH	32,4		26,0-33,0	pg
MCHC	338		310-360	g/l
RDW	14,4		11,6-14,4	%CV
Platelet	193,0		140,0-440,0	Giga/l
MPV	7,31	!	9,40-12,40	fl

# Disorders of the pancreas/ Chronic pancreatitis

- slow progression
  - causes: chronic alcoholism, hyperlipidemia, biliar duct (partial) obstruction
  - symptoms and laboratory findings might not be specific
  - random acute exacerbations: symptoms and lab tests show similarity to acute pancreatitis
  - the endocrin function of the pancreas is also deteriorating
- 
- **Lab tests:**
  - **Amylase, lipase, urine amylase**
  - stool elastase, trypsin
  - Oral administration of Fluorescein dilaurate or Benzoilthyrosil-PABA (absorption and subsequent urine excretion of these metabolits requires pancreas enzymatic activity
  - $^{13}\text{C}$ -triolein breath test: radioactive isotope labelled triglyceride is given to the patient and the isotope content of exhaled  $\text{CO}_2$  is measured



# Peptic Ulcer

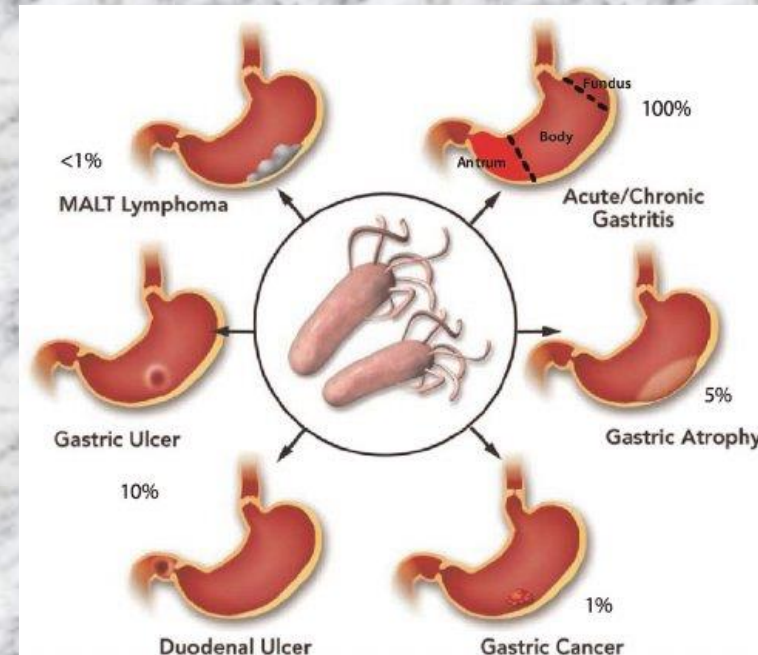
## Causes:

- H. pylori (~2/3)
- NSAID (~1/3)
- Zollinger Elison syndrome (~ 1%)

***Diagnosis is primarily based on endoscopic methods***

**H. pylori breath test has a very high sensitivity and specificity**

- the isotope content of exhaled CO<sub>2</sub> is measured after the administration of 75 mg <sup>13</sup>C-urea
- alternative tests for H. pylori detection: serology (might be positive even after eradication), histology, H. pylory cultivation



Analysis of acid secretion using a nasogastrical tube

Physiological reference ranges:

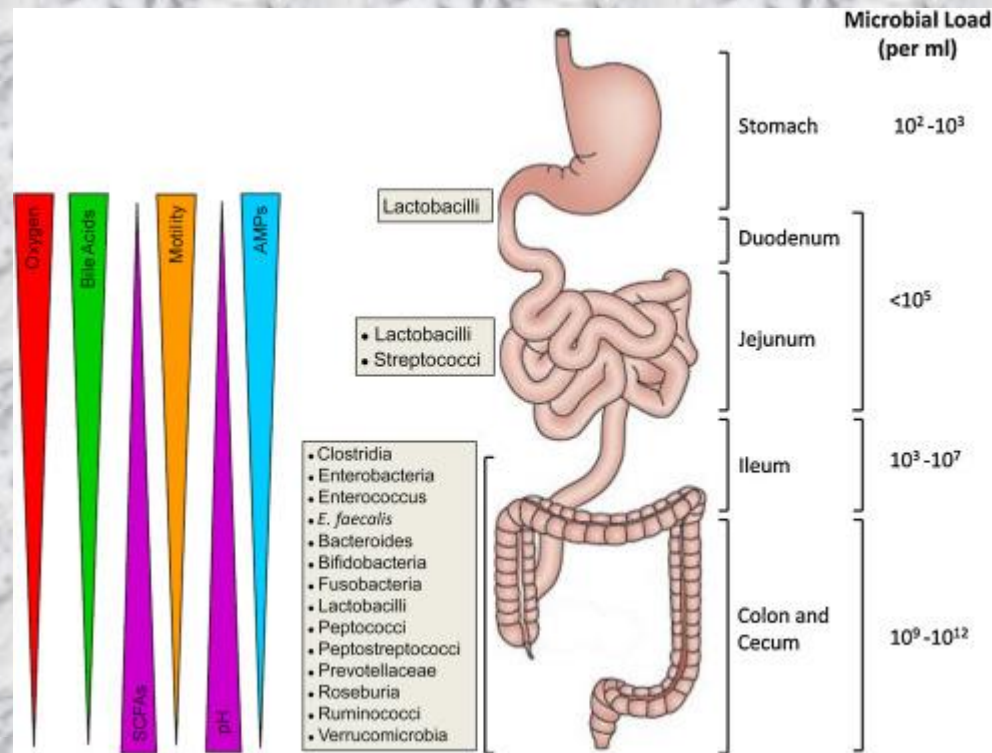
- basal secretion: < 10 mmol/h
- Stimulated (pentagastrin): < 45 mmol/h

# Inflammatory disorders of the gut / Acute

- **Acute inflammation** has no specific laboratory tests
- However systemic inflammatory markers combined with clinical symptoms and imaging techniques have high diagnostic values
- Laboratory tests are also useful to monitor the progress of the disease

## Laboratory markers:

- Westergren
- HS-CRP
- WBC count
- Neutrophil percentage
- LDH
- Liver and/or pancreas specific markers



# Inflammatory bowel disorders; Colitis ulcerosa, Crohn's disease

- Prevalence is 10 – 130 / 100.000 ppl
- Clinical symptoms include diarrhea, bleeding, abdominal pain, weight loss
- Genetical, environmental factors both contribute
- Auto-immun disorders
- **Laboratory markers:**
- Systemic inflammatory markers:
  - CRP
  - We
  - Platelet count
  - Orosomuroid (alpha-1-acid glycoprotein)
- More specific markers:
  - pANCA (Perinuclear Anti-Neutrophil Cytoplasmic Antibodies)
  - ASCA (Anti-saccharomyces cerevisiae antibody)
  - Calprotectin (stool)

# Inflammatory bowel disorders; Coeliac disease

Systemic autoimmun disorder

- Genetic predisposition (HLA-DQ2, DQ8)
- Triggered by gluten
- T-cell mediated autoimmun enteropathy

Prevalence: 1:100-300

Gluten penetrates the epithel barrier of the bowels ->

Tissue Transglutaminase (tTG) converts gliadin to the active antigen ->

it is presented by MHC class II on professional antigen-presenting cells to CD4+ Tcells

Symptoms:

Diarrhea, weight loss, steatorrhoea, abdominal distension

**Laboratory findings:**

- anti-endomysial (EMA) antibodies
- **anti-transglutaminase antibodies (anti-tTG)**
- anti-DGP (antibodies against deamidated gliadin peptides)

***Biopsy and histology is not necessary in childhood if: 1) presence of clinical symptoms, 2) HLA-DQ2 or DQ8 positivity, 3) large tTG titer***

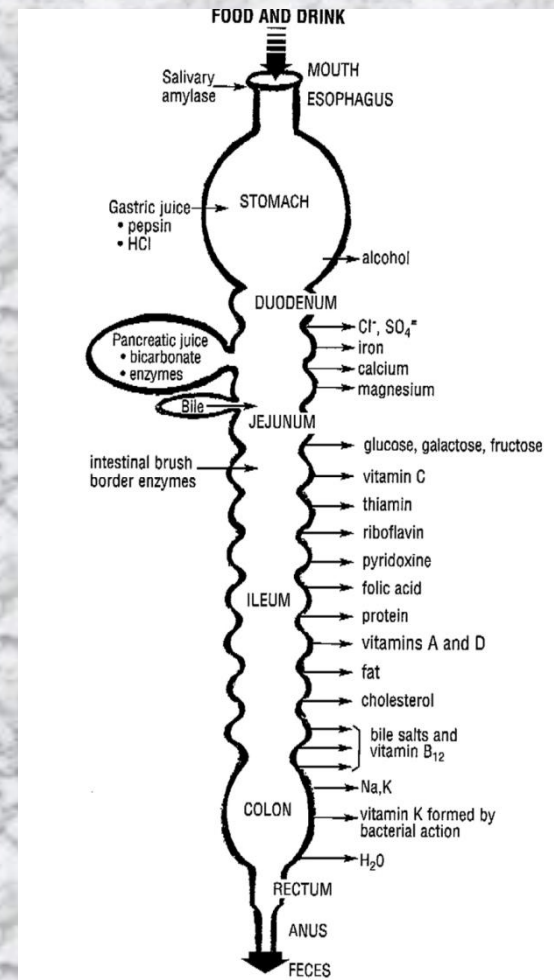


# Inflammatory disorders of the gut / Chronic

- **Chronic inflammation** may present elevated inflammatory markers similar to acute inflammation
- However in remission, markers may be normal or only slightly elevated

**Functional disorders (Malabsorption)** due to the chronic disease can be revealed by various tests:

- Serum albumin, prealbumin, calcium, phosphate
- CBC count (anemia)
- RBC parameters (MCV, MCH)
- Serum Iron, ferritin
- B12-vitamin and folic acid
- Prothrombin time (Vit. K deficiency)
- Functional absorption tests:
  - Xilose (carbohydrates in the jejunum)
  - Disaccharide (Disaccharidase deficiency)
  - Triolein breath test
  - H<sub>2</sub> breath test (lactose, fructose malabsorption or bact. overgrowth)
  - Stool tests for lipids, aminoacids





# Laboratory markers in malignant disorders of the GI tract

## ***There is no „ideal“ tumor marker***

- Tumormarkers characteristic for e.g. colorectal cancer can be presented by other cancers (e.g. ovarian cc.) as well
- Not all cancers of the same type produce tumormarkers at a detectable level

General acute phase tests: - CRP, We, Leukocytosis

Metabolic disorders: elevated uric acid, hyperkalemia, hyponatremia, anemia, hypoproteinemia

Tissue damage markers: LDH, GOT, ALP, amylase

Coagulation disorders: both pro- and anti-coagulation; increased platelet count, increased D-dimer

## ***„Specific“ tumormarkers:***

- AFP (Hepatocellular cc. / Also in cirrhosis, testicular cc.)
- CEA (Colorectal, Liver, Pancreas, Lung)
- CA 72-4 (gastric, pancreatic cc. / also in ovarian cc.)
- CA 15-3 (pancreatic, colon cc. / but more specific for breast cc!)
- CA 19-9 (pancreatic, colon cc. )
- K-Ras (pancreatic, colon cc. / gene, its product is a GTPase protein that mediates growth factor signaling.)

Date of birth: 1950.09.07

Sex: Male

Sampling time : 2011.12.15 08:45

Test	Results		Reference range	Unit
Urea	5,14		2,00-9,00	mmol/l
Creatinine	89		62-106	umol/l
Uric acid	361	!	180-350	umol/l
LDH	379		<450	U/l
GOT	17		<44	U/l
GPT	13		<50	U/l
Alkaline phosphatase	252		100-300	U/l
Gamma-GT	31		<70	U/l
Amylase	27	!	28-100	U/l
Total protein	76,4		66,0-83,0	g/l
Albumin	44,1		35,0-53,0	g/l
Ultrasensitive CRP	111,00	!	<5,00	mg/l
CEA	155,3	!	<3,0	ng/ml
CA-19-9	138,2	!	<27,0	U/ml
Protrombin INR	1,11		0,90-1,15	.
Complete blood count				
White blood cells	10,500	!	4,000-10,000	Giga/l
Neutrophil%	63,2		34,0-67,9	%
Lymphocyte %	22,1		21,8-53,1	%
Monocyte %	8,5		5,3-12,2	%
Eosinophil %	2,4		0,0-7,0	%
Basophil %	1,2		0,0-1,2	%
Red blood cell	4,57		4,50-6,00	T/l
Hemoglobin	135	!	137-175	g/l
Hematokrit	40,0	!	40,1-51,0	%
MCV	87,5		80,0-95,0	fl
MCH	29,6		26,0-33,0	pg
MCHC	338		310-360	g/l
RDW	12,5		11,6-14,4	%CV
Platelet	392,0		140,0-440,0	Giga/l
MPV	8,50	!	9,40-12,40	fl
Westergren	50	!	0-10	mm/h
Stool hematest	Positive			

# Related Exam questions:

34. Laboratory diagnosis of acute pancreatitis.

35. Laboratory diagnosis of chronic pancreatitis.

36. laboratory diagnosis and monitoring of malignant and inflammatory bowel diseases.