HYGIENE OF WORK WITH CHEMICAL SUBSTANCES

INDUSTRIAL AND AGROCHEMICAL TOXICOLOGY

TOXICOLOGY –
science, which investigated laws of action chemical substances on organism, pathogenesis and clinical picture of poisonings

MAIN DIVISIONS OF TOXICOLOGY:

-General toxicology

-Industrial toxicology

-Agricultural toxicology (toxicology of agrochemicals)

-Military toxicology

- Municipal toxicology (toxicology of chemical substances, using in home conditions)

GENERAL TOXICOLOGY

MAIN INDEXES OF TOXICITY OF CHEMICAL SUBSTANCE
(TOXICOMETRY OF CHEMICAL SUBSTANCE)

1. Indexes of toxico-dynamics – level of toxicity of chemical substance
2. Indexes of toxico-kynetics – speed of absorbing, matabolism and removing chemical substance from organism

BASIC PARAMETERS OF TOXICOMETRY

CHEMICAL SUBSTANCES

PARAMETERS OF TOXICODYNAMICS

1. ACUTE TOXICITY

Lethal doses and concentrations
DL_0, DL_{50}, DL_{100} (LC)

LIMIT of acute integrated action
$Lim_{ac.\ integr.}$

LIMIT of acute specific action
$Lim_{ac.\ sp.}$

PARAMETERS of TOXICODYNAMICS

2. SUBACUTE TOXICITY

Coefficient of cumulation - C cum. = DL_{50} summary / DL_{50}

3. CHRONIC TOXICITY

LIMIT of chronic integral action
Lim $_{ch.\ integr.}$
(LOAEL) *

LIMIT of chronic specific action
Lim $_{ch.\ sp.}$

Zone of chronic action
Z ch. = Lim $_{ac.}$ / Lim $_{ch.}$

.

SAFE LEVELS FOR the MAN

Maximal not acting dose (NOAEL) *, MPC, MPL, MPD

LOAEL - lower level of observed harmful effect
NOAEL - level of unobservable harmful effect

PARAMETERS OF TOXICOKYNETICS

- Time of half-life substance in organism T_{50}
- Time of full removing substance from organism T_{95}
- Coefficient of cumulation C cum.

CLASSIFICATION CHEMICAL SUBSTANCES BY LEVEL OF TOXICITY

I class of danger -	EXTREMELY DANGEROUS MATERIALS (Extremely toxic)
II class of danger –	HIGH DANGEROUS MATERIALS (High toxic)
III class of danger -	MIDDLE DANGEROUS MATERIALS (Middle toxic)
IV a class of danger –	LOW DANGEROUS MATERIALS (Low toxic)

CLASSIFICATION CHEMICAL SUBSTANCES BY LEVEL OF TOXICITY

Parameter	I class	II class	III class	IV class
MPC in air, mg / m^3	< 0,1	0,1 - 1,0	1,0 - 10	> 10
DL_{50} per oral, mg/kg	< 15	15 - 150	150 - 5000	> 5000
DL_{50} at skin, mg/kg	< 100	100 - 500	500 - 2000	> 2000
CL_{50} inhalation, mg/kg	< 500	500 - 5000	5000-50000	> 50000
Zone acute action Z ac.	< 6	6 - 18	18 - 54	> 54
Zone chronic action Z ch.	> 10	10 - 5	5 - 2,5	< 2,5

CLASSIFICATION TOXICANTS BY ABILITY TO CUMULATION

Level of cumulation	Coefficient cumulation C cum.
Supercumulation	< 1
Expressed cumulation	1 - 3
Middle cumulation	3 - 5
Weak cumulation	> 5

WAYS OF ENTERING, ADSORBTION AND REMOVING POISONS FROM ORGANISM

WAYS OF ENTERING:

Through lungs – Inhalation way – most dangerous way

Through a skin – fat-soluble substances, heavy metals

Through mouth and mucous stomach and intestines – in professional conditions very rare way

WAYS OF ADSORBTION:

in Liver

in Blood

in Bones

in Lymph

in Hair

in Nails

WAYS OF REMOVING:

Through Lungs – flying substances

Through Skin – heavy metals

Through Intestines with faecal masses – bad soluble substances

Through Renal ways with urine – soluble substances

Through glands of external secretion – Lactic, Saliva, Sweat, Tear glands

CONFIRMATION DIAGNOSIS OF THE POISONING – definition toxins or it metabolites in blood and excreted biosubstrates

MECHANISMS OF DETOXICATION

POISONS IN ORGANISM

1. **CHANGE CHEMICAL STRUCTURE OF POISON:**

- **Hydroxylation (connection OH-groupe)**
- **Methylization (connection CH_3-groupe)**
- **Oxidation**
- **Regeneration**
- **Connecting (with glucuronic acid, amino acids etc.)**

MECHANISMS OF DETOXICATION POISONS IN ORGANISM

2.REMOVING FROM ORGANISM –
through intestines, kidneys, lungs, skin, glands (as poison or as metabolites) - probably secondary damage these bodies.

3. DEPOSITION IN BODIES AND TISSUES - temporary decreasing concentration of poison in blood.
(At unfavorable conditions – poison going out from depot - aggravation chronic poisoning).

THE BASIC PARTS OF DETOXICATION SYSTEM

Mechanisms of protection	Parameters
1. Microsome oxigenation (in liver)	Microsomal monooxygenase cytochromes P- 450, b5
2. Conjugation	Restored glutathione
3. Bioenergy processes	activity of phosphatase
4.Peroxide oxidation of lipids (POL)	diene conjugates, malonic dialdehyde
5. Antiradical and antiperoxide protection	activity of catalase, peroxidase, superoxide dismutase

At activation 1 and 4 links in norm must be activated other parts, at their oppression - toxicogenic dishomeostasis (concealed decompensation).

KINDS OF CUMULATION POISONS IN ORGANISM:

1. **MATERIAL - accumulation poison or it metabolites in organism**

2. **FUNCTIONAL - accumulation only toxic effects poison in organism**

3. **MIXED - accumulation in organism poison and it pathological effects**

DISPLAYS OF ACTION POISONS ON ORGANISM:

1. ACUTE poisonings (specific and nonspecific)

1. CHRONIC poisonings (specific and nonspecific)

3. THE SPECIFIC and REMOTE effects:

- Allergenic
- Gonadotrophic
- Embriotropic
- Immunodepressive
- Cancerogenic
- Mutagenic
- Drop of lifetime

INDUSTRIAL TOXICOLOGY

CLINICAL PICTURE OF ACUTE POISONINGS BY MAIN INDUSTRIAL POISONS

CARDINAL SIGNS OF LEAD POISONING (SATURNISM):

1. Lead "border" on gums grey color

2. Lead color of a skin (pale – grey color)

3. Lead encephalopathy – violations of CNS

4. Lead polyneuritis – violation NS (pareses and paralyses)

5. Lead colic - sharp colic pains in a stomach, which can not take away by spasmolytic drugs

6. Liver syndrome - development toxic hepatitis

Occupational lead poisoning

lead polyneuritis (hanging hand)

lead margin on gingivae

Changes in blood at saturnism:

In the beginning – irritation blood formation organs:

In blood:

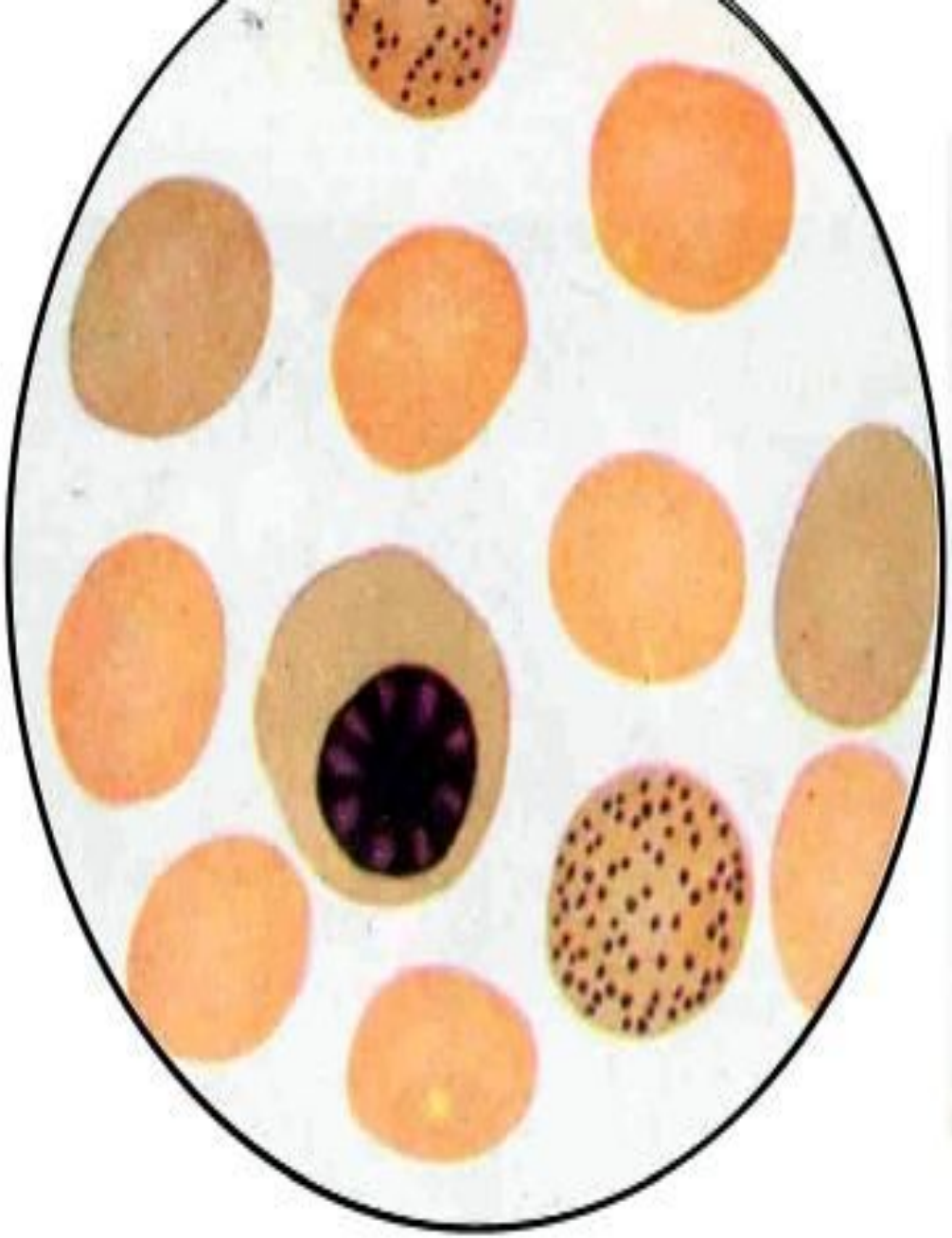
1) Basophilic stippling of erythrocytes (more than 500 on 1 million.)

2) Reticulocytosis of 45- 60 %

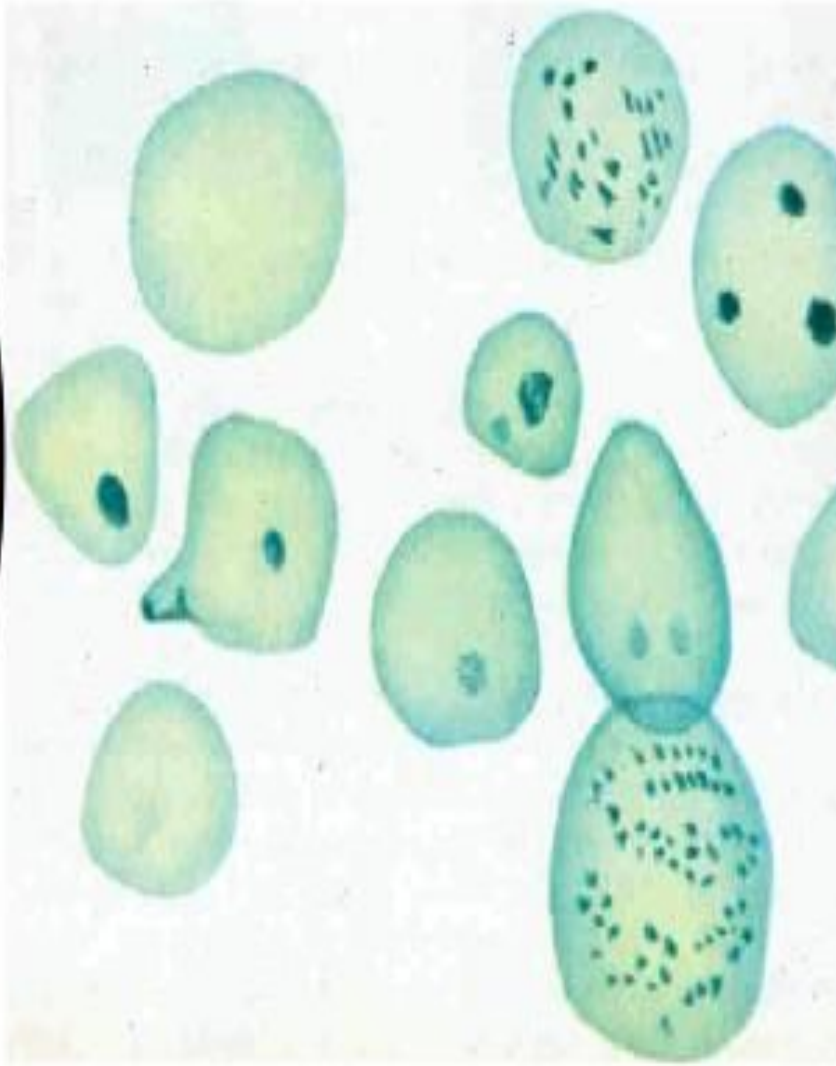
In further - lead anemia hypochrome type, leucopenia, trombocytopenia.

Changes in urine:

- porphyrin-uria - more than 50 - 60 mcg / l
- content lead more than 0,04 mg / l



Картина крови при свинцовой анемии.



Эритроциты с тельцами Гейнца и ретикулоцит
в периферической крови

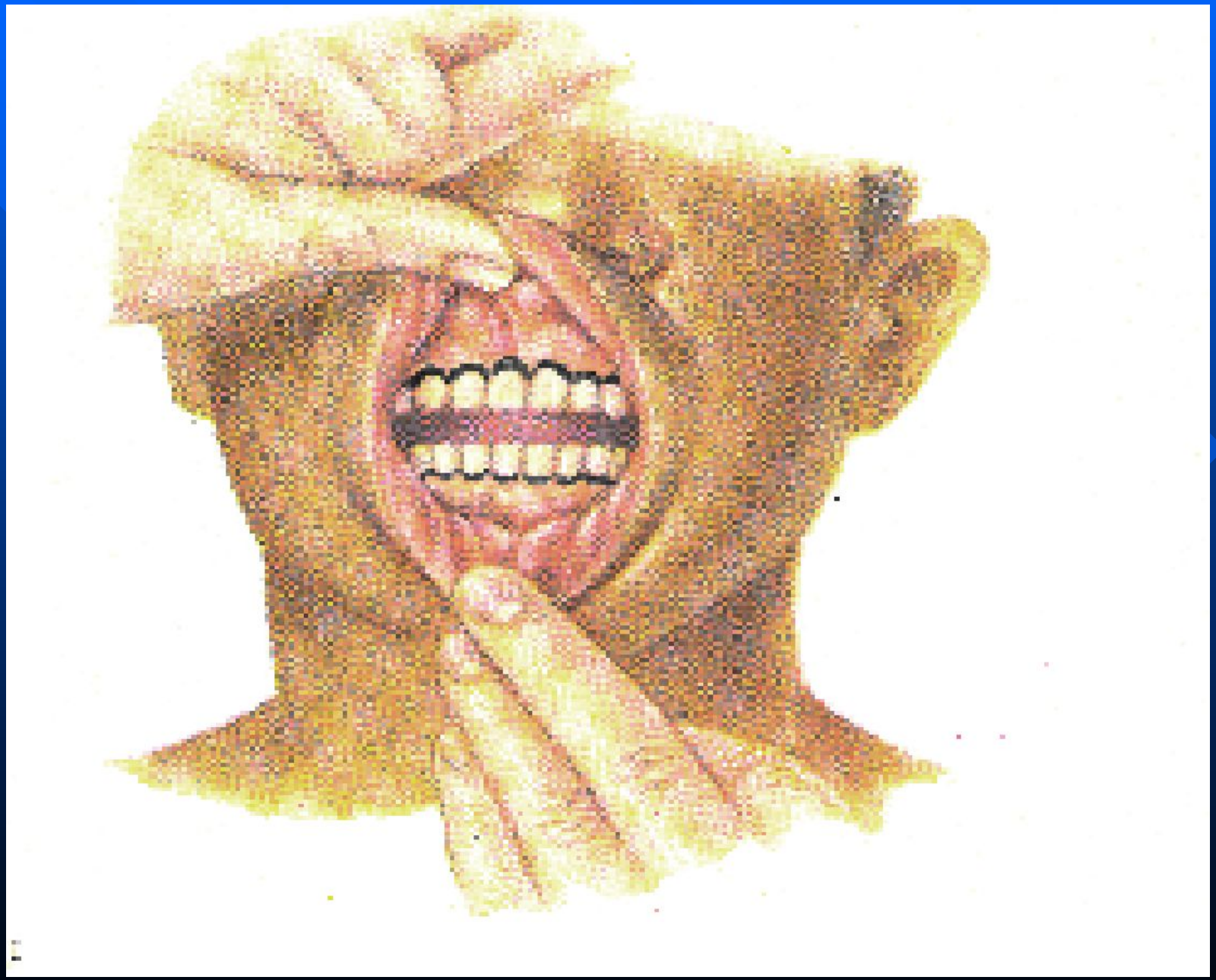
POISONING BY LEAD TETRAETHYL (addition to benzene):

- Infringement of CNS, liver, blood formation

- Vegetative triad: bradycardia, hypotonia, hypothermia

POISONING BY MERCURY (MERCURIALISM):

- Mercurial “border“on gums black color
- Mercurial neurotism
- Mercurial eretism (whining, sense anxiety)
- Mercurial encephalopathy
- Mercurial gingivitis (inflammation tonque)
- Violations cardiac system, kidney (nephrosis)
- In blood - lymphocytosis, monocytosis, leukopenia, anemia
- Content of mercury in urine more than 0,01 - 0,02 mg/l



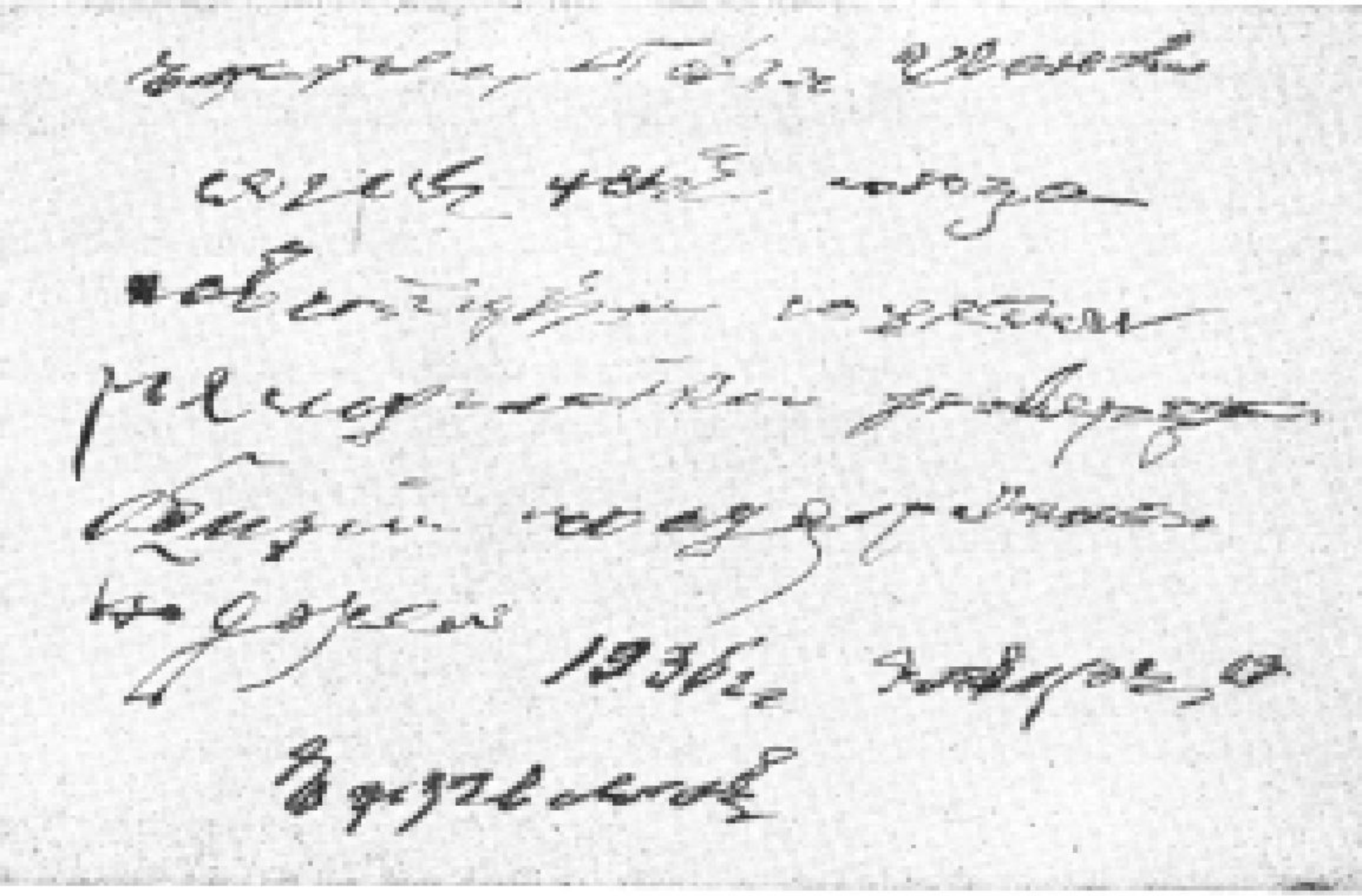


Рис. 113. Почерк при ртутном треморе (Н. А. Вигдорчик).

POISONINGS BY INDUSTRIAL POISONS – ORGANIC COMBINATIONS

Hydrocarbons of aromatic structure (dissolvents) - benzene, toluene, ksylol.

- Violation CNS as narcotic action, polyneuritis
- Violation hemopoesis - leukopenia, thrombocytopenia, aplastic anemia
- Hepatotropic action - toxic hepatitis
- Allergenic effects
- Gonadotrophic activity
- Mutagen and cancerogenic action - polycyclic aromatic hydrocarbons - (benz (a) pyren)

SYNTHETIC POLYMERIC And PLASTIC SUBSTANCES

At heating such substances can formed the different excreting metabolites, which gives such kinds of action:

- Narcotic action
- Irritation action
- Influence on blood genesis, internals
- Infringement pregnancy
- Allergenic activity
- Teratogenic and embryotropic action
- Cancerogenic effects

THE REMOTE AND SPECIFIC EFFECTS OF INDUSTRIAL POISONS AND POLLUTANTS OF ENVIRONMENT

The remote effects

Oncogen (cancerogenic)

Mutagen

Teratogenic

Immunodepressive

Drop of lifetime

Specific effects

Gonadotrophic

Allergenic

Emryotropic

ONCOGEN (CANCEROGENIC) ACTION

Chemical cancerogen – it is:

1) substance or it mixture, which can cause in the man or animal formation tumors which are not meeting without their action (true cancerogens - initiators)

2) substance, which can cause acceleration formation or earlier appearance of usial tumors (promoters – pre-cancerogens)

CLASSIFICATION CANCEROGEN SUBSTANCES (by International Agency of Cancerogen Investigation)

1. Cancerogenic for the man

(23 substances - arsenic, asbest, chrome, beryllium, nickel, carbon black, petroleum, benzene etc.)
It cancerogenicity are proved by the epidemiological data on people

2. Probably cancerogenic for the man:

a) Probable cancerogens (produce tumors in 80-100 % experimental animal in 4-6 months) –
14 substances - benz (a) pyren, Chlorine – organic combinations, etc.

b) Possible cancerogens (produce tumours in 20-30 % experimental animal during life) –
47 substances, for example, cadmium, nitrozocombinations, some pesticides

3. Not categorized on cancerogenic ability (the data of cancerogen activity are discordant) - 64 substances, for example, lead and its salts

4. Probable not cancerogenic for the man – other substances – for which until now no data about cancerogen activity.

MUTAGENIC EFFECT

CLASSIFICATION CHEMICAL MUTAGENS

1. NATURAL - inorganic and organic substances, meeting in a nature (mycotoxins, oxides of nitrogen, nitrites etc.)

2. ANTHROPOGENIC - medicines, pesticides, alimentary additives

EXAMINATION MUTAGEN ACTIVITY SUBSTANCES:

1) experiments on model tests - systems - microbes, plants, cells of the man and animal in experience in vitro, in vivo

2) cyto-genetic monitoring of the population and working in contact with mutagen factors

3) biological indication mutagens in biosphere

EMBRYOTROPIC ACTIVITY OF CHEMICAL SUBSTANCES

KINDS of VIOLATION OF FETATION UNDER INFLUENCE OF CHEMICAL MATERIALS:

1. **Embryotoxic action - destruction of fetus, drop mass and dimension of embryons, violations of normal differentiation tissues of embryon**

2. **Teratogenic action - anomalies and defects of development of new-born.**

EMBRYOTROPIC ACTIVITY OF CHEMICAL SUBSTANCES

Chemical teratogens - more than 600 materials – mercury and its combinations, dioxines, pesticides, benzol, benzine, etc.

The evaluation of embryotoxity will be carried out in experiments on laboratory animal.

In experiment it is determined Lim sp. action and Z sp. = Lim integr. / Lim sp.

If Z sp. > 1, the substance has selective embryotropic activity - it is taken into account at installation MPC.

OTHER REMOTE EFFECTS AT THE ACTION OF CHEMICAL MATERIALS:

- Neuro-psychical violations at action phosphorus-organic combinations.

- Violations of haemopoiesis (anemia), cardiac functions (acceleration of infarcts, development of atherosclerosis) – at action chlorine-organic combinations.

HYGIENE OF WORK IN AGRICULTURE

FEATURES OF WORK IN AGRICULTURE:

1. Work on open air in different seasons of year – action harmful climatic factors – overheating or cold complications, action high level of UV radiation – melanoma of skin

2. Often change of working operations, hard physical work

3. Contact with trauma dangerous mechanisms

4. Contact with different agrochemicals

BASIC GROUPS AGROCHEMICALS:

1. PESTICIDES - chemical and biological agents for protection plants from illnesses and insects

2. FERTILIZERS - mineral and organic substances for fast growth of plants

3. OTHER - growth-promoting factors of plants, inhibitors of nitrification, etc.

CLASSIFICATION PESTICIDES

1. TECHNOLOGICAL - by application:

- **insecticides** - for struggle from insects
- **acaricides** - for destruction pincers
- algicides – for destruction water-plants
- arboricides – for protection trees and bushes
- **bactericides** – for struggle from illnesses of plants
- larvicides – for struggle with larvas and caterpillars
- Ovicides – for eggs of insects
- **Zoocides** - for struggle with the rodents (mice, rats)
- Limacides - for struggle with molluscus
- **Fungicides** - for struggle with fungi on a grain
- **Herbicides** - for struggle with weeds:
  - Desicantes - for dry plants
  - Defoliants - for erasion foliage of plants

CLASSIFICATION PESTICIDES ON WAYS OF HIT TO THE ORGANISM OF INSECTS:

- Contact – is poisonous at contact to any part of a body of insect
- Intestinal – getting in organism of insect per os
- Fumigants - through a respiratory organs of insect
- Systemic – plants become poison for insect in all part

HYGIENIC CLASSIFICATION PESTICIDES

1. By general toxicity for experimental animal

Degree of a toxicity	DL_{50} mg/kg per os
Strongly acting poison substances (SAPS)	< 50
High-toxic	50 - 200
Middle - toxic	200 - 1000
Low- toxic	> 1000

2. On stability in environment

Degree of stability	Time of destruction
Very stable	> 2 years
Stable	0,5 - 2 years
Moderately stable	1 - 6 month
Low stable	< 1 month

CLASSIFICATION PESTICIDES ON CHEMICAL STRUCTURE AND IT ECOLOGIC AND TOXICOLOGIC ESTIMATION

1. Chlorine – organic pesticides (COP) - aldrine, DDT, hexachlorane.

Very stable in environment (DDT – more 100 years) – in people can be most often chronic poisonings

Mechanism of action - Blocade respiratory enzymes in tissues (cytochrom-oxidase)

CLASSIFICATION PESTICIDES ON CHEMICAL STRUCTURE AND IT ECOLOGIC AND TOXICOLOGIC ESTIMATION

2. Phosphorus - organic pesticides (POP) - Carbophos, Chlorophos, Phosphamid

Not stable in environment – in people more often acute poisonings

Mechanism of action - Stable blocade enzyme acetyl-cholinesterase – cumulation acetylcholine in synapses – endogenic poisoning by acetylcholine

CLASSIFICATION PESTICIDES ON CHEMICAL STRUCTURE AND IT ECOLOGIC AND TOXICOLOGIC ESTIMATION

3. Carbamates - derivants carbamin acids - sevin, zineb, maneb.

Mechanism of action - Convertible blocade enzyme acetyl-cholinesterase – poisonings easy, than at using POP

CLASSIFICATION PESTICIDES ON CHEMICAL STRUCTURE AND IT ECOLOGIC AND TOXICOLOGIC ESTIMATION

4. Mercury and Arsenic – organic pesticides – mercuran, granosan, arsenite of calcium.

Very stable and toxic group – used as fumigants at grain (prevention development micotoxins)

Mechanism of action - Blocade thyolov enzymes (contains SH-groupe)

CLASSIFICATION PESTICIDES ON CHEMICAL STRUCTURE AND IT ECOLOGIC AND TOXICOLOGIC ESTIMATION

5. Combinations of copper – $CuSO_4$, bordeaux liquid

Used at vine-yards in Crimea in big amounts.

Poisonings not heavy – formation in intestines albuminates of copper, not absorbed in organism

6. Derivants symmetric tryasines - Atrazin, Propazin, Simazin

7. Synthetic pyretroids - ambush, cimbush, decis.

CLASSIFICATION BIOLOGICAL AGENTS PROTECTION OF PLANTS (BIOLOGICAL PESTICIDES)

1. Bacterial, fungi, virus substances producing illnesses of the insects (Boverin, dendrobacyllin, entobacterin)

2. Biological preparations for struggle from illnesses of plants - antibiotics: (arenaryn, polymicyn)

3. Feromones (sexual hormonum) insects
- âttractants
- repellents

CLASSIFICATION FERTILIZERS

1. Organic - peat, manure

2. Mineral:

1) Macro fertilizers - nitrogen, phosphoric, potassium:

a) Single - ammonia, superphosphate etc.

b) Composite - ammophos etc.

2) Micro fertilizers – copper, zinc etc.

TOXICOLOGY OF FERTILIZERS

All fertilizers at experiments on laboratory animal has DL_{50} > 5000 mg/kg – low toxic substances

At excess usage of nitrogen fertilizers at plants - accumulation in food products nitrates and nitrites – formation met-hemoglobin in blood – hypoxia.

The phosphoric fertilizers as admixing contain FLUORINE - in districts of effecting such fertilizers – fluorosis in population

HYGIENE OF WORK AT DUST POLLUTION OF AIR

CLASSIFICATION OF INDUSTRIAL DUST

1. **By composition:**

- **inorganic (mineral, metal)**
- **organic (vegetative, animal, polymeric)**
- **mixed**

2. **By formation:**

- **aerosols of desintegration (at cleavage solids)**
- **aerosols of condensation pairs of metals**

CLASSIFICATION OF INDUSTRIAL DUST

3. By disperse:

- visual (dimension of particles > 10 microns)
- microscopical (2,5 - 10 microns)
- ultramicroscopical (< 0,25 microns)

4. By activity on an organism:

- toxic (manganese, lead, arsenic etc.)
- irritating (lime, alkaline etc.)
- infectious (microbes, spores etc.)
- allergic (woolen, synthetic etc.)
- cancerogenic (soot etc.)
- fibrinogenic (pneumoconiotic) - silicion

CLASSIFICATION OCCUPATIONAL DUST DISEASES (PNEUMOCONIOSIS)

1. **Dust diseases at action highly fibrinogenic dust (content of free silicon dioxide SiO 2 > 10 %):**
   - silicosis,
   - antraco-silicosis (coal-miners disease),
   - silicosis with complication by tuberculosis - tuberculosilicosis

2. **Dust diseases from low fibrinogenic dust (SiO 2 < 10 %):**
   - silicatosis (asbestosis, talcosis, cementosis etc.)
   - carboconiosis (anthracosis, etc.)
   - bisinosis (vegetative dust)

3. **Dust diseases from aerosols of toxic-allergenic activity:** Berylliosis, aluminosis, farmer lung, etc. chronic pneumonitis with allergenic component

PATHOGENESIS DEVELOPMENT OF PNEUMOCONIOSIS

Particles of dust in lung's tissue give non-infectious inflammation, here is high concentration of macrofags – hystiocytes, fibroblasts – formation connection tissue instead of lung's tissue – decreasing alveolar surface.

X-RAY DIAGNOSTICS OF DUST DISEASES

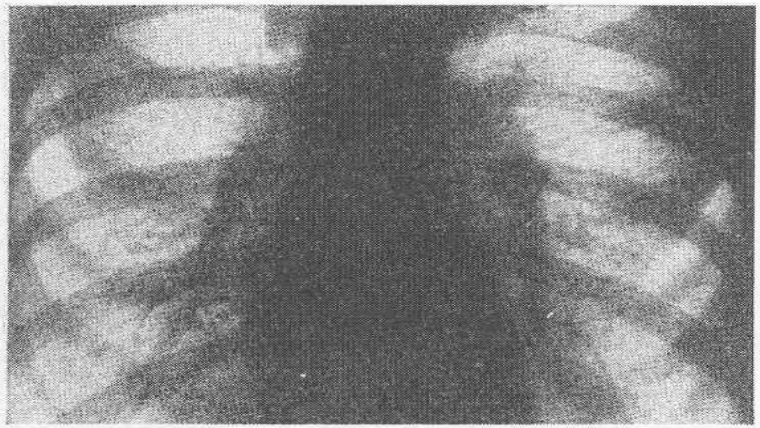
1 stage - interstitial pneumosclerosis in lungs, small amount of nodules by diameter 1 mm, moderate bilateral intensifying of a pulmonary drawing

2 stages - numerous nodules 2 - 4 mm on a background of places of atelectasis - "snow storm", expressed strain of a pulmonary drawing

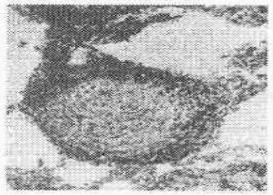
3 stages - massive pneumosclerosis, big nodules of connecting tissue, sharp strain draw of bronchial tree, violation of bronchial permeability

For metal-coniosis – roentgen-contrast dust of metals in lungs.

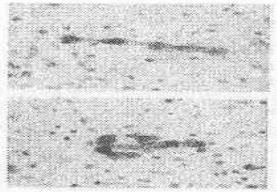
Pneumoconiosis



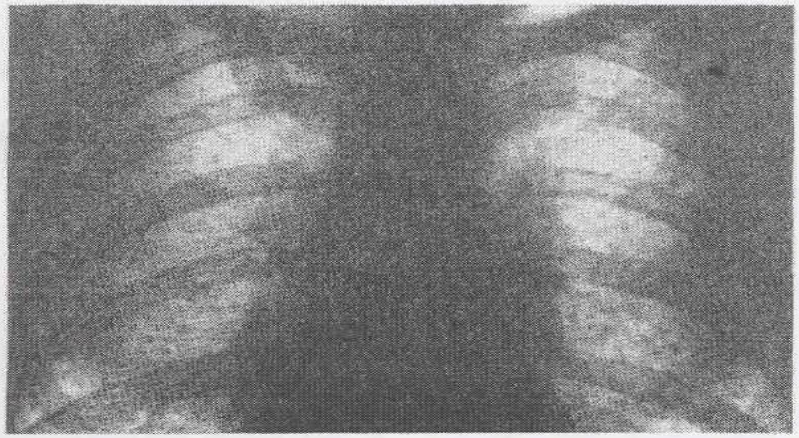
1 stage of Pneumoconiosis



Silica nodule in lung



"asbestos body" in lung



2 stage of Pneumoconiosis

3 stage of Pneumoconiosis

CLINICAL AND FUNCTIONAL DIAGNOSTICS OF PNEUMOCONIOSIS

Bronchitis, bronchiolitis, lungs emphysema, respiratory failure, violation of blood circulation in a small circle of blood circulation - hypertrophy of a left ventricle, changes on a Electrocardiogramme - "pulmonary heart".

Asbestosis - in a sputum - asbestic bodies,

Anthracosis – sputum has black colour,

Bisinosis – bronchospastical syndrome.

Complications: lungs cancer, apposition of tuberculosis, pneumonia, bronchial asthma, rheumatoid artritis etc.

PROPHYLACTIC OF PNEUMOCONIOSIS

- Preventive sanitary control – establishing MPC of dust in air:
- - for usual dust – 10 mg/m3
- - for fibrinogenic dust (SiO_2) – 1 mg/m3
- - for toxic dust (lead dust) – 0,01 mg/m3
- Current sanitary control dust in aid
- Medical inspection of wokers

Technological measures