

*NATIONAL UNIVERSITY OF PHARMACY
DEPARTMENT of PATHOLOGICAL PHYSIOLOGY*

HYGIENE IN PHARMACY AND ECOLOGY

**CHEMICAL AIR COMPOSITION.
VAPOROUS AND GASEOUS SUBSTANCES
IN THE WORK AREA AIR.
MAXIMUM PERMISSIBLE CONCENTRATION .
METHODS OF THEIR DETERMINATION**

Kharkiv, 2017/18

Plan of lecture

1. The chemical composition of the air.
2. Steam and gaseous substances in the air of the working area.
3. Maximum permissible concentration.
4. Industrial dust, normalization.
5. Preventive measures.

Suggested Reading

Basic

- Hygiene in Pharmacy. Manual for foreign students of higher schools / O. S. Kalyuzhnaya, O. P. Strilets, L. S. Strelnikov et al. – 2nd Edition, supplemented and revised. – Kharkiv: NUPh, 2013. – 224 p.
- Bardov V. G. Hygiene and Ecology/ Editor by V. G. Bardov. – Vinnytsya : Nova Knyha Publishers, 2009. – 687 p.

Auxiliary

- Kjellstrom Y. Basic environmental health / Y. Kjellstrom, K. Guidotti. – Oxford. – 2001. – 546 p.
- General Hygiene and environmental health / Zaporozhan V. M., Bazhora Yu. I., Vitenko I. S. et al. – Odessa, 2005. – 300 p.

Information resources, including the Internet

- 1. Library of NPhaU: <http://lib.nuph.edu.ua>
- 2. Specialized medical and biological portals of the Internet.

```
graph TD; AIR([AIR]) --> ATMOSPHERIC[ATMOSPHERIC AIR]; AIR --> RESIDENTAL[AIR OF RESIDENTAL AND PUBLIC PREMISES]; AIR --> INDUSTRIAL[INDUSTRIAL AIR];
```

AIR

**ATMOSPHERIC
AIR**

**AIR OF
RESIDENTAL
AND
PUBLIC
PREMISES**

**INDUSTRIAL
AIR**

OXYGEN
20.95 %

NITROGEN
78.09 %

**CARBON
DIOXIDE**
0.03-0.04 %

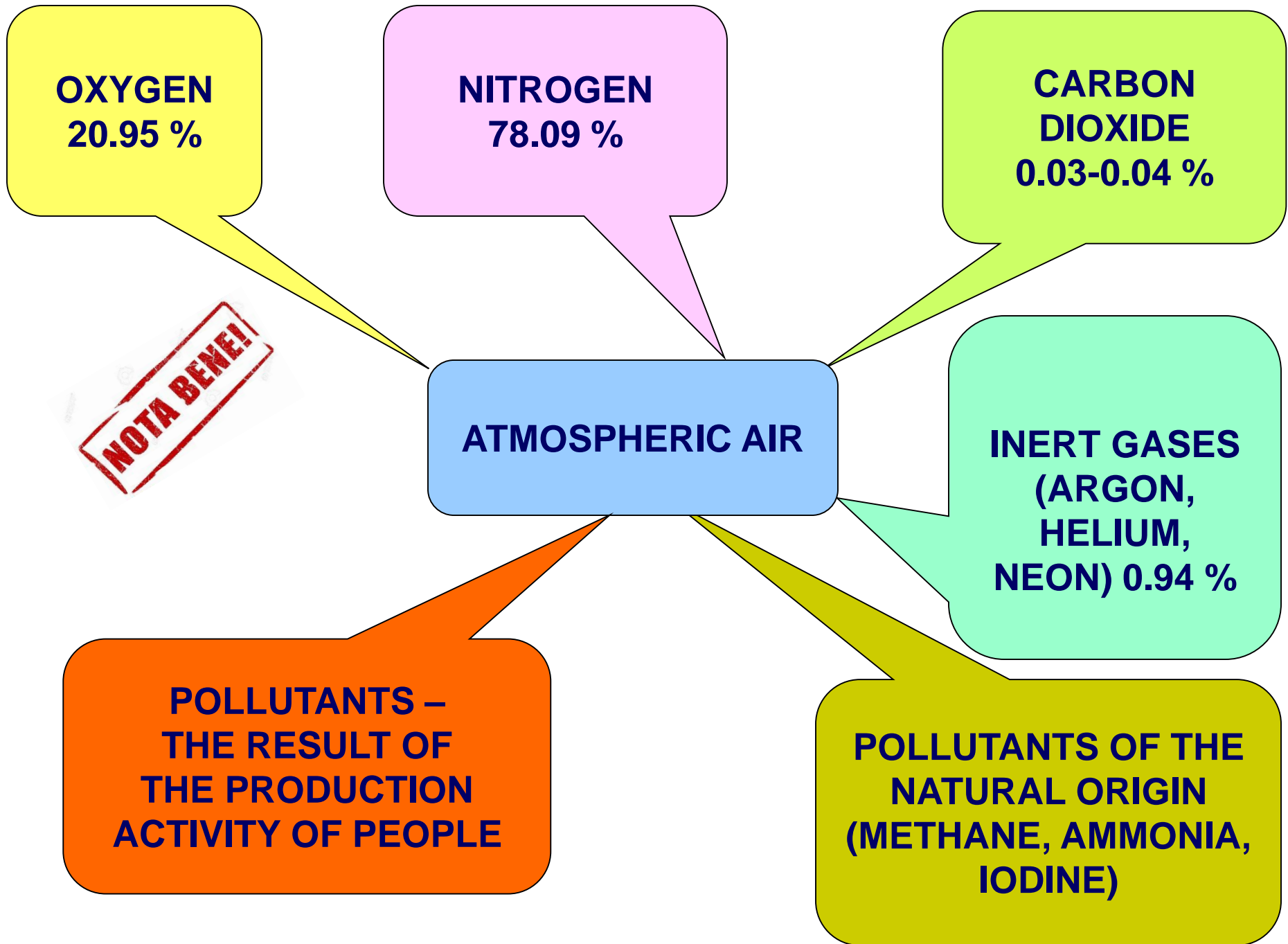
**INERT GASES
(ARGON,
HELIUM,
NEON) 0.94 %**

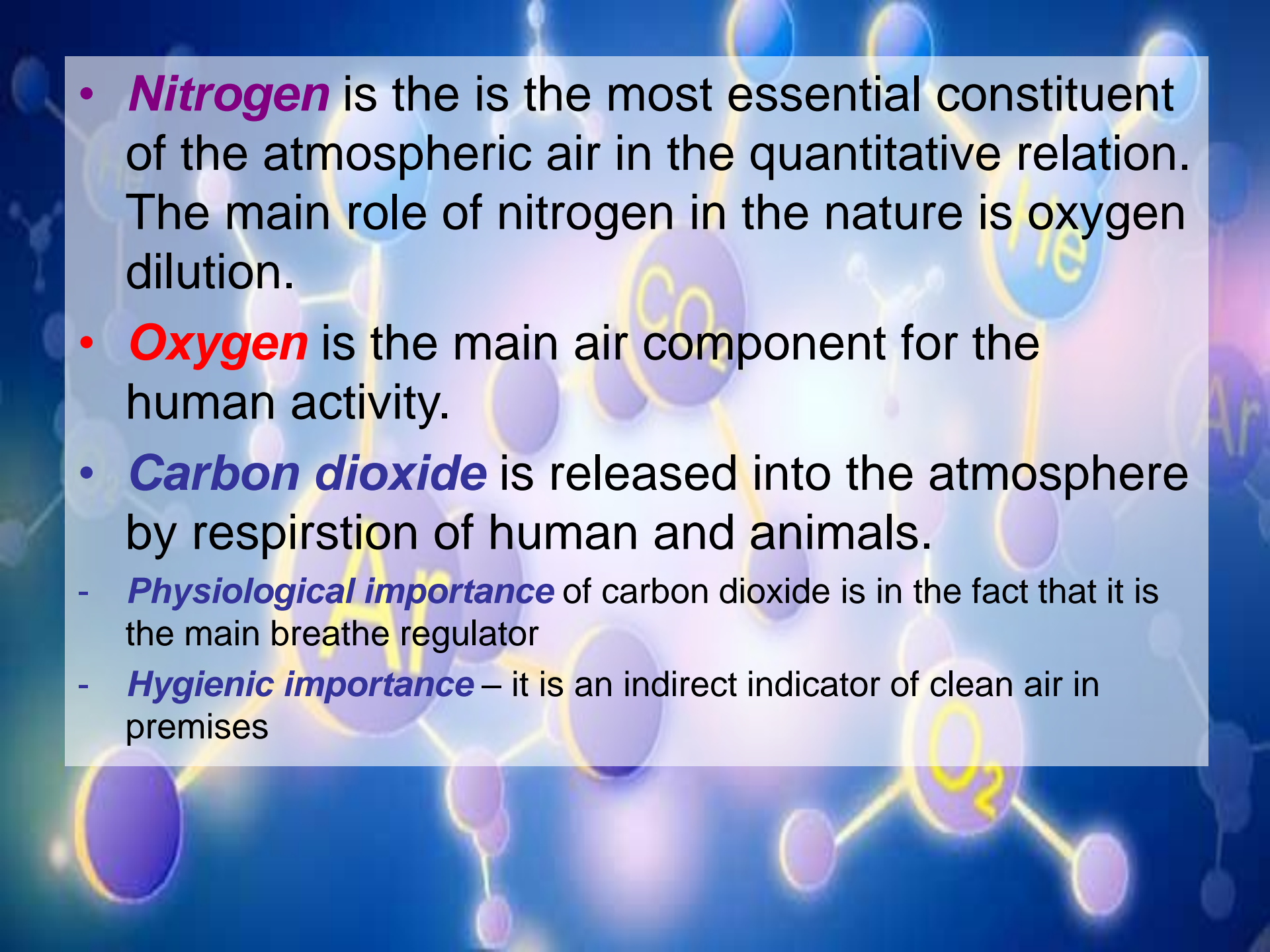
ATMOSPHERIC AIR

**POLLUTANTS OF THE
NATURAL ORIGIN
(METHANE, AMMONIA,
IODINE)**

**POLLUTANTS –
THE RESULT OF
THE PRODUCTION
ACTIVITY OF PEOPLE**

NOTA BENE!



- 
- The background of the slide features a blue gradient with glowing molecular models. Visible are carbon dioxide (CO₂) molecules with a central carbon atom (yellow) and two oxygen atoms (red), and oxygen (O₂) molecules with two red oxygen atoms. Argon (Ar) atoms are also depicted as single yellow spheres. The molecules are interconnected by faint yellow lines, creating a network-like structure.
- **Nitrogen** is the most essential constituent of the atmospheric air in the quantitative relation. The main role of nitrogen in the nature is oxygen dilution.
 - **Oxygen** is the main air component for the human activity.
 - **Carbon dioxide** is released into the atmosphere by respiration of human and animals.
 - **Physiological importance** of carbon dioxide is in the fact that it is the main breathe regulator
 - **Hygienic importance** – it is an indirect indicator of clean air in premises

INDUSTRIAL TOXICOLOGY

THIS SCIENCE STUDIES HARMFUL EFFECTS, PRODUCED ON THE HUMAN BODY BY CHEMICAL COMPOUNDS, WHICH ENTER THE ORGANISM AS RESULT OF INDUSTRIAL ACTIVITY.

THE SUBSTANCES, WHICH CAUSE DEVIATIONS IN THE STATE OF HEALTH OR DISEASES, ARE CALLED **HARMFUL / HAZARDOUS SUBSTANCES**.



INDICATOR OF TOXICITY

MAXIMUM PERMISSIBLE CONCENTRATION (MPC) IS AN OFFICIAL HYGIENIC STANDARD FOR THE AIR IN THE WORKING AREA.

MPC OF HARMFUL SUBSTANCES IN THE AIR OF THE WORKING AREA ARE SUCH CONCENTRATIONS, WHICH IN CASE OF EVERYDAY WORK DURING 8 HOURS OR WITH ANOTHER DURATION, BUT NOT MORE THAN 41 HOURS A WEEK, **do not leads** DISEASES OR DEVIATIONS IN THE STATE OF HEALTH.

NOTA BENE!



CLASSIFICATION **OF HARMFUL CHEMICAL SUBSTANCES**

BY THEIR AGGREGATE STATE

**gases,
vapours,
aerosols (liquid and solid)**



CLASSIFICATION

OF HARMFUL CHEMICAL SUBSTANCES

BY CHEMICAL STRUCTURE

- **organic,**
- **inorganic**
- **mixture**



CLASSIFICATION

OF HARMFUL CHEMICAL SUBSTANCES

■ BY THE WAY OF THEIR PENETRATION INTO THE ORGANISM



inhalation



ingestion

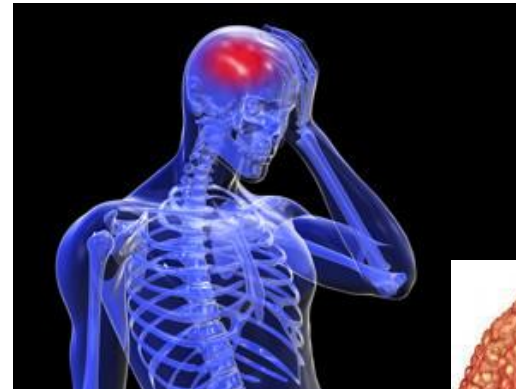


percutaneous

CLASSIFICATION

OF HARMFUL CHEMICAL SUBSTANCES

- **BY THEIR PREDOMINANT EFFECT ON ORGANS AND TISSUES (irritants, sensitizers, neurotoxic, hepatotoxic, systemic toxic)**



CLASSIFICATION OF HARMFUL CHEMICAL SUBSTANCES

BY THE DEGREE OF THEIR TOXICITY:

- **extremely,**
- **highly,**
- **moderately,**
- **low**

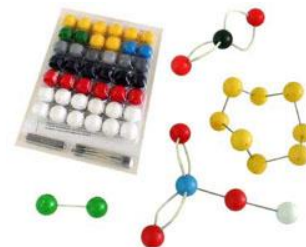
BY THE DEGREE OF DANGER

NOTA BENE!

- 1 – **EXTREMELY HAZARD SUBSYANCES**: the **MPC** of these substances in the air of the working area is **up to 0.1 mg/m³**.
- 2 – **HIGHLY HAZARD SUBSYANCES**: the **MPC** of these substances in the air of the working area is within **0.1 – 1.0 mg/m³**.
- 3 – **MODERATELY HAZARD SUBSYANCES**: the **MPC** of these substances in the air of the working area is within **1.1 – 10.0 mg/m³**.
- 4 – **LOW HAZARD SUBSYANCES**: the **MPC** of these substances in the air of the working area **exceeds 10.0 mg/m³**.

THE TOXIC EFFECT OF SUBSYANCES ON THE ORGANISM DEPENDS UPON:

- THEIR CHEMICAL STRUCTURE;
- SEX AND AGE OF THE PERSON;
- THEIR DISPERSION;
- THEIR CONCENTRATION IN THE AIR;
- THE DURATION OF THEIR CONTACT WITH THE ORGANISM;
- MICROCLIMATE CONDITIONS;
- INDIVIDUAL PECULIARITIES OF THE ORGANISM.



**HARMFUL CHEMICAL AGENTS
CAN BE INTO THE AIR OF ROOM
FOR PACKING THE PHARMACY.**



**THE AIR OF WASHING AND
DISTILLATION-STERILIZATION
ROOMS MAY CONTAIN RESIDUAL
AMOUNTS OF DETERGENTS AND
DISINFECTANTS.**



**ETHYL ALCOHOL, CHLOROFORM, BENZENE, ACETONE, Cl, Br, J,
CAMPHOR, HYDROCHLORIC ACID**

Acute intoxications develop, when large amounts of chemical substances (in case of their high concentration in air) get into the organism.

Chronic intoxications are observed in case of a long-term effect of small concentrations of a substance and characterized by rising functional and organic disturbances.



**THE DISEASES, CAUSED BY INDUSTRIAL POISONS,
ARE CALLED **PROFESSIONAL POISONINGS****

**METHODS FOR PREVENTING OCCUPATIONAL
INTOXICATIONS AND DISEASES:**

- HYGIENIC STANDARDIZATION;**
- TECHNOLOGICAL MEASURES;**
- SANITARY-TECHNICAL MEASURES;**
- USE OF PERSONAL PROTECTIVE EQUIPMENT;**
- PUBLIC HEALTH MEASURES.**

TECHNOLOGICAL MEASURES

- **SUBSTITUTION OF TOXIC SUBSTANCES WITH NON-TOXIC OR LOW-TOXIC ONES.**
- **HYGIENIC STANDARDIZATION OF RAW MATERIALS AND PRODUCTS.**
- **ALL-ROUND MECHANIZATION AND AUTOMATION OF PROCESSES, REMOTE CONTROL.**



SANITARY-TECHNICAL MEASURES

EFFECTIVE VENTILATION OF WORKROOMS

USE OF PERSONAL PROTECTIVE EQUIPMENT

WORKING CLOTHES; GAS MASKS.

PUBLIC HEALTH MEASURES

CONTROL OVER THE STATE OF THE AIR, MEDICAL EXAMINATIONS, SAFETY ENGINEERING.



METHODS FOR DETERMINE CHEMICAL SUBSTANCES IN AIR

CHEMICAL ONES

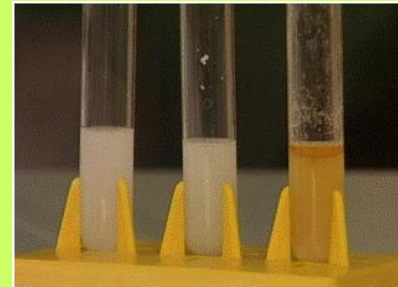
PHYSICAL ONES

PHYSICAL-CHEMICAL ONES

THE COLORIMETRIC METHOD
IS BASED ON THE
DETERMINATION OF THE
DEGREE OF COLOURING
POWER OF A SOLUTION AS
RESULT OF A CHEMICAL
REACTION.



THE NEPHELOMETRIC METHOD
IS BASED ON THE
DETERMINATION OF THE
DEGREE OF TURBIDITY, WHICH
RESULTS FROM INTERACTIONS
OF KNOWN REAGENTS WITH
THE INVESTIGATED SUBSTANCE



AIR SAMPLING METHODS

AIR SAMPLES IN WORKROOMS ARE TAKEN FOR THEIR CHEMICAL ANALYSIS ON THE LEVEL OF A PERSON'S BREATHING, i.e. APPROXIMATELY 1.5 – 2,0 m FROM THE FLOOR, WITH A REGISTRATION OF THE TEMPERATURE, HUMIDITY AND PRESSURE.

ASPIRATION AND ONE-SHOT AIR SAMPLING TECHNIQUES ARE USED. ASPIRATION ONES ARE THE MOST COMMON.

THE CHOICE OF THE AIR SAMPLING TECHNIQUE DEPENDS ON:

- AGGREGATE STATES OF SUBSTANCES;**
- THEIR AMOUNTS AND POSSIBLE CHEMICAL REACTIONS;**
- VOLUME OF THE TAKEN AIR;**
- PECULIARITIES OF THE ANALYSIS.**

AIR SAMPLING TECHNIQUES

THE ASPIRATION TECHNIQUE MAKES IT POSSIBLE TO SAMPLE SOLID, VAPOROUS AND GASEOUS COMPOUNDS, **WHEN THEIR CONTENT IN THE AIR IS NOT SIGNIFICANT.**

THE TECHNIQUE IS BASED ON PASSING OF THE TEST AIR BY MEANS OF THE **ASPIRATOR** THROUGH SOLID OR LIQUID MEDIA, WHICH ARE ABLE TO ABSORB THE REQUIRED INGREDIENTS IN NECESSARY AMOUNTS.

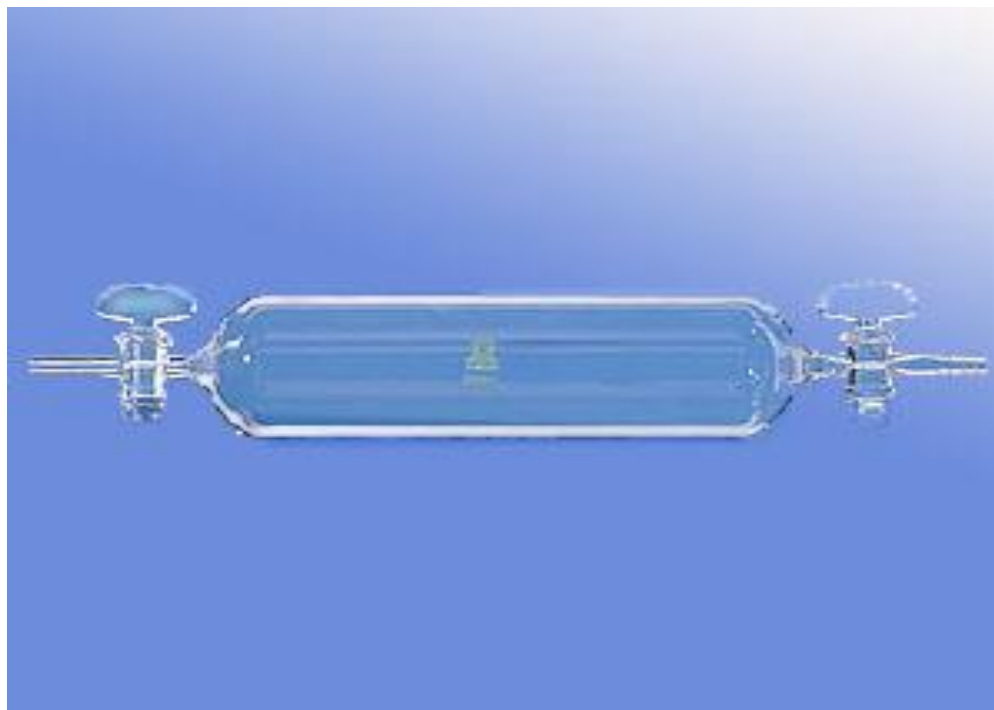


Migunov electric aspirator

AIR SAMPLING METHODS

ONE-SHOT METHODS

THESE TECHNIQUES ARE EFFECTIVE, WHEN THE AIR CONTAINS HIGH CONCENTRATIONS OF SUBSTANCES!



Special glass absorption devices – GASEOUS PIPETTES

ONE-SHOT AIR SAMPLING TECHNIQUES

NOTA BENE!

THE METHOD OF POURING: BEFORE AIR SAMPLING THE BOTTLE ARE FILLED WITH SOME LIQUID, WHICH IS INDIFFERENT TO THE TESTED SUBSTANCE (HYPERTONIC SOLUTION OF NaCl); IN THE PLACE OF SAMPLING THE LIQUID IS POURED OUT AND THE AIR TO BE TESTED GETS INSIDE.

THE EXCHANGE METHOD: THE AIR TO BE TESTED IS PASSED THROUGH A VESSEL MANY TIMES WITH HELP OF AN ASPIRATOR OR A RUBBER BAG.

THE VACUUM TECHNIQUE: REMOVAL OF THE “USELESS” AIR FROM A VESSEL WITH A VACUUM PUMP, DETERMINATION OF THE DEGREE OF VACUUM (BY A PRESSURE GAUGE); IN THE PLACE OF SAMPLING THE VESSEL IS OPENED AND FILLED WITH THE REQUIRED AMOUNT OF AIR.

INDUSTRIAL DUST

DUST IS A PHYSICAL STATE OF A SUBSTANCE, WHICH IS REDUCED TO MINUTE PARTICLES.

THIS IS AN AEROSOL, WHOSE DISPERSED PHASE CONSISTS OF SOLID PARTICLES, AND AIR IS ITS DISPERSIVE MEDIUM.





CLASSIFICATION OF INDUSTRIAL DUST. :

- **BY ORIGIN** (organic, inorganic, mixed);
- **BY WAY OF FORMATION** (disintegration aerosols, condensation aerosols);
- **BY SIZE OF DUST PARTICLES (DISPERSION)** (dust proper – more than 0.1 mcm; smoke – less than 0.1 mcm).



THE EFFECT OF DUST ON THE HUMAN ORGANISM DEPENDS UPON THE FOLLOWING FACTORS:

- DURATION OF THE EFFECT;**
- SHAPE AND CHARACTER OF DUST PARTICLE EDGES;**
- TOTAL SPECIFIC SURFACE OF THE DUST AEROSOL;**
- SOLUBILITY IN THE ORGANISM'S MEDIA;**
- CHEMICAL COMPOSITION;**
- ELECTRIC CHARGE;**
- SIZE OF PARTICLES;**
- INDIVIDUAL PECULIARITIES OF THE ORGANISM.**

MAIN SOURCES OF DUST IN THE CHEMIST'S SHOP CONDITIONS

HIGH CONCENTRATIONS OF DUST ARE REVEALED: IN MATERIAL ROOMS – AT THE TIME OF PACKING OF FINISHED AND SEMI-FINISHED DRUGS AND MEDICINAL HERBS INSIDE THE CHEMIST'S SHOP; IN ASSISTANTS' ROOMS – IN THE PROCESS OF DIRECT PREPARATION OF DRUGS AND EXTREMELY COMPLEX MEDICINAL MIXTURES.

BARBAMYLUM
SALICYLIC ACID AND ITS SALTS
CHLORAL HYDRATE
NICOTINIC ACID
ANTIBIOTICS
HERBAL DUST



HARMFUL EFFECTS OF DUST ON THE ORGANISM

- 1. DISEASES OF THE SKIN AND MUCOUS MEMBRANES (DERMATITIS, CONJUNCTIVITIS).**
- 2. NONSPECIFIC DISEASES OF THE RESPIRATORY ORGANS (RHINITIS, PHARINGITIS).**
- 3. ALLERGIC DISEASES (ALLERGIC DERMATITIS, BRONCHITIS, BRONCHIAL ASTHMA).**
- 4. OCCUPATIONAL INTOXICATIONS.**
- 5. ONCOLOGICAL DISEASES.**
- 6. PNEUMOCONIOSIS.**

PREVENTIVE MEASURES

- **HYGIENIC STANDARDIZATION (THE MAXIMUM ALLOWABLE CONCENTRATION FOR DUST OF VEGETABLE AND ANIMAL ORIGIN IS 2.0 mg/m^3 ; FOR SILICATES IT IS 4 mg/m^3).**
- **RATIONALIZATION OF THE TECHNOLOGICAL PROCESS.**
- **PERSONAL PROTECTIVE EQUIPMENT.**
- **REGULAR MEDICAL EXAMINATIONS.**

METHODS FOR REVEALING THE AIR DUST LEVEL

IN ORDER TO MAKE THE HYGIENIC ASSESSMENT OF DUST, IT IS NECESSARY TO DETECT:

- 1. AMOUNT OF DUST IN ONE AIR VOLUME UNIT (mg/m^3);**
- 2. SIZE DISTRIBUTION OF DUST PARTICLES;**
- 3. CHEMICAL COMPOSITION OF DUST PARTICLES.**

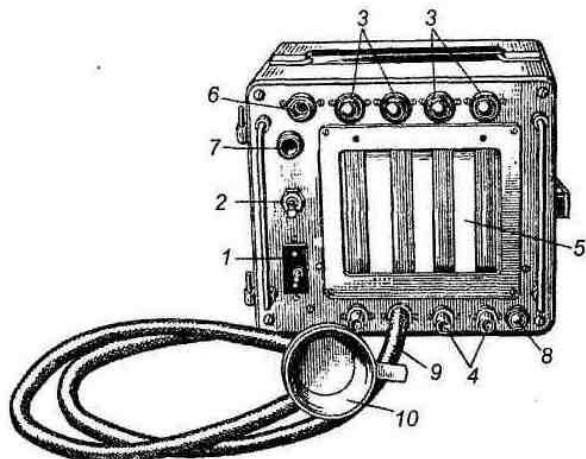
THE AIR TO BE TESTED IS SAMPLED AT A HEIGHT OF 1.5 m DIRECTLY ON THE PLACE OF WORK OR, IF THERE ARE NO FIXED WORK PLACES, IN THOSE PLACES WHERE THE PEOPLE STAY MOST FREQUENTLY, ALSO TAKING INTO ACCOUNT THEIR MOVEMENT ROUTES.

THE GRAVIMETRIC TECHNIQUE IS REGARDED BY THE HEALTH LEGISLATION OF UKRAINE AS THE CHIEF METHOD FOR MEASURING DUST CONCENTRATIONS IN THE AIR OF WORKROOMS.

THE METHOD IS BASED ON DRAWING AIR WITH HELP OF AN ASPIRATOR THROUGH AN AEROSOL ANALYTICAL FILTER, MADE OF PERCHLOROVINYL FABRIC, WHICH CATCHES THE FINEST PARTICLES OF DUST AND AEROSOL.

NOTA BENE!

**Electrical aspirator
with an allonge**



**Analytical
aerosol filters**



THANK YOU FOR ATTENTION!

0,03%
 CO_2

21%
 O_2

78%
 N_2

0,9%
 Ar