

# **Lecture 2.**

## **Characteristic of grain mass**

- 1. Characteristic of grain mass, as storage object.**
- 2. Classification of grain and seed by chemical composition.**
- 3. Physical properties of grain mass.**
- 4. Physiology properties of grain mass.**
- 5. Selfheating of grain mass.**

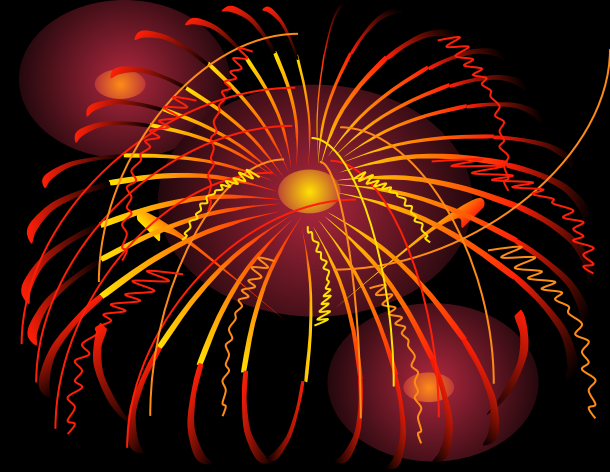


# Recommended literature



*Подпрятов Г.І., Скалецька Л.Ф.,  
Сеньков А.М., Хилевич В.С. Зберігання  
і переробка продукції рослинництва.  
К.: "Мета", 2002.*

## Content of grain mass:



Grain of  
base  
culture  
60 - 95 %

Admixture:  
seeds of other  
cul-ture plants;  
orga-nic and  
mineral admixture;  
grains damage  
pest

Microor-gan  
isms and  
insects

Intergrain  
air space

# Chemical content of grain and seeds.

**Water, %:** from 7—9 to 25—30 and more.

**Mineral's substance, %:** carbon — 45; oxygen — 42; hydrogen — 6,5; nitrogen — 1,5.

**Nitrogen's substance:** present basically of proteins.

**Carbohydrates** – constitute to 2/3 weight of grains cereals. Present basically of polysaccharide: starch, cellulose. The grain rye and flax content slimes or gum to 2—2,5 %.

**Fats .**

**Pigments.** There are four groups of pigments: porphyrines (chlorophyll - the green color of many garden-stuffs), carotenoid (carotin, xanthophyll - yellow coloring), anthocyanins (a dark blue or violet color), flavones (give to the grain yellow coloring).

**Vitamins.** There are 9 basically vitamins: water-soluble (vitamin B1, B2, B6, C, nicotinic acid); fat-soluble (carotenoids, B, E).

**Enzymes.** Basically of dehydrogenase, decarboxylase, lipase, phosphatase, amylase, protease.

**Acidity.** Basically presence of phosphoric, acetic, lactic and apple acids.



## **Classification grain and seeds by chemical substances:**



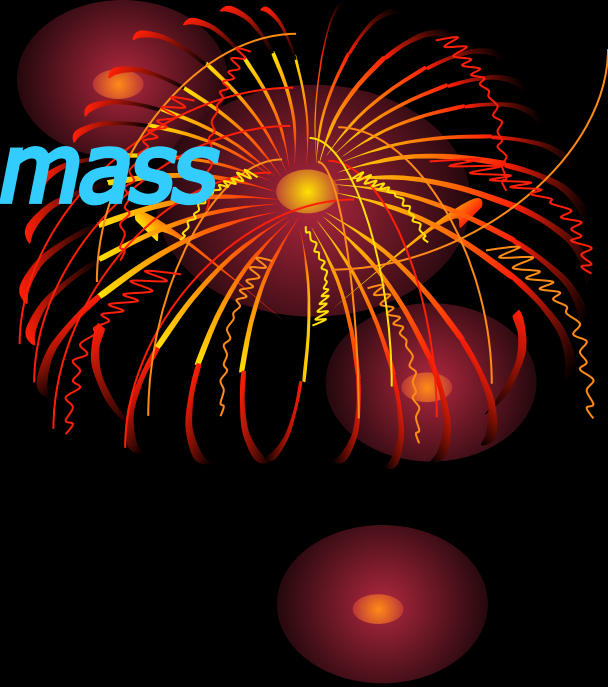
**1) rich on starch (55 - 80 %) - cereals (rye, wheat, oat, barley, rice) groats (buckwheat, millet);**

**2) rich on proteins (over 20 %) - pulses (pea, haricot, bean, sorghum at. al.);**

**3) rich on a plant oil (over 35 %) — sunflower, flax, mustard, rape, poppy at. al.;**

**4) rich at the same time on plant and essential oils (fennel, coriander, cumin at. al.;).**

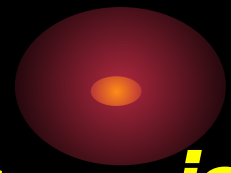
# *Physical properties of grain mass*



- *Friableness;*
- *Self sorting;*
- *Porousness;*
- *Sorption properties - capacity for sorption and desorption of different steam and gases (sorption capacity);*
- *Heat conductivity;*
- *Heat capacity;*
- *Thermal conductivity;*
- *Thermal-moisture conductivity.*



***Friableness is an ability of grain and grain mass to move on the surface placed under a certain angle to horizon.***



***Friableness of grain mass is characterized by the angle of friction or angle natural slope (the least angle between basis and slope of bulk grain for which grain mass begin to slide on a surface).***

*Self sorting is property of grain mass to lost the homogeneity during moving and free falling.*



*Porousness of grain mass is presence of the intervals between its hard particles, filled by air.*



**Sorption properties** of grain mass is an ability to absorb steam from an environment, smells, different volatile matters and gases and also desorption them back.

**Heat conductivity** of grain mass consists in its ability to carry a warmth from areas with high temperature to the areas with a lower temperature.

**The heat capacity** of grain is characterized by the amount of warmth necessary for the increase of temperature of grain by mass 1 kg on 1 °C.

**Temperature conductivity** is speed of change of temperature in a grain and his thermal inertia.

**Thermal-moisture conductivity** is an ability of grain mass directly to transfer moisture from an area with high temperature to the areas with a lower temperature together with the stream of warmth.



*Processes which take place in grain mass as a result of vital functions of its components are called **physiology**.*

**Physiology property of grain mass**



**Breathing Afterripening  
Germination**



*Breathing is an important physiology process which is the basis of exchange of matters in living organisms energy.*




*The process of breathing of grain can be estimated by a respiratory coefficient (correlation of volume of carbon dioxide, that was remove, to the amount of the oxygen spent in the process of breathing directly) and breathing intensity.*

*$K=1$  – aerobic breathing*

*$K<1$  – anaerobic breathing*

*$K>1$  – anaerobic breathing*



**Breathing intensity is determined by the quantitative losses of mass of dry matter of grain, given off warmth, used oxygen and given off carbon dioxide by grain mass at the certain values of humidity, temperature and access of air.**

**Intensity of process of breathing is expressed in milligrams or in the cube centimeters of carbon dioxide, that was given off from a 1000 g dry matter of grain for days.**

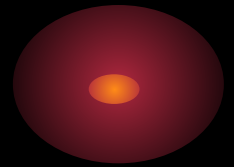
# ***Factors which influence intensity of breathing of grain mass:***



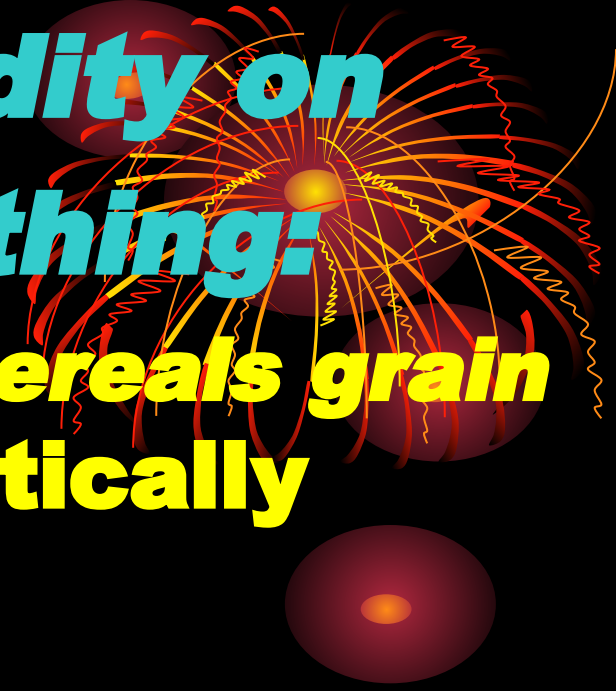
- humidity;***
- temperature;***
- degree of aeration;***
- duration of storage;***
- quality and state of grain  
mass.***

# Grain division at the quantity of a humidity:

- ***dry grain (seed);***
- ***middle dryness;***
- ***moist;***
- ***wet.***



# ***Influence of humidity on intensity of breathing:***




***Intensity of breathing of cereals grain  
with humidity 11-12 % practically  
equals zero.***

***The grain of middle dryness breathes  
from 2 till 4 times, than dry;***

***Moist breathes from 4 till 8 times, than  
dry;***

***Wet breathes from 20 till 30 times,  
than dry.***

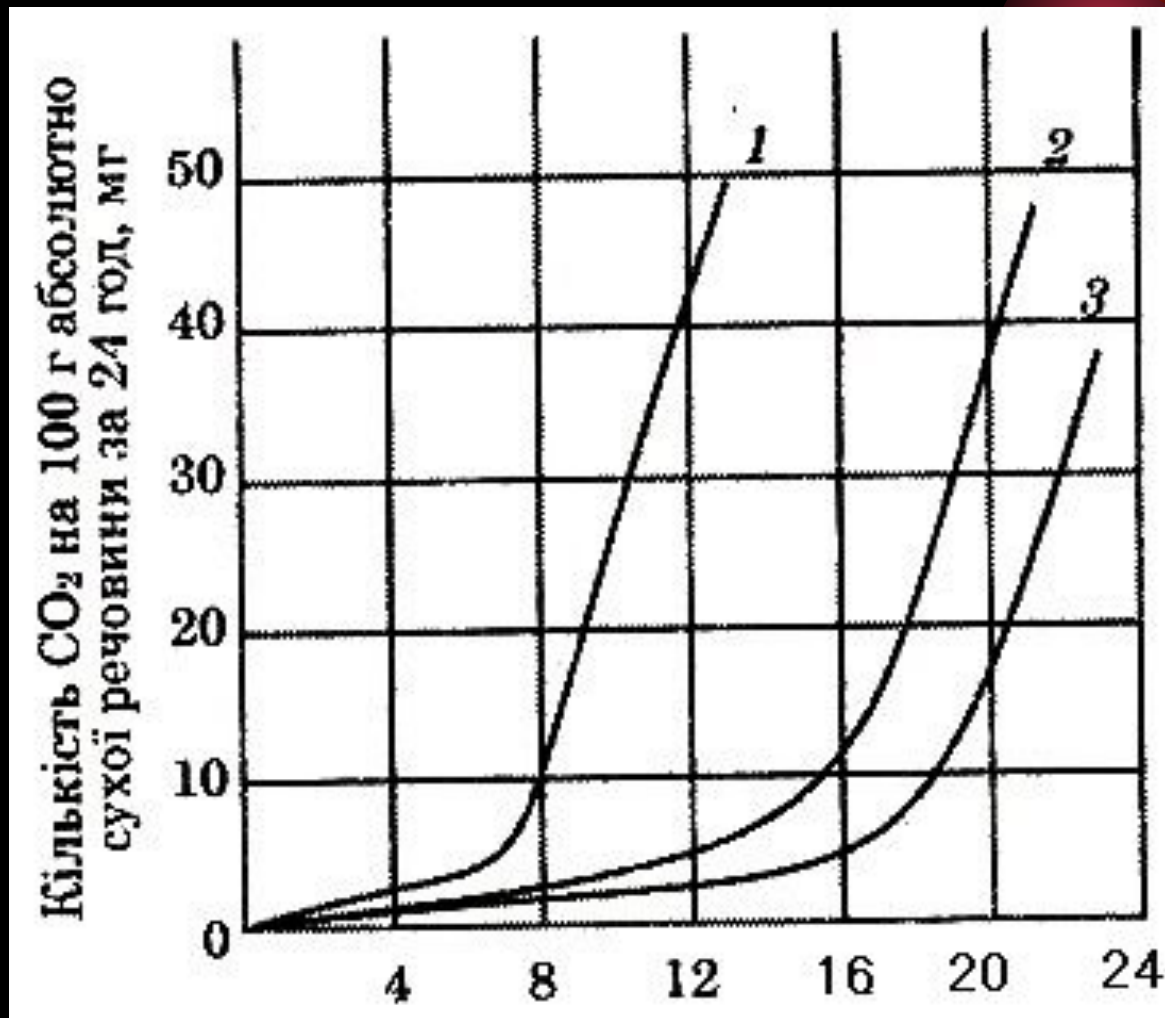


**Humidity of grain, beginning from physiology-biochemical and microbiological processes sharply increase and the terms of storage change is called *critical*.**

**The critical humidity is a level of the humidity of grain, when free moisture appears in it, so breathing intensity increases sharply and there is the threat of damage by microorganisms.**

**Critical humidity is within the limits**



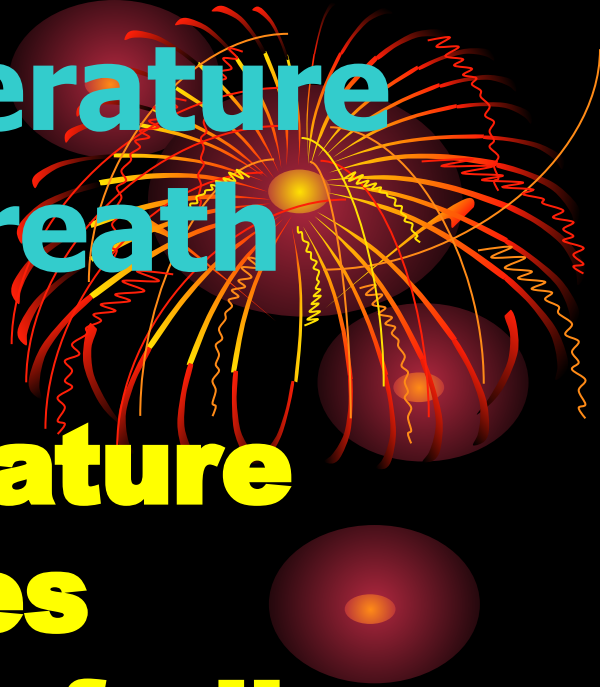


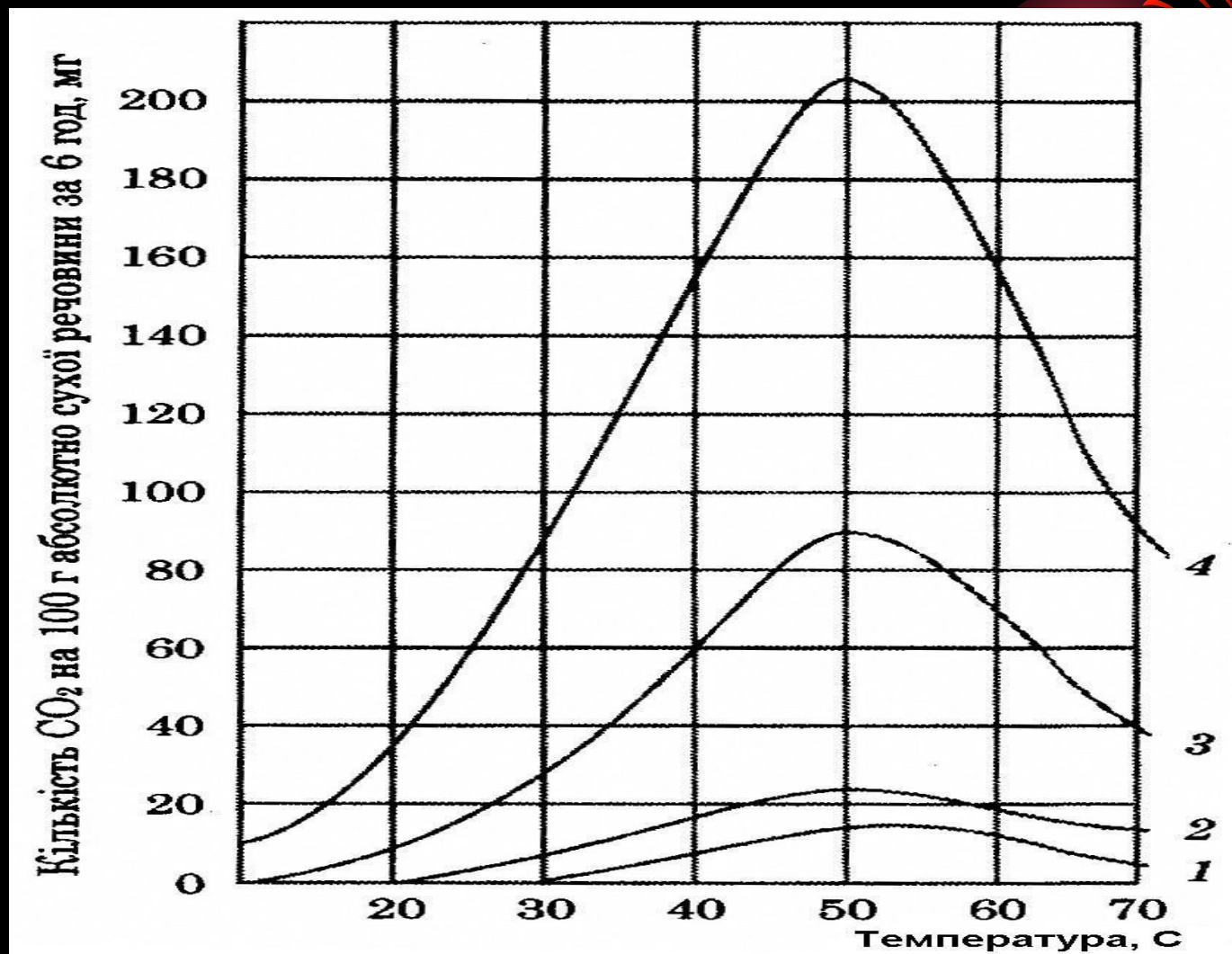
**Рис. 1.** Вплив вологості на інтенсивність дихання зерна різних культур:

**1 — соняшник; 2 — пшениця; 3 — горох**

# Influence of temperature on intensity of breath

**The decline of temperature considerably decreases intensity of breathing of all living components of grain mass and increase of terms of storage (pic. 3).**





**Рис. 3.** Вплив температури на інтенсивність дихання зерна при різній його вологості:

**1 — 14 %; 2 — 16 %; 3 — 18 %; 4 — 22%**

**The lower temperature is the less intensity of breathing of grain and less given off carbon dioxide (table 6).**



**Table 6. Breathing intensity of grain, mg CO<sub>2</sub> on a 100 g absolute dry matter at 24 h.**

Humidity of grain, %	Temperature of grain, °C				
	10	20	30	40	50
16	0	1	3	8	15
18	1	4	18	30	85
22	5	18	40	65	200

# Afterripening.

**Processes which take place in a grain and seeds during storage, result of the improvement of its sowing of property and technological qualities are called *afterripening*.**

**It is characterized by two indexes:**

- **by the increase of germination;**
- **decline of intensity of breathing.**

**The basic factors of the afterripening is dry grain, good access of air and higher temperature (20-22 °C).**

**At the favorable condition of storage the processes of the afterripening of grain of**



# **Germination of grain.**

**For the germination of grain certain conditions are necessary - sufficient humidity, heat and access of air.**

**A grain begins to germinate only at absorption of drop-liquid moisture and moistening to 40 % and higher.**

**Careful control at the humidity of grain in different layers and areas of bulk, prevention of formation of drop-liquid moisture in grain mass is the basic method of germination of grain prevention during its storage.**



# **Self heating of grain mass**

**Self heating of grain mass is the increase of its temperature as a result of physiology processes, which take place in it, and low heat conductivity.**

**The physiology basis of self heating of grain mass is breathing of all living components of grain mass, which causing to considerable excrete of heat.**

**The physical basis of self heating of grain mass is bad heat conductivity.**

**Formation of heat in one or another area of grain bulk exceeds the return of it in the environment. It causes the self**

# **The factors, which influence on development of process self heating:**



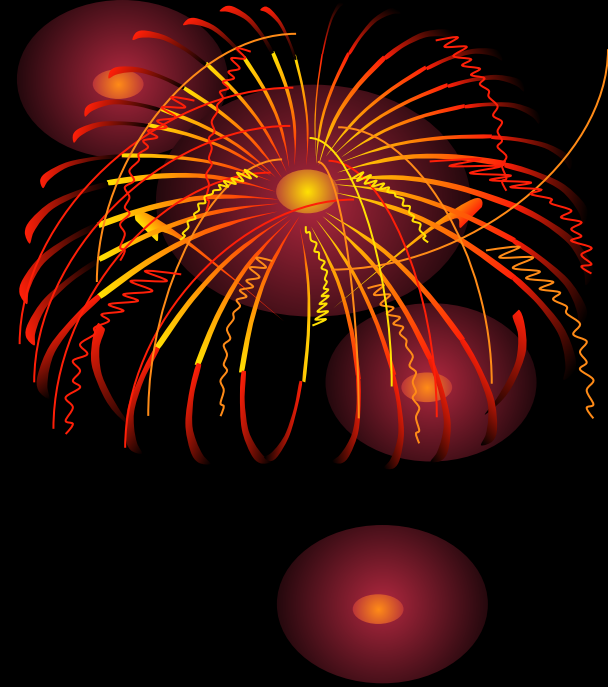
**1) Intensive breathing of grain basis of culture, grain and seeds, which enter to content of admixture;**

**2) Intensive growth of microorganisms;**

**3) Intensive vital activity of insects and ticks.**



# The type of self heating:



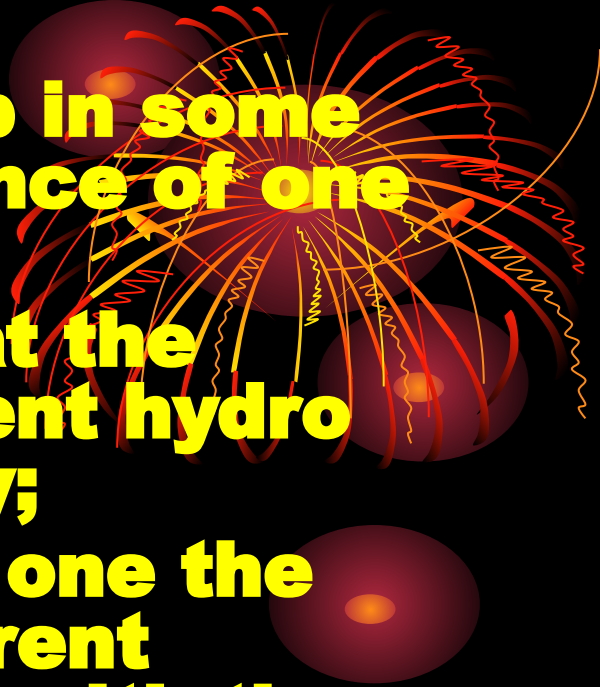
□ **nesting;**

□ **layering;**

□ **wholing.**

***Nesting* self heating** arises up in some part of grain mass at presence of one of such rea-sons:

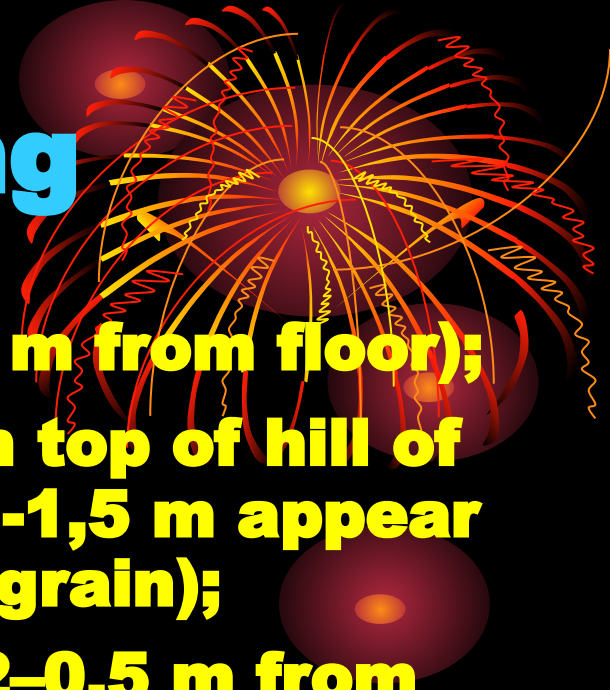
- 1) moistening of grain mass at the flowing of roofs or insufficient hydro isolation of walls of granary;**
- 2) to fill up in one granary or one the gra-in-bin of grain of a different humidity and centre (nests) with the increased of humidity are created as a result;**
- 3) presence in grain mass of areas with the increased content of admixtures and dust;**
- 4) accumulation of insects and ticks in one area of bulk.**

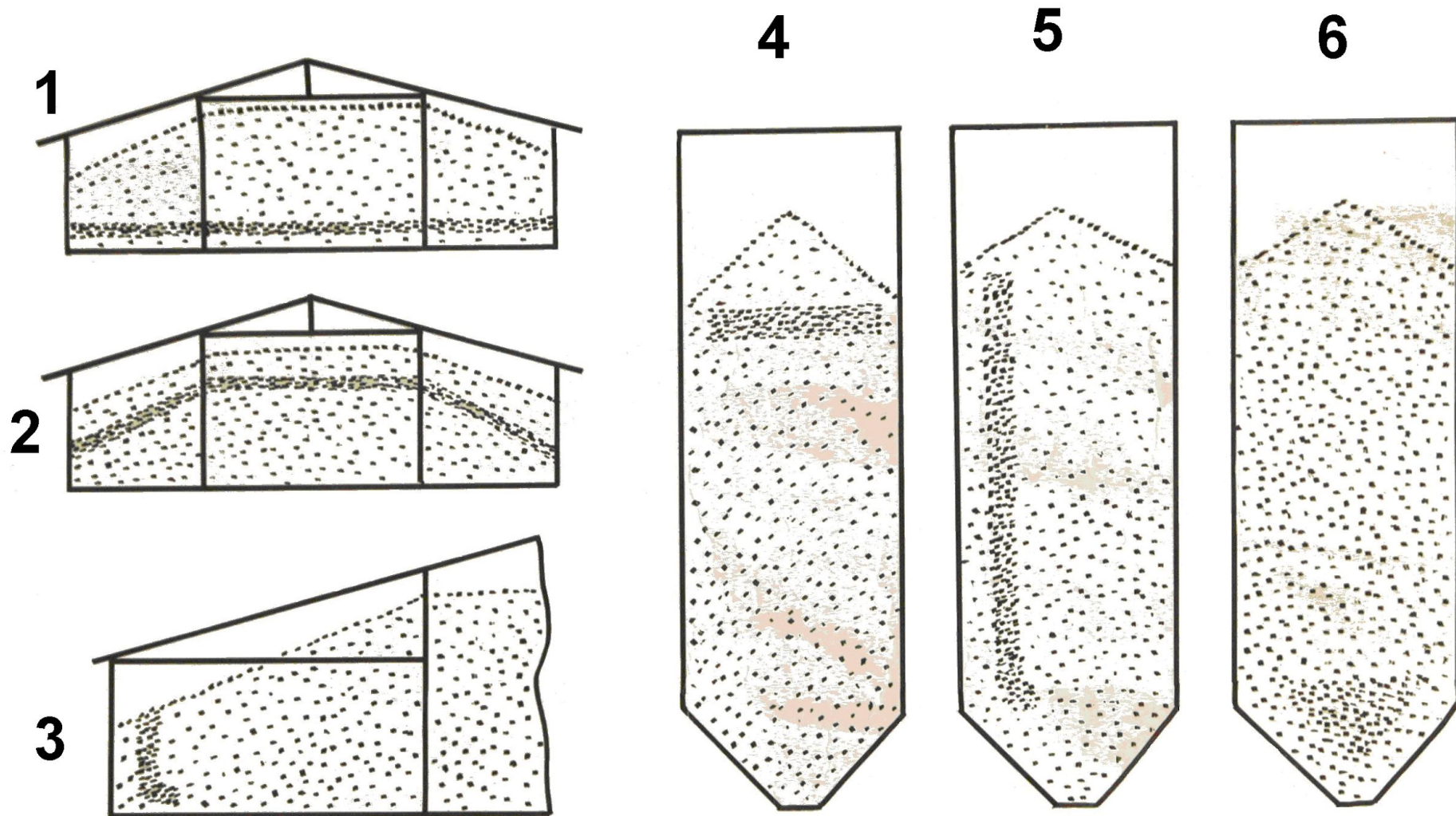


# Types of self heating layering

- **Lowling** (appear under on 0,2–0,5 m from floor);
- **Topping** (appear on 0,7–1,5 m from top of hill of grain; about height of grain hill 1-1,5 m appear on 0,15-0,25 m from top of hill of grain);
- **Vertical-layering** (appear on 0,2–0,5 m from wall).

**The basic reason of self heating layering is physical property of grain mass, as the heat-moisture conductivity - moving of moisture in grain mass in direction of stream of warmth, that is predetermined by the temperature drop.**





## Види шарового самозігрівання зерна

1, 6 - низове самозігрівання    2, 4 - верхове самозігрівання    3, 5 - вертикально-пластове самозігрівання

# **Toping self heating.**



**Toping self heating arises up in a period with most temperature drop of grain and environment, that lately in autumn and early in spring. Horizontal layer of grain, where there is self-heating is in, placed on a depth 0,7 - 1,5 m from the surface of grain bulk, and at the thickness of the last in a depository 1-1,5 m — on a depth 0,15- 0,25 m from its surface.**

**To liquidate toping self heating, the top layer of grain is taken off, cool, dry and place in other granary.**

## **Lowing self heating.**

**Apear at low layer bulk of grain on 0,2 - 0,5 m from floor of granary or basis of silo of elevator .**

**Usually arises up in summer or in autumn at the load of the fresh non-cooled grain from granary with cold floor.**

**Such self-heating is often accompanied by the germination and compressed of grain in the low layer of grain bulk and at the oversight can result in wholing self-heating. It is possible to liquidate only by active aeration.**



# ***Vertical-layering self heating.***



***Usually appear of grain mass, which store in metal bin, silo of elevators or granary above moister at the wall, that contact to grain mass.***

***Appear at vertical layer of grain on distance 0,5 - 0,6 m from wall.***

***It can prevent, if a wall grain-bins are removed on 0,5 - 0,6 m from the outside wall of granary.***

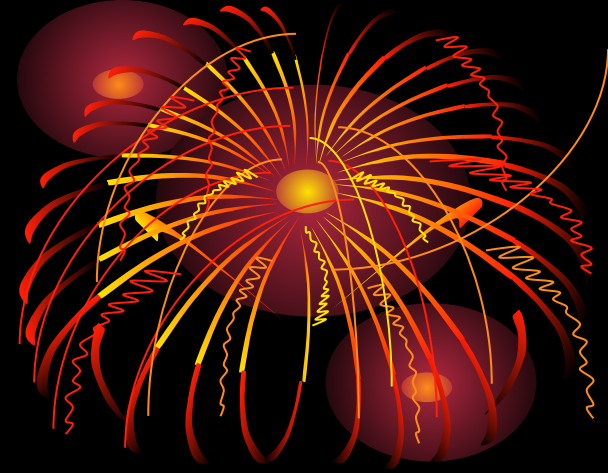
# **Wholing self heating.**

**May be in grain mass with of  
higher humidity and content  
non-ripped of grain and  
admixture or nests self  
heating do not  
liquidate.**

**The color of grain about self  
heating changing to  
dark-brown and black.**







**Thank you  
for attention.**

