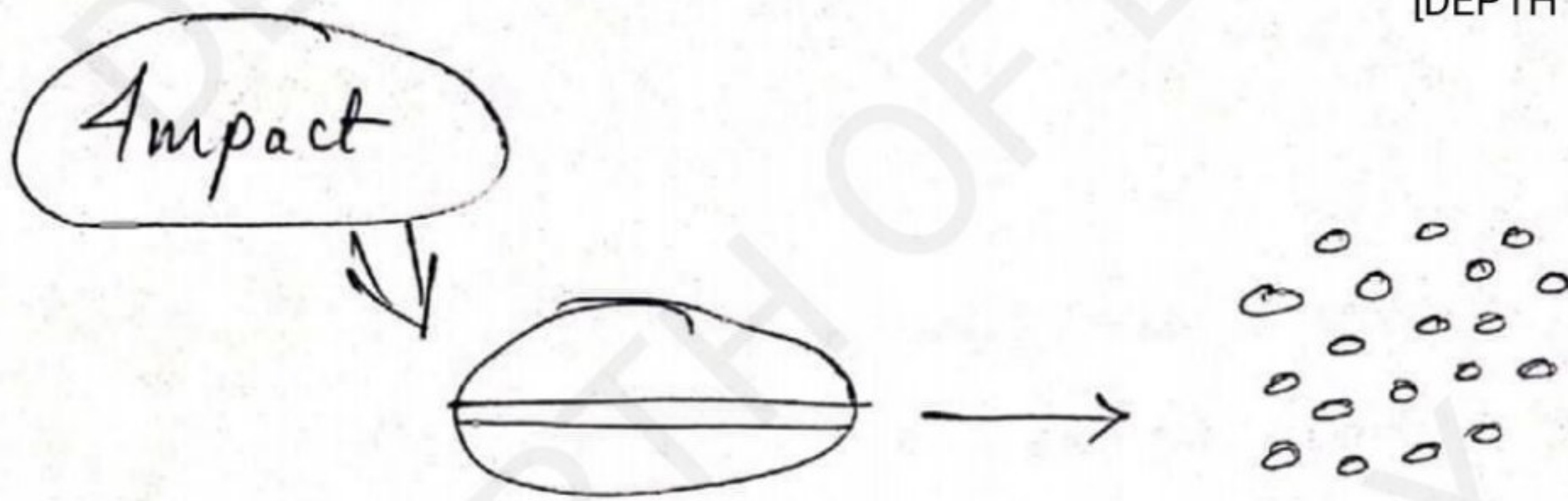


Unit - 1

► Chapter - 2 :-

↳ Size Reduction :-

[DEPTH OF BIOLOGY]



- The process in which a drug is converted into small particles through any impact.

Objective :- [DEPTH OF BIOLOGY]

Why do we need the process of size reduction?

↳ For increasing surface area.

↳ For increasing absorption.

↳ Less energy in mixing.

↳ Easy in mixing. [DEPTH OF BIOLOGY]

↳ Easy to be absorbed in our body.

Mechanism :-

- ① Impact
- ② Attrition
- ③ Combination of impact & attrition
- ④ Cutting [DEPTH OF BIOLOGY]
- ⑤ Compression

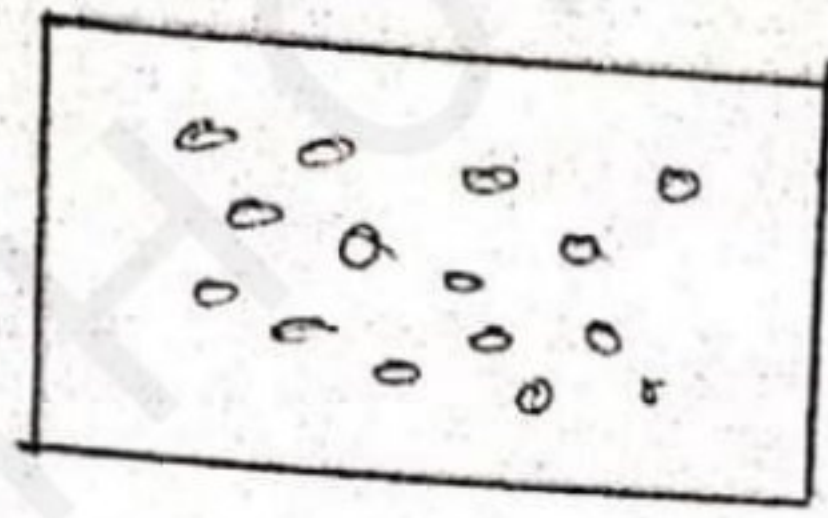
① Impact :- In this method, drug molecules converted into small particles through any type of impact.
→ Amount of drug remain constant.

eg:- Hammer mill [DEPTH OF BIOLOGY]



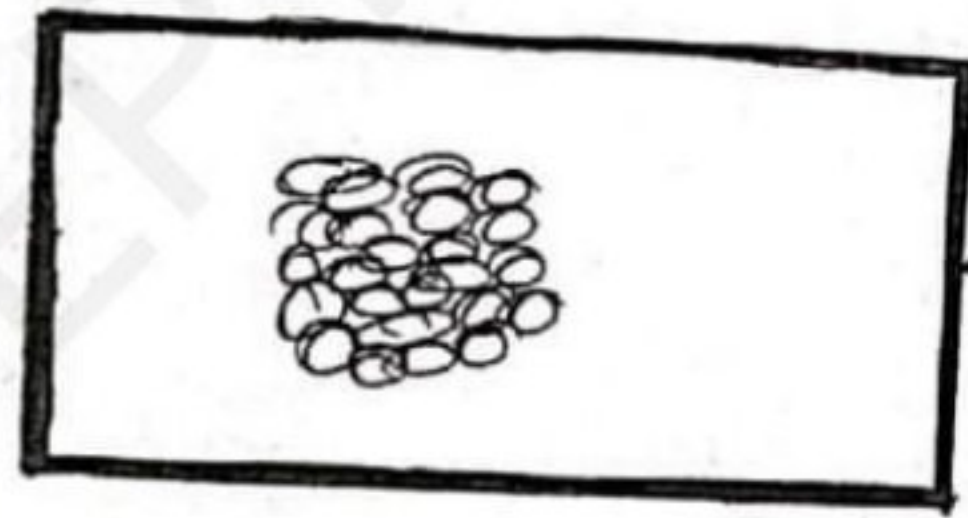
② Attrition :- In this drug particles collide with each other and reduce their size from large molecules to small molecules. [DEPTH OF BIOLOGY]

eg:- fluid energy mill



③ Combined impact & attrition :- [DEPTH OF BIOLOGY]
 Impact & attrition both apply simultaneously.

eg:- Ball mill



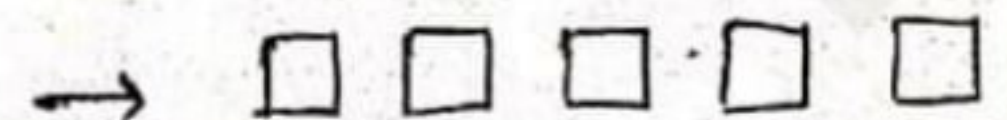
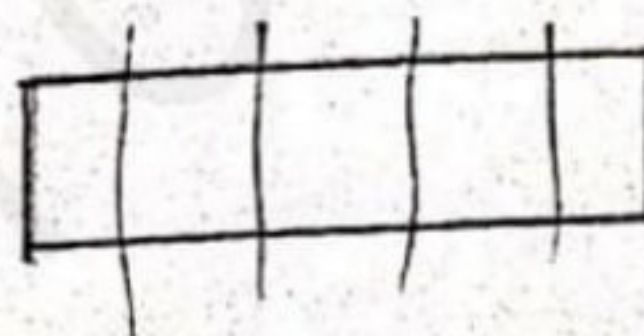
← Container

[DEPTH OF BIOLOGY]

④ Cutting :- In this method, large drug molecules reduced to small through cutting.

It is mostly used for soft & fibrous drugs.

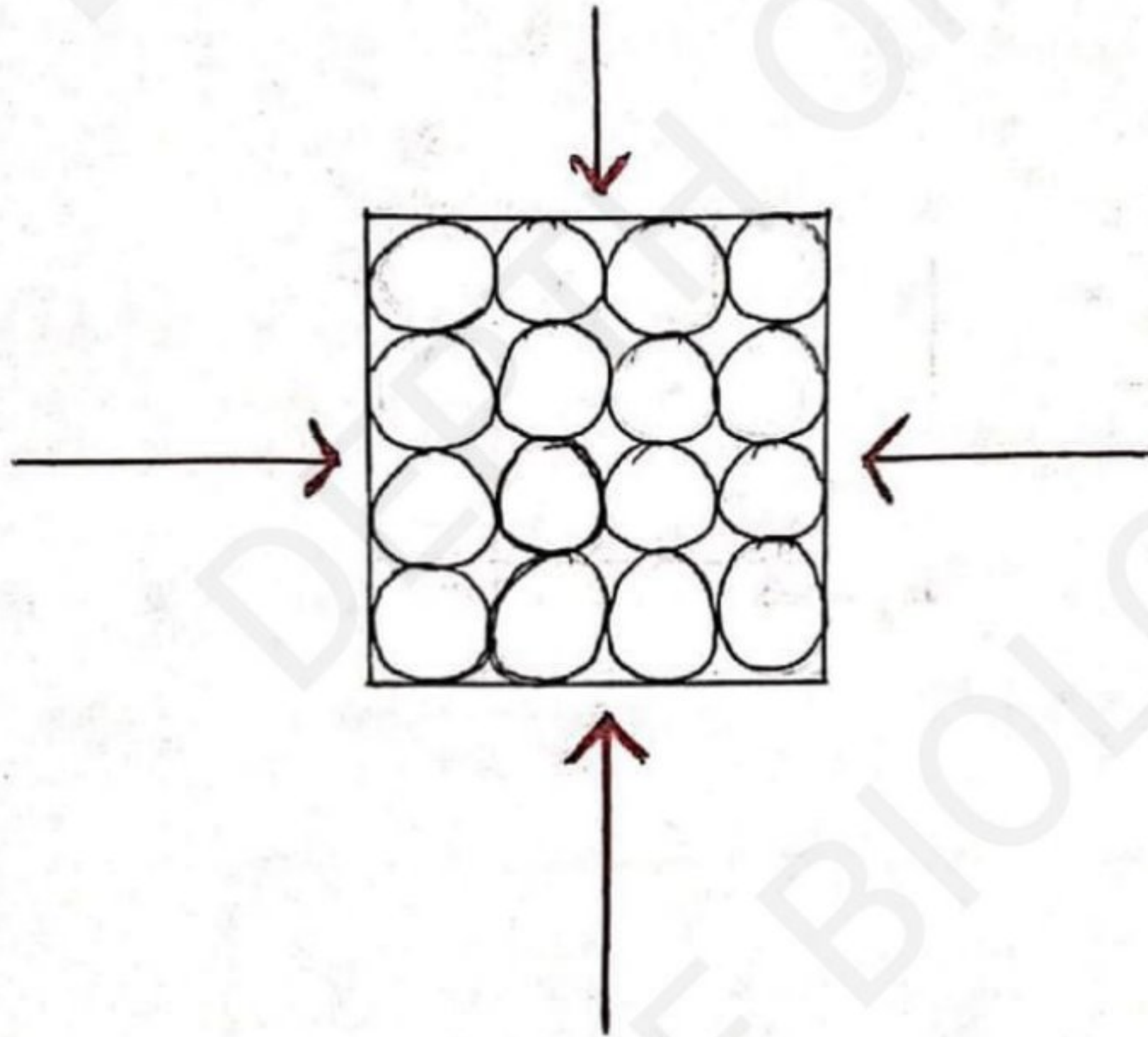
eg:- Cutter mill [DEPTH OF BIOLOGY]



⑤ Compression :- In this, we can reduce drug molecules through compression or by applying pressure on it.

↳ Mostly used for hard nature drugs.
eg:- Roller mill.

[DEPTH OF BIOLOGY]



Law governing size reduction :-

[DEPTH OF BIOLOGY]

① Kick's law :- The energy required to reduce the size of particles is proportional to the ratio of the initial size of a typical dimension to the final size of that dimension.

[DEPTH OF BIOLOGY]

$$E = K_k \ln \left(\frac{d_1}{d_2} \right)$$

where,

E = Energy

d_1 = diameter of initial particle

d_2 = diameter of final particle

K_k = Kick's Constant [DEPTH OF BIOLOGY]

② Rittinger's Law :- The energy required for reduction in particle size of a solid is directly proportional to the increase in surface area.

$$E = K_R \left[\frac{1}{d_1} - \frac{1}{d_2} \right]$$

where, [DEPTH OF BIOLOGY]

E = Energy required

K_R = Rittinger's Constant

d_1 = initial size

d_2 = final size

[DEPTH OF BIOLOGY]

③ Bond's Law :- Energy required is proportional to the square root of the surface to volume ratio of the product. [DEPTH OF BIOLOGY]

$$\frac{E}{W} = \sqrt{\frac{100}{d_2}} - \sqrt{\frac{100}{d_1}}$$

where,

E = the energy required

W = the bond work index required to reduce a unit weight.

d_1 = diameter of sieve aperture that allow 80% of the mass of the feed to pass.

d_2 = diameter of sieve aperture that allow 80% of the mass of the ground material to pass.

Factor affecting Size reduction :-

↳ Hardness [DEPTH OF BIOLOGY]

↳ Material Structure

↳ Softening temperature

↳ Stickiness

↳ Soapiness

↳ Explosive

↳ Material yielding dusts that are harmful to the health.

▶ Hardness → [DEPTH OF BIOLOGY]

↳ Surface property of the material.

↳ Harder the material, more is the difficulty to reduce the size.

▶ Material Structure →

↳ The process of size reduction is also affected by the structure of substance.

eg:- Long particles can be reduced through cutting. [DEPTH OF BIOLOGY]

- Hard or small particles can be reduced through impact.

▶ Softening temperature →

↳ On increasing temperature some substances melt during size reduction.

eg:- waxy substance [DEPTH OF BIOLOGY]

▶ **Stickiness** :- A sticky material will tend to clog the grinding equipment. Therefore, it should be ground in a plant that can be cleaned easily.

[DEPTH OF BIOLOGY]

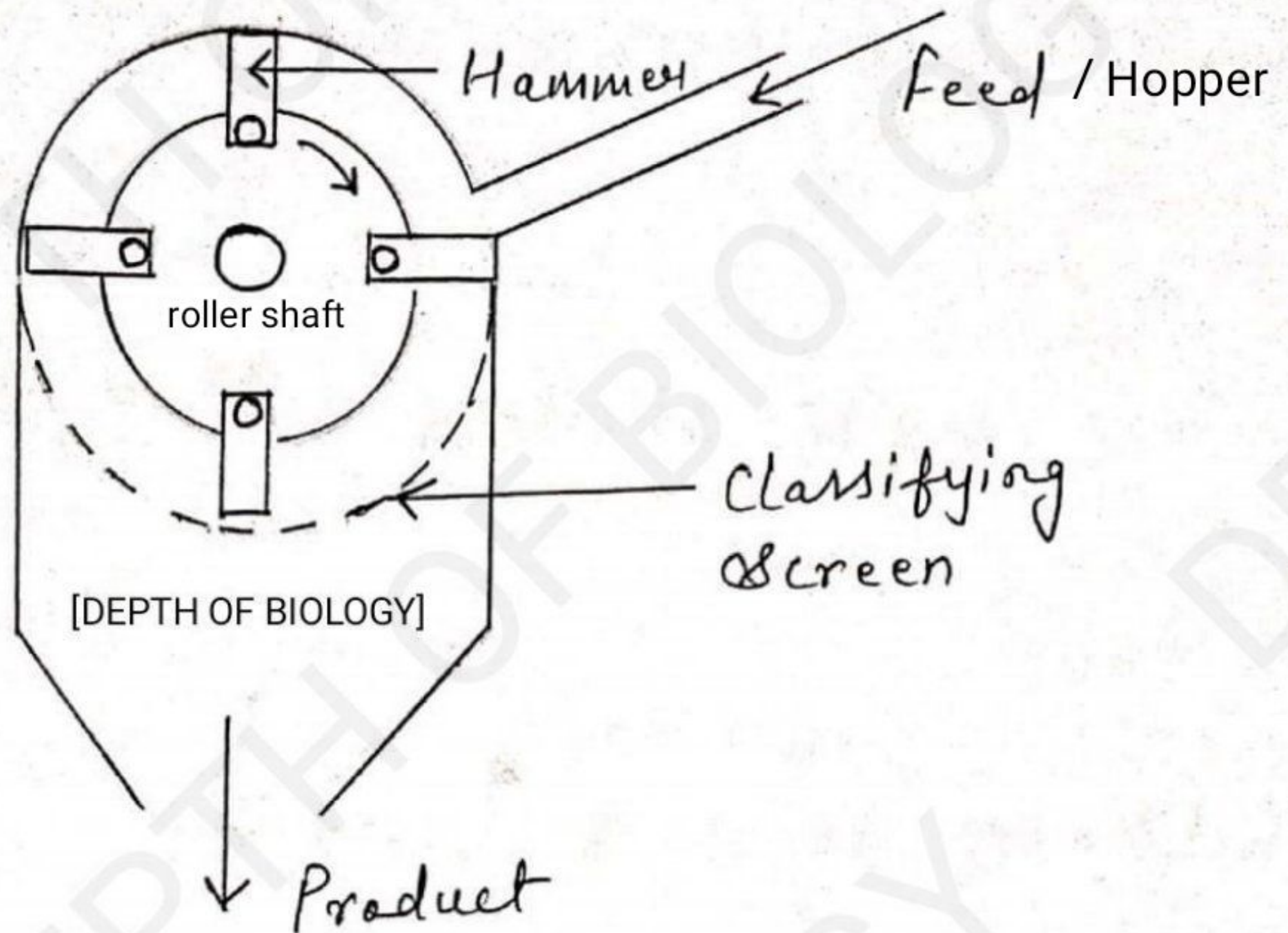
▶ **Soapiness** :- A measure of the coefficient of friction of the surface of the material. [DEPTH OF BIOLOGY]

- If the coefficient of friction is low, the crushing may be more difficult.

▶ **Explosive** :- Such material must be ground wet or in the presence of an inert atmosphere.

Hammer mill :- [DEPTH OF BIOLOGY]

- Used to reduce particles size through impact.



Principle :- Based on impact

Working :- [DEPTH OF BIOLOGY]

↳ First of all, bulky drug material store in hopper, through hopper it will start to fallen down.

↳ On starting the machine hammer will start to hit the drug particles.

[DEPTH OF BIOLOGY]

↳ By the impact particles started to reduce.

↳ After reduction, particles stored in receiver through screen.

↳ Particle does not reduce again rolled in mill.

Uses :- [DEPTH OF BIOLOGY]

↳ Used to reduce particles sizes.

Advantages :-

↳ Useful for

- ↳ Big particles
- ↳ Hard & tough particles

↳ Easy & fast in use.

↳ Used to reduce in very small particle through screen. [DEPTH OF BIOLOGY]

Disadvantages :-

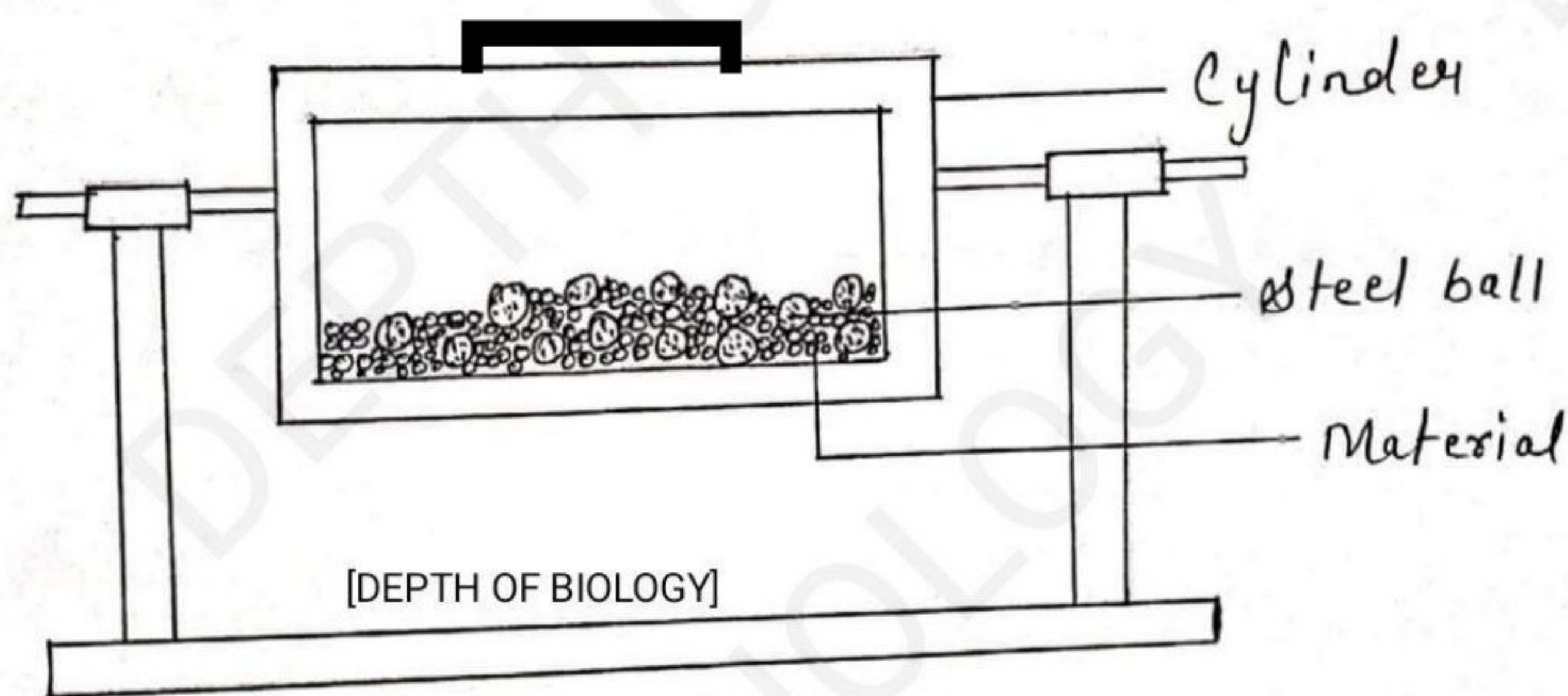
↳ Produces noise

↳ Large heat production [DEPTH OF BIOLOGY]

↳ Fibrous material cannot be used.

Ball mill :- Used to reduce particle size through impact & attrition.

Principle :- Combination of impact & attrition. [DEPTH OF BIOLOGY]



fast operate (no)
slow operate (no)
medium operate (attrition and impact good)

Working :-

- ↳ Open the cap of box and enter the drug molecules into it.
- ↳ Start the machine and adjust the speed of mill.
- ↳ On medium speed, it will start and reduce the particle size. [DEPTH OF BIOLOGY]
- ↳ After reduction stop the machine then exist out the material.

↳ Separate out the ball from particle.

Uses :- [DEPTH OF BIOLOGY]

↳ To reduce particle size through impact & attrition.

Advantages :-

↳ Noise free

↳ Neat & clean

↳ All types of particles reduce easily.

↳ Less energy usage.

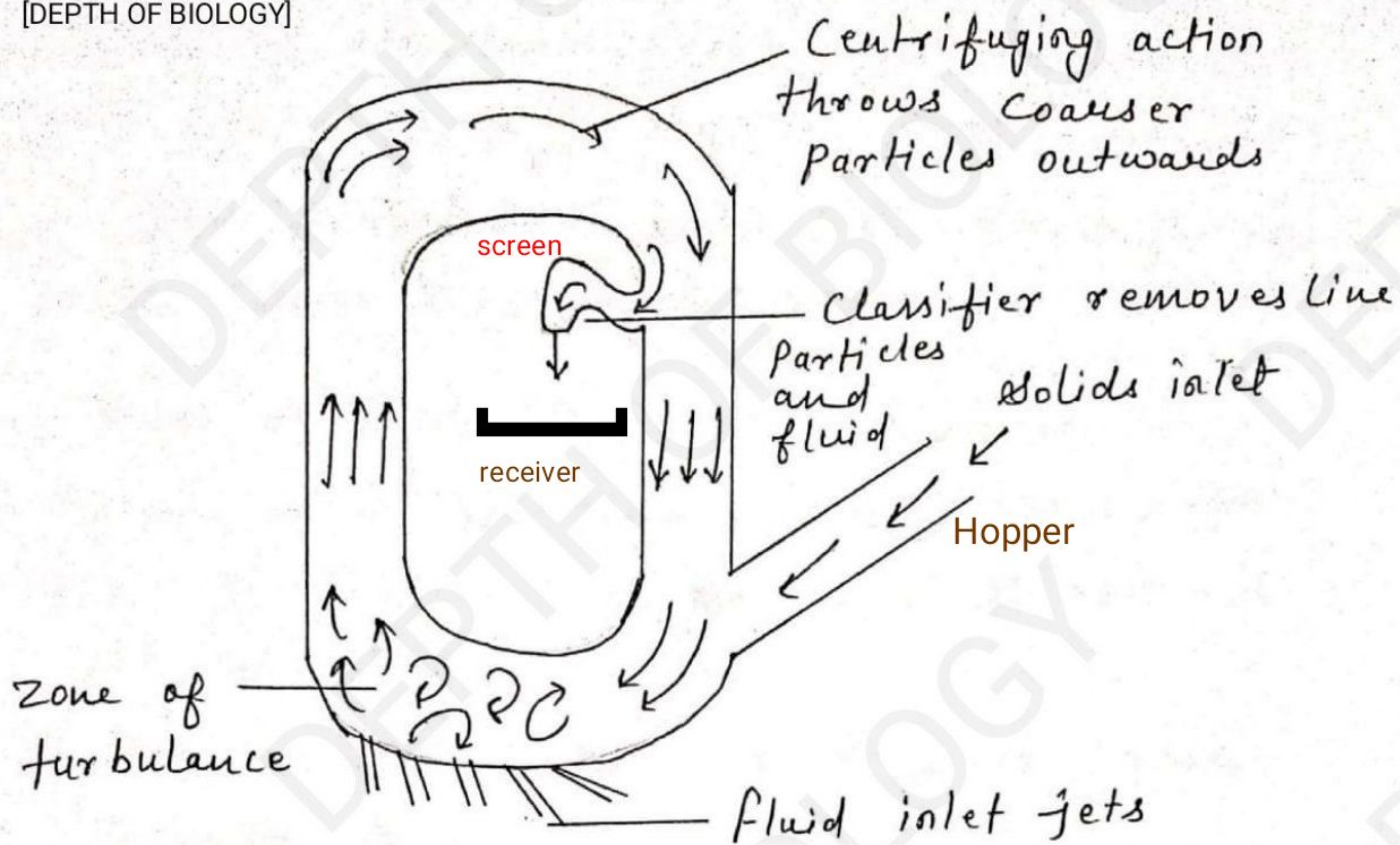
Disadvantages :- [DEPTH OF BIOLOGY]

↳ Fibrous material cannot be reduced.

↳ Not reduced in very big amount of particle.

Fluid energy mill :-

Principle :- Works on the principle of attrition and impact.



↳ It consists of a loop of pipe, which has a diameter of 20-200 mm, depending on the overall height of the loop, which may be upto about 2 meters.

↳ There is a hopper for inlet of particles which we have to reduce & one inlet for air or any inert gas.

↳ One outlet, from where we get reduced particles.

Working :- [DEPTH OF BIOLOGY]

- ↳ First of all solid particle is introduced into pipe through hopper then close it.
- ↳ Air introduced into pipe through air inlet with very high pressure.
- ↳ Due to high degree of turbulence, impact and attrition forces occurs betⁿ the particles, the particles start to get smaller. [DEPTH OF BIOLOGY]
- ↳ It will received in receiver passes through screen.

Uses :-

- ↳ The mill is used to grind heat sensitive material to fine powder.
- ↳ The mill is used to grind those drugs in which high degree of purity is required. [DEPTH OF BIOLOGY]
- ↳ It will reduces the particle to 1 to 20 micron.

Advantage :-

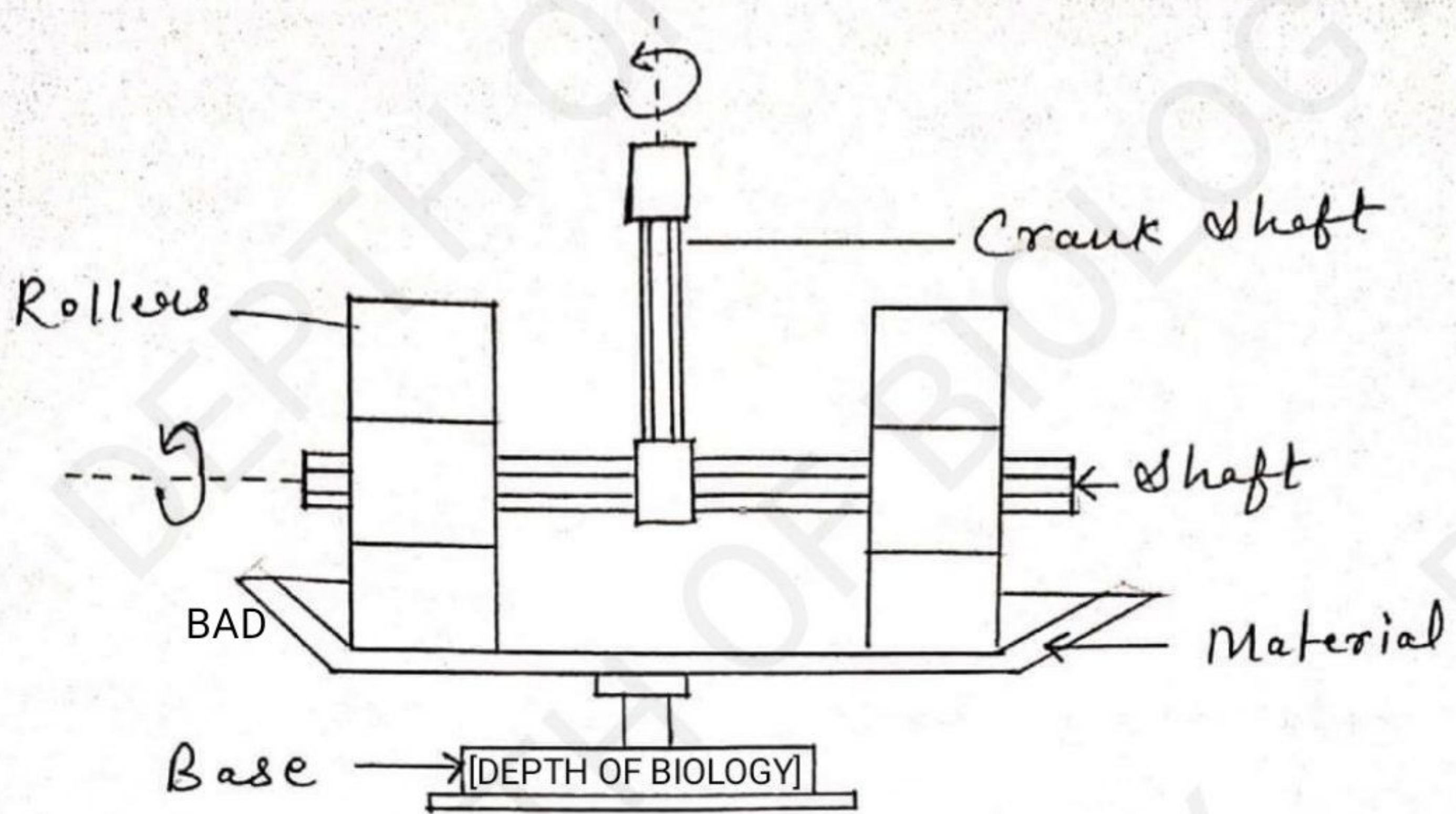
- ↳ Used to grind the material to fine powder. [DEPTH OF BIOLOGY]
- ↳ By the use of classifier particle size of powder can be controlled.
- ↳ No Contamination of the product.
- ↳ Useful for grinding heat sensitive substances such as Sulphonamides, vitamins and antibiotics. [DEPTH OF BIOLOGY]

Disadvantage :-

- ↳ High energy Consumption.
- ↳ Generation of amorphous content due to high energy impact. [DEPTH OF BIOLOGY]

Edge Runner Mill :-

Principle :- Works on the principle of Compression.



- ↳ Consist of a two heavy weight roller which rolled with the help of shaft. [DEPTH OF BIOLOGY]
- ↳ The roller move on a bed, which is made of stone or granite.
- ↳ Roller and bed joined with base & gives support to it.

Working :-

- ↳ Put the particles on the bed between roller with the help of scraper.
- ↳ Roller started rolling and also bed revolve at same time. [DEPTH OF BIOLOGY]
- ↳ Bed revolves with greater speed than roller. So that, particles will

be shared or crushed through roller.

↳ Powder is collected and separated through sieve. [DEPTH OF BIOLOGY]

Uses :-

↳ Used to grind tough material to very fine particles.

↳ Used for plant based products.

Advantages :-

- No need of attention during process.

[DEPTH OF BIOLOGY]

Disadvantages :-

- Contamination of other materials.

- Sticky material is not used.

- occupy more space than other mill.

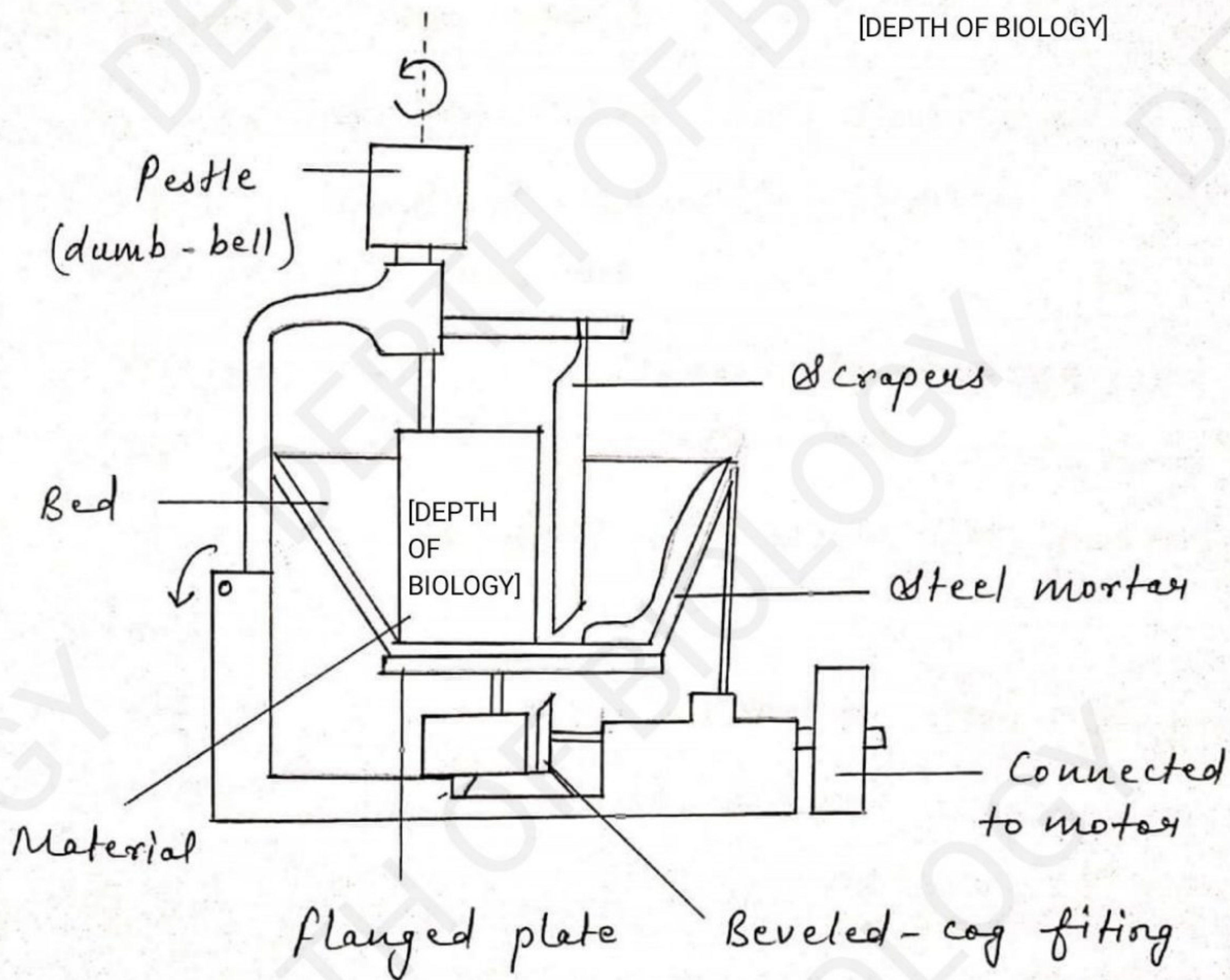
- Time & energy consumption is high.

[DEPTH OF BIOLOGY]

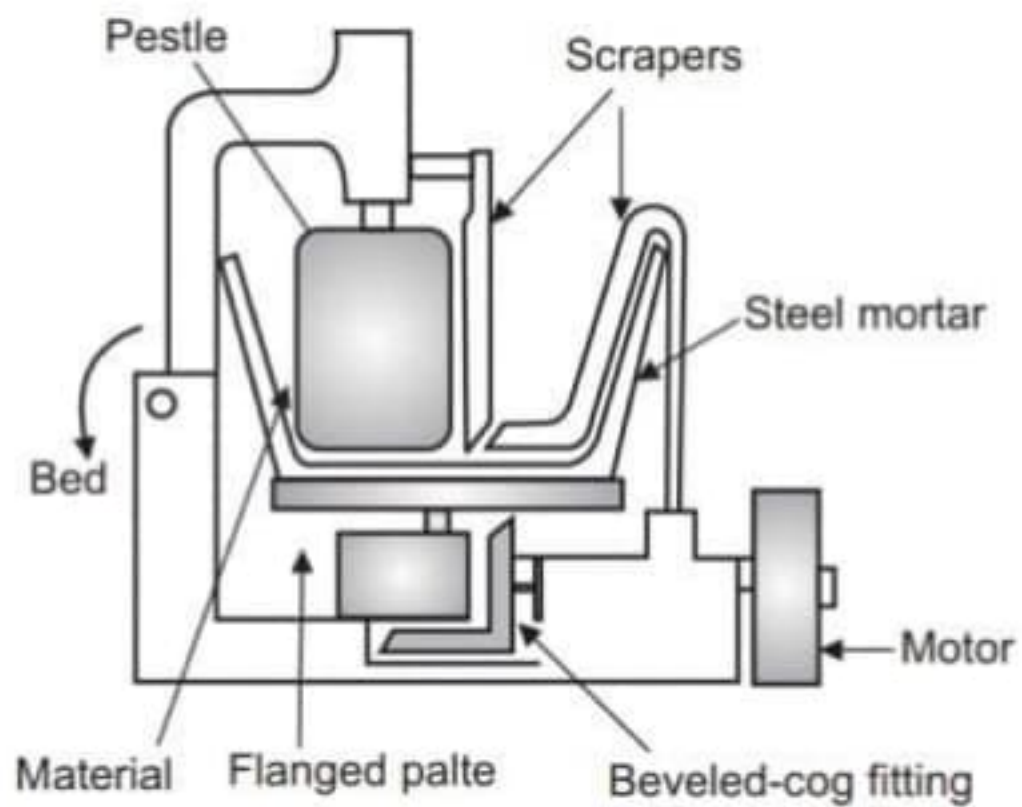
End Runner Mill :-

Principle :- Work on the principle of impact and attrition.

[DEPTH OF BIOLOGY]



- Consist of one stationary motor and one rotating pestle.
 - Some stone also present inside the motor.
- [DEPTH OF BIOLOGY]



Working :-

- First, Putting drug particles in motor which have to be reduced.
- Start the mill. [DEPTH OF BIOLOGY]
- Pestle fallen down in stationary motor and it create impact on drugs present in motor.
- After that it start to rotate, on rotating it starts attrition.
- Through impact & attrition particles start to be smaller. [DEPTH OF BIOLOGY]
- After reduction collect the fine powder.

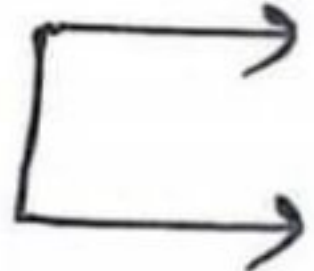
Uses :-

- Drug material reduced into very fine powder.

Advantage :- [DEPTH OF BIOLOGY]

- Easy to handle.
- No heat production.
- Less electricity required.

Disadvantage :-

- Not used for  sticky material
big particles.

[DEPTH OF BIOLOGY]

[DEPTH OF BIOLOGY]