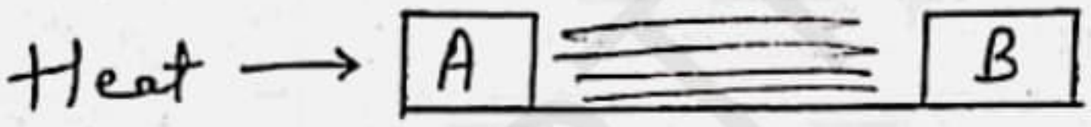
Unit - 2

Heat Transfer :—

↳ A form of energy transferring from one place to another is called Heat Transfer.



↳ Transfers through solid or liquid (medium).

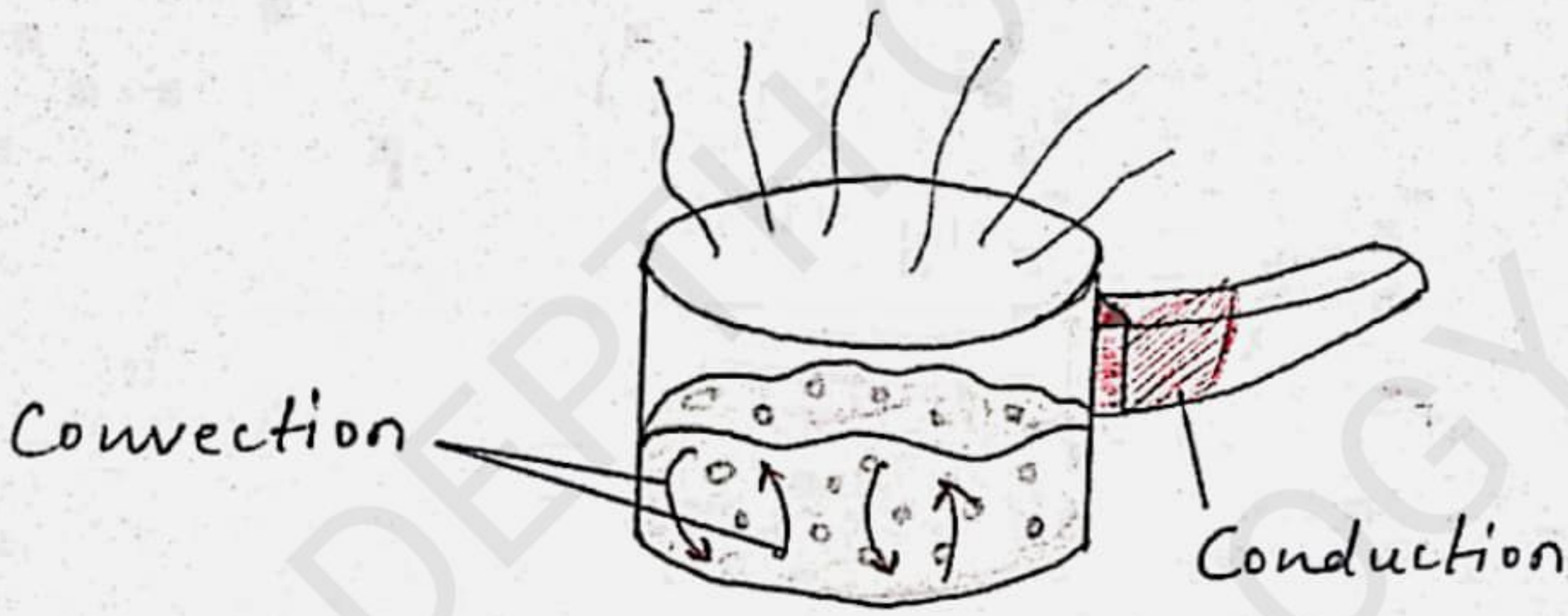
↳ Can also be transfer through surrounding i.e. air.

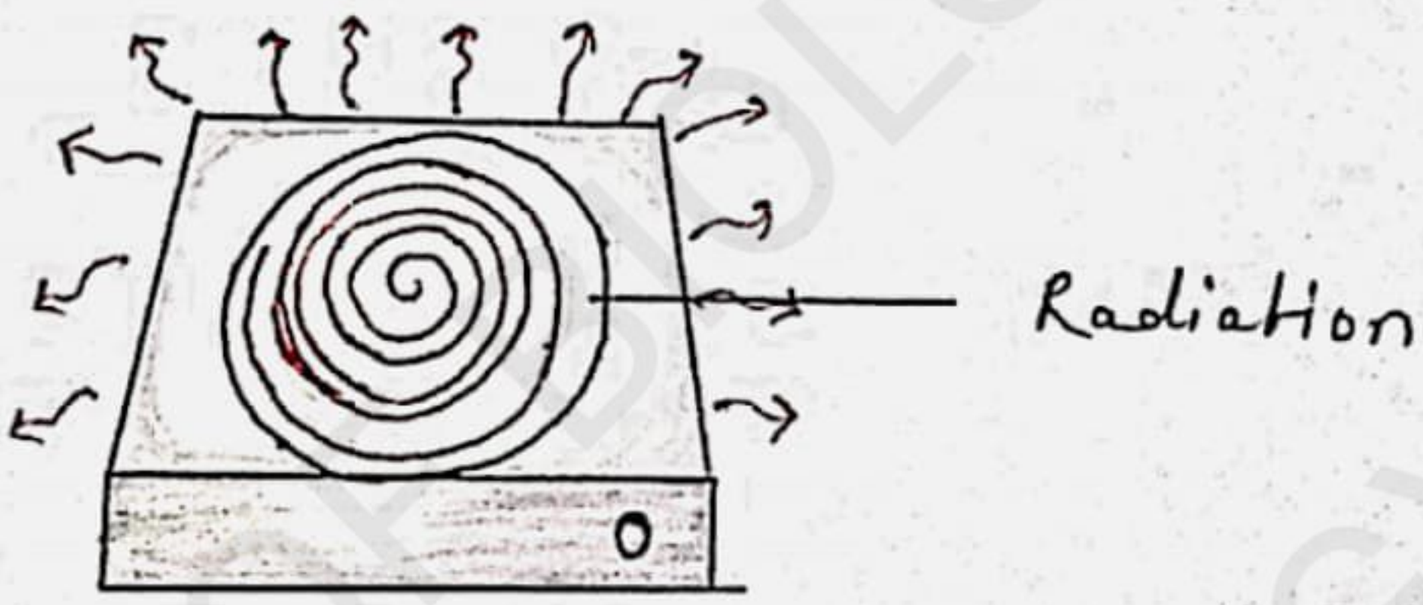
- Applications :—

(1) Evaporation :— Process in which liquid transform into gas through heat.

(2) Distillation :— Separation of components of a mixture based on a different boiling points.

[DEPTH OF BIOLOGY]


Convection
Conduction


Radiation

③ Drying :- Removal of water / solvent by evaporation from solid or semisolid.

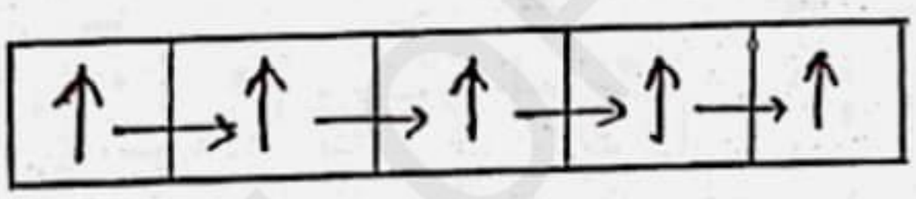
[DEPTH OF BIOLOGY]

④ Sterilization :- Used to eliminate / kill bacteria, micro-organisms by using heat.

▶ Heat transfer Mechanism :-

① Conduction ⇒ In this process heat transfer in a solid in series.

↳ Particles are directly connect with each other and heat transfers one by one.

Heat → 

↳ Particles must be stationary.

↳ Heat transfer temperature gradient.

↳ Transfer of heat from high to low temperature.

[DEPTH OF BIOLOGY]

② Convection :- Transfer of heat through the movement of liquid.

↳ Initial position's particle absorb heat and displace with final position's particle.

[DEPTH OF BIOLOGY]

③ Radiation :- Transfer of heat without medium.

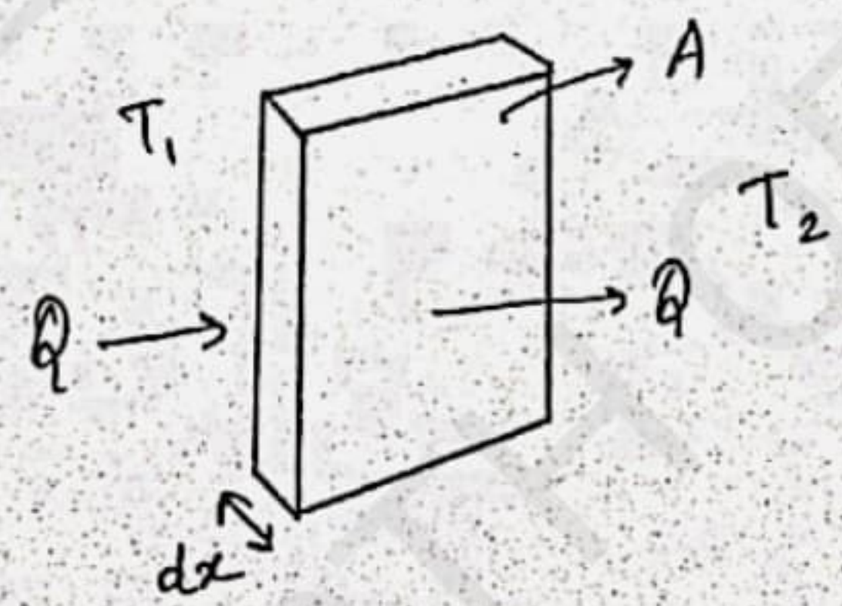
↳ Electromagnetic waves

eg:- Heat of sun to water for vapourisation.

Fourier's Law

- According to this law -

The rate of heat flow through a uniform material is proportional to the area perpendicular to the heat flow, the temperature drop and inversely proportional to the length of the path of flow.



[DEPTH OF BIOLOGY]

Temperature gradient → Difference of temperature from one place to another. (dT)

[DEPTH OF BIOLOGY]

According to this law,

$$Q \propto A$$

$$Q \propto dT$$

$$Q \propto \frac{1}{dx}$$

$$\therefore Q \propto \frac{A \cdot dT}{dx}$$

$$\boxed{Q = -\frac{KA \cdot dT}{dx}}$$

Where,

Q = Rate of change of heat transfer

A = Area of wall

dT = change in temperature

dx = thickness of wall

-K = Constant

[DEPTH OF BIOLOGY]

↳ Negative sign indicates drop in temperature.

Heat transfer by :—

① Conduction ⇒

↳ Transfer of heat through a solid material.

Also, through stationary fluid.

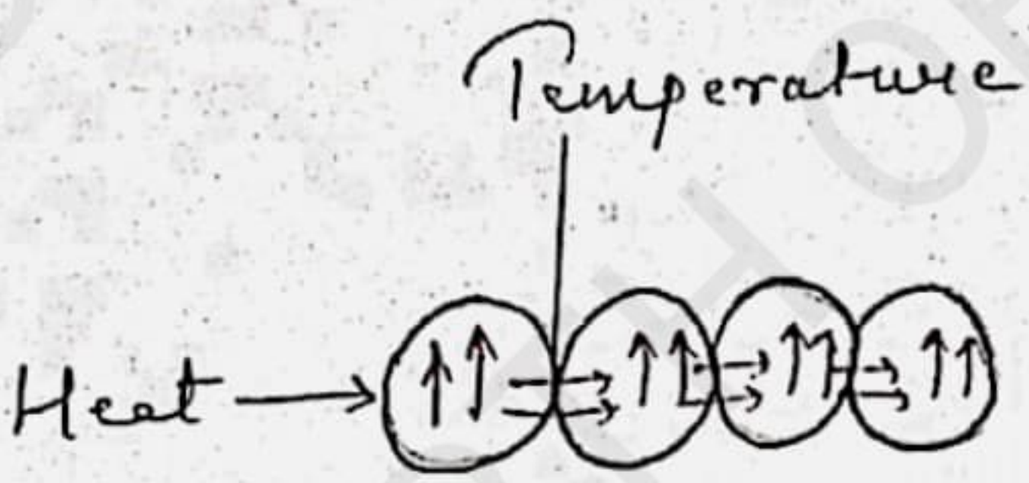
[DEPTH OF BIOLOGY]

↳ Depends upon temperature, since heat transfer from high to low temperature.

↳ On providing heat at one end of substance particles of that end vibrate vigorously and collide with neighbouring particles & transfer energy.

[DEPTH OF BIOLOGY]

- Untill the last end particles should absorb heat this process should be continuous.



[DEPTH OF BIOLOGY]

- Driving force = Responsible for heat transfer.

- Resistance = Resist heat in heat transfer.

$$\text{Rate of heat transfer} = \frac{\text{Driving force}}{\text{Resistance}}$$

[DEPTH OF BIOLOGY]

② Convection ⇒ The way of heat transfer occurs mostly in liquids and gases.

↳ Heat transfer takes place with the actual motion of matter within the body from one place to other.

↳ On boiling water one can see bubbles and development of water current on observing carefully.

[DEPTH OF BIOLOGY]

↳ So this hot water at bottom become lighter and moves upwards, the cold and denser water gets forced at

the top to come down and therefore heated up. [DEPTH OF BIOLOGY]

② Radiation :-

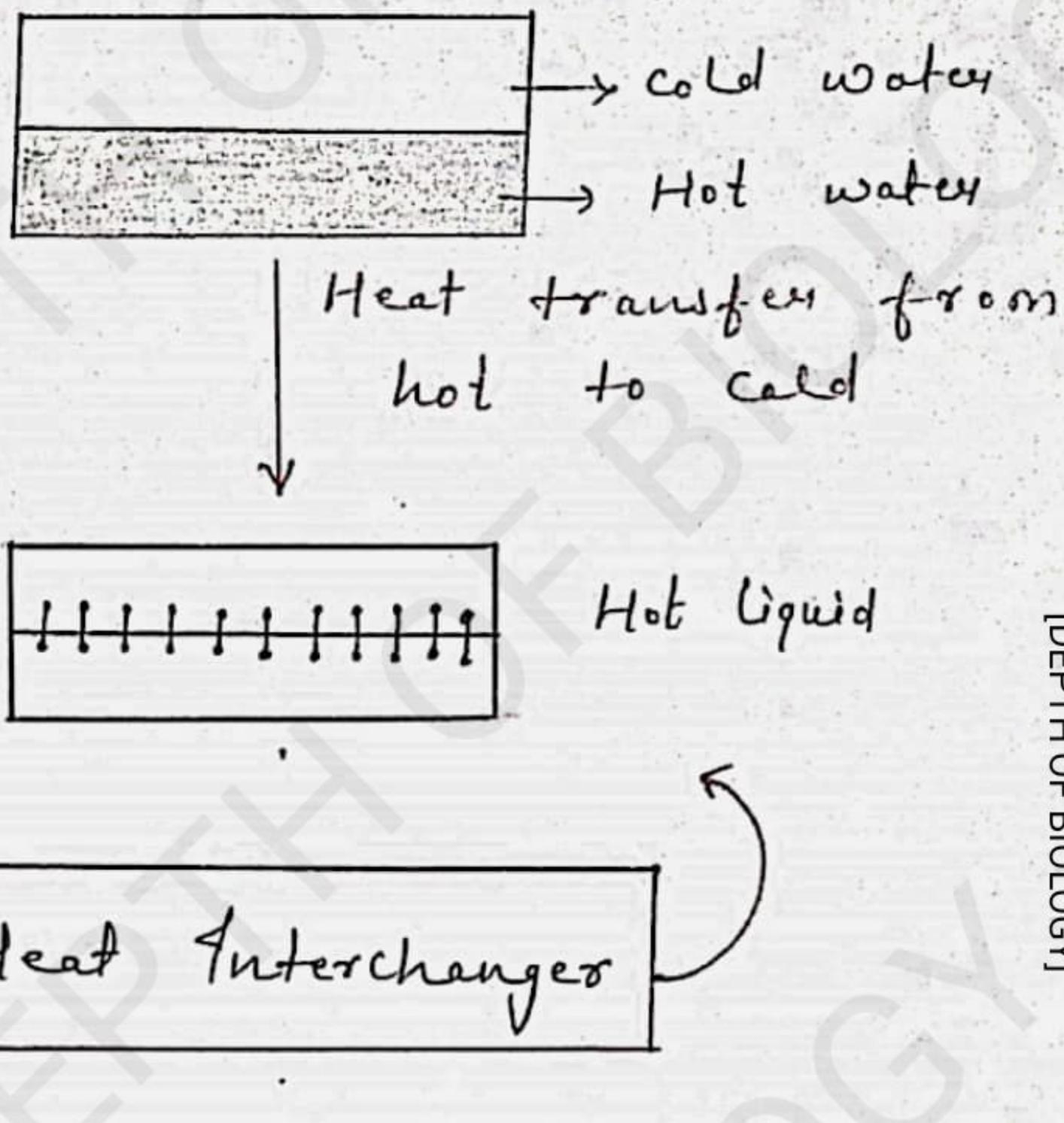
↳ Doesn't require any medium.

↳ Used for heat transfer in vacuum as well.

↳ Uses electromagnetic waves to transfer heat from one place to other.

↳ In our Solar System the heat and light from the Sun in our planet reach through radiation only.

eg:- On sitting near fire one can feel warm without touching fire, this is an example of radiation.



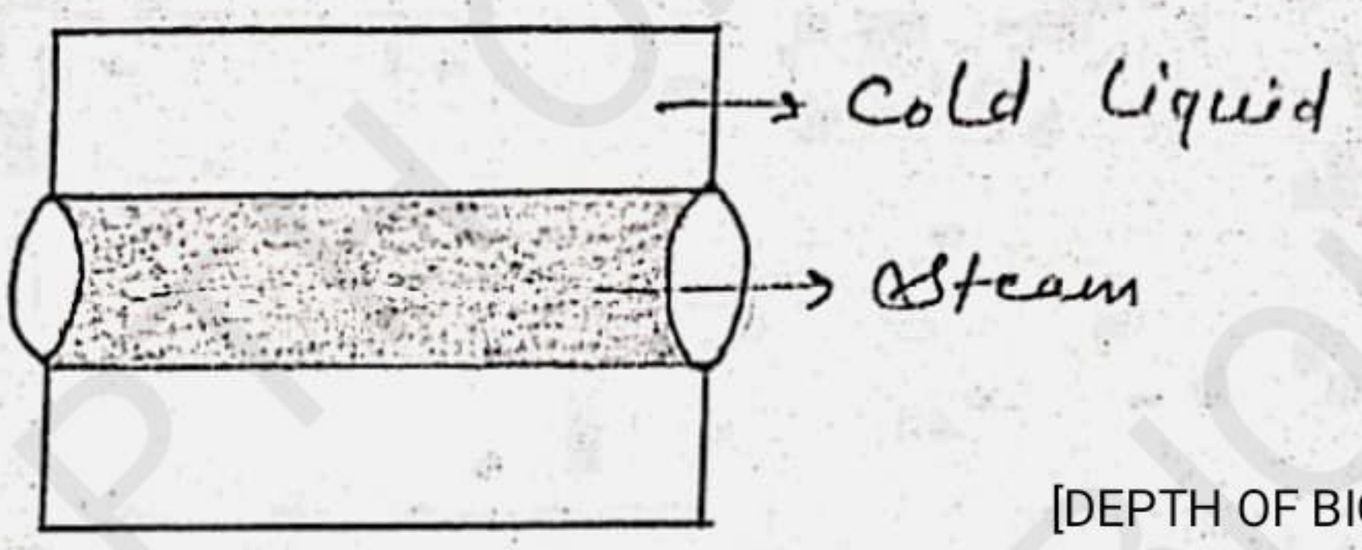
[DEPTH OF BIOLOGY]

- Devices used for transferring heat from one liquid to another liquid or for gas through any medium (metal walls).

Heat Exchangers

- Devices used to transfer heat between two or more fluids.
- Used in both heating and cooling process.

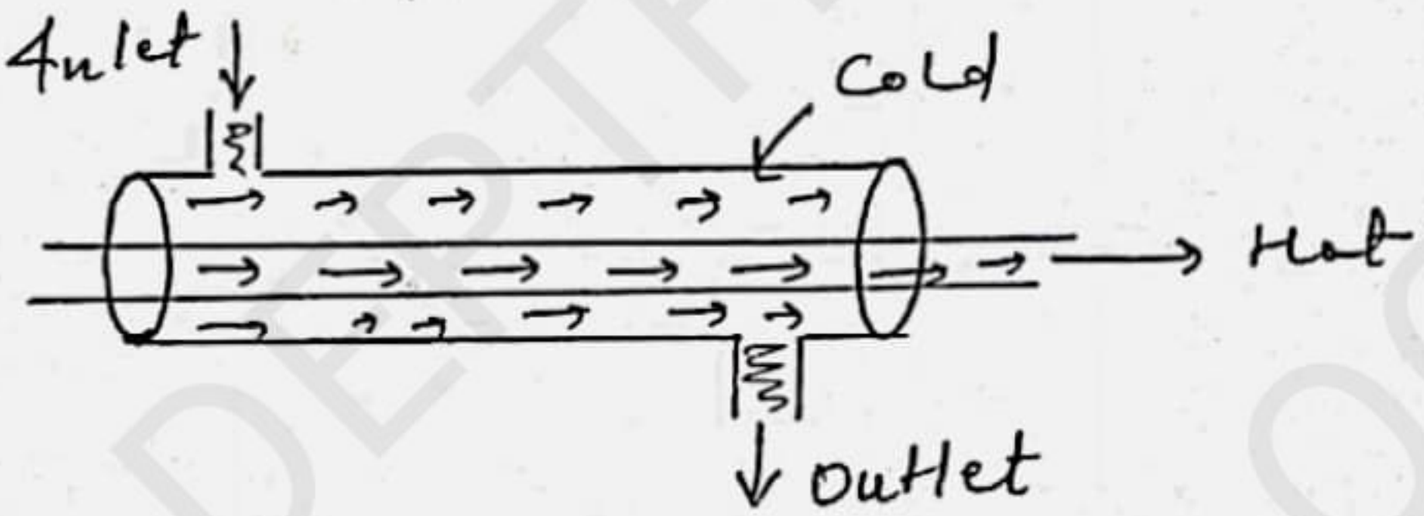
[DEPTH OF BIOLOGY]



[DEPTH OF BIOLOGY]

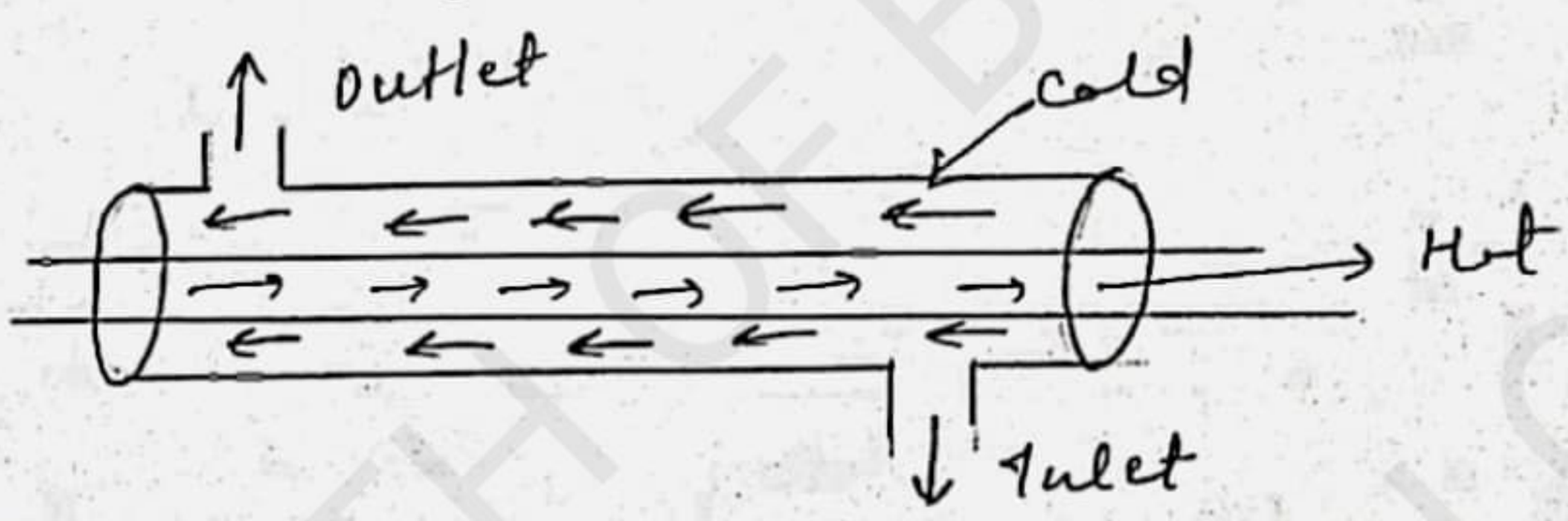
Types —

① Parallel flow :— Hot Steam and cold liquid's direction is same



② Counter flow :—

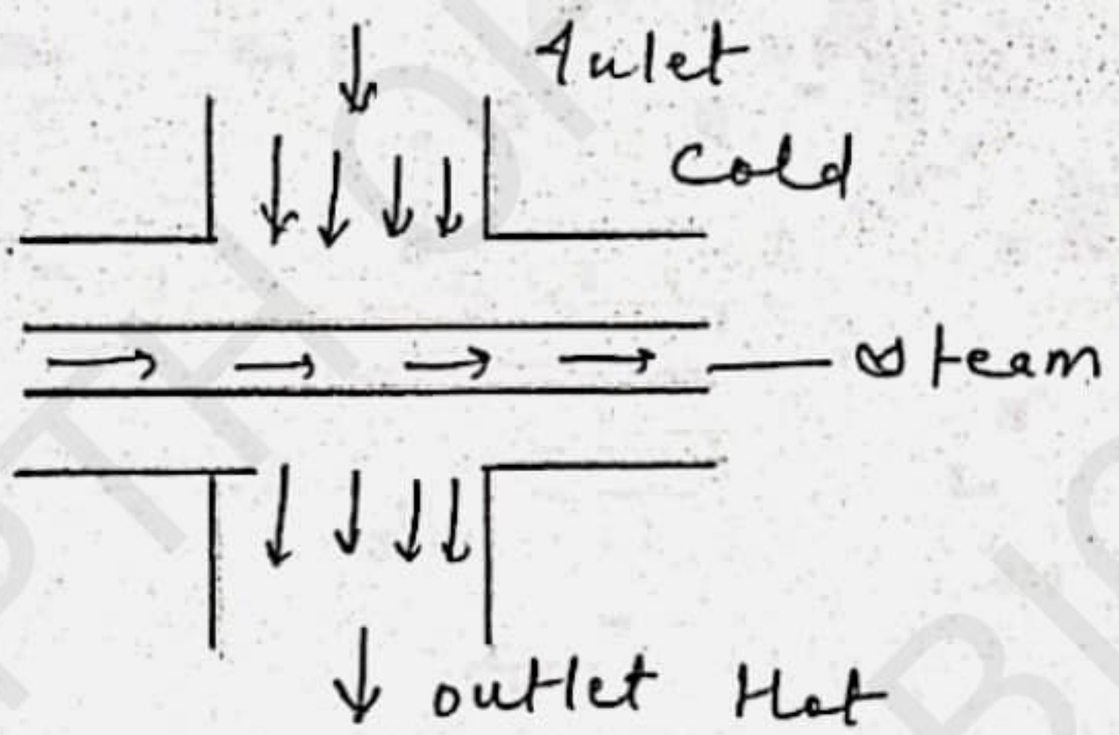
- Direction of flow is opposite.



③ Cross flow :—

- Direction of flow is perpendicular.

[DEPTH OF BIOLOGY]

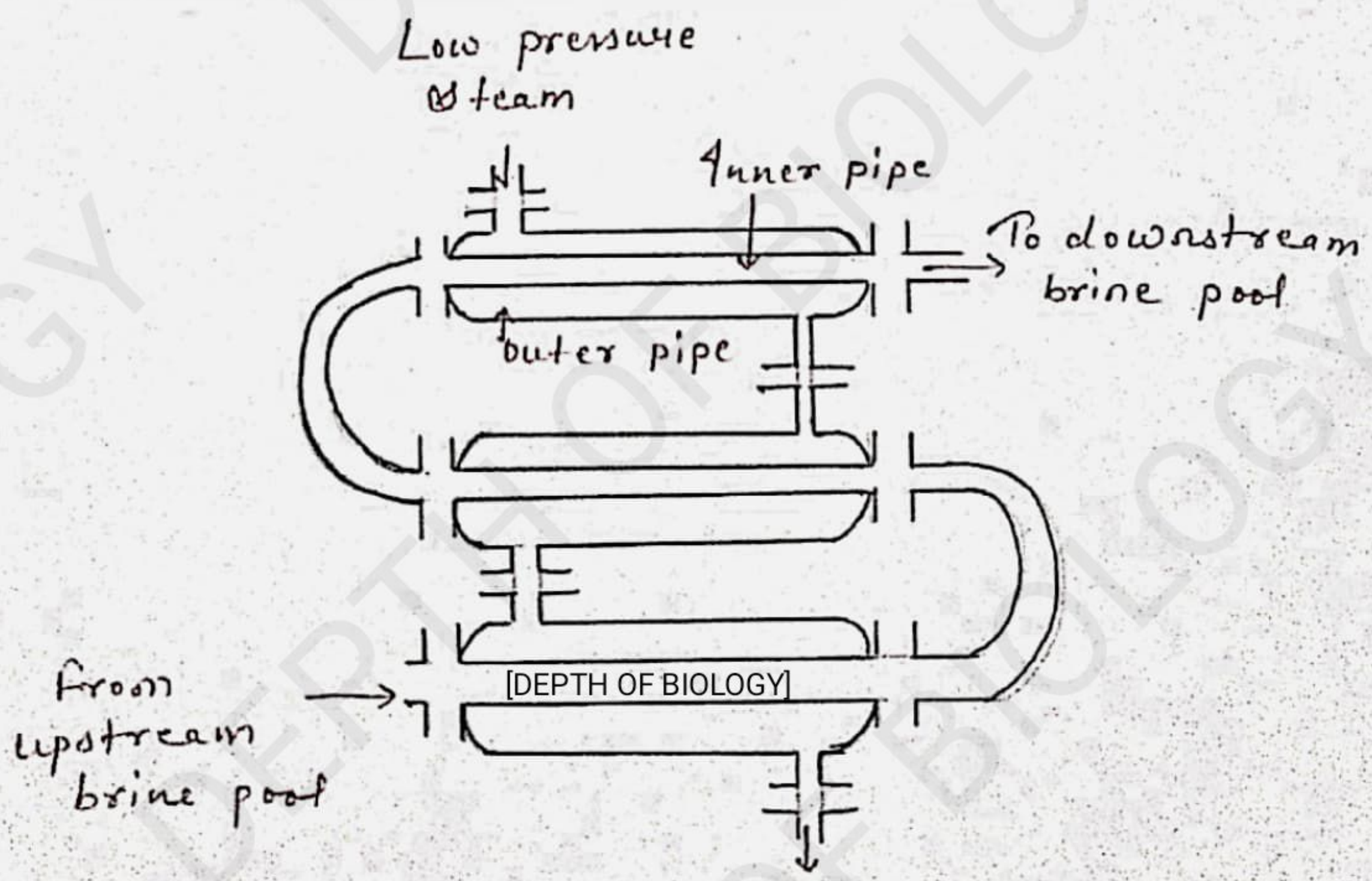


[DEPTH OF BIOLOGY]

Exchangers Example :-

① Double Pipe Heat Exchanger:-

— Consists of two pipe
↳ one is fit inside the other pipe.



[DEPTH OF BIOLOGY]

↳ Hot steam is passed inside tube and the fluid that we want to get hot pass on outside of the pipe.

↳ Hot liquid pass out from outlet after heating.

[DEPTH OF BIOLOGY]

↳ These exchangers are simple and easy to use, therefore, are used in industries.

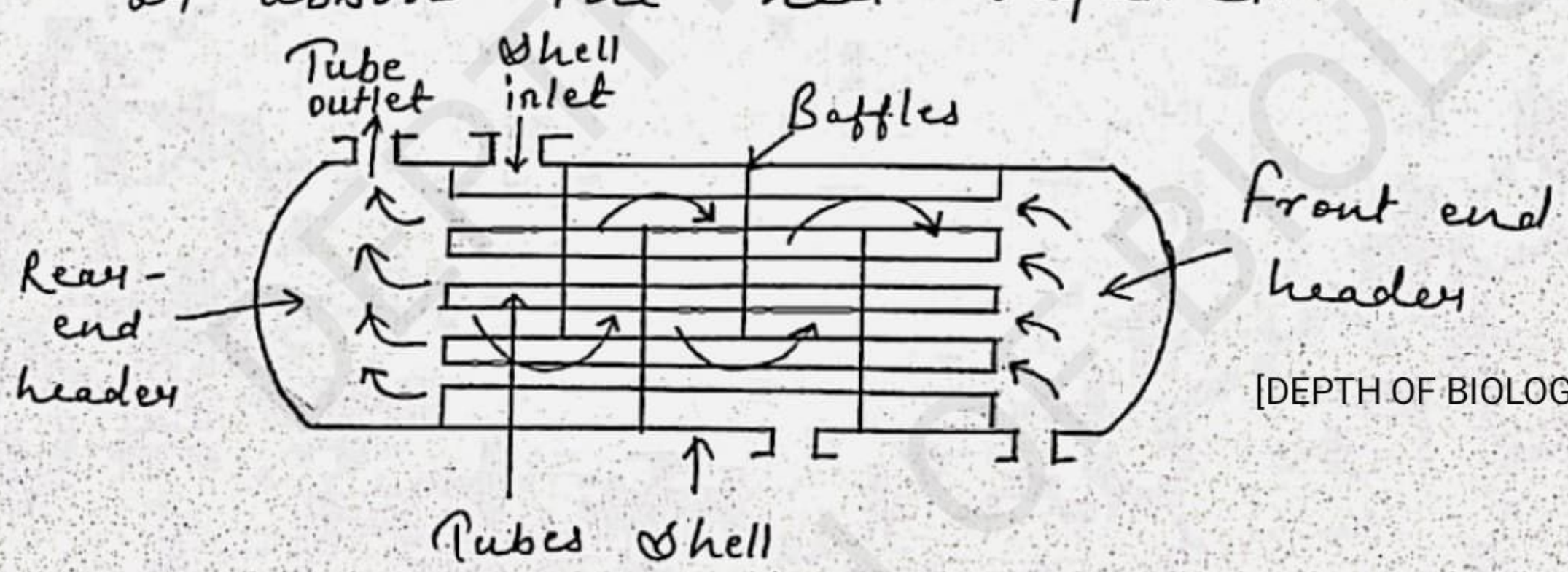
↳ Cheap for both design and maintenance.

② Shell and tube exchangers :-

- Consists of a series of tubes containing fluids that must either heated or cooled.

- Another fluid runs over the tubes that are being heated or cooled.

- So it can either provide the heat or absorb the heat required.



[DEPTH OF BIOLOGY]

↳ Tube bundles - A set of tubes.

[DEPTH OF BIOLOGY]

↳ Baffles hold tubes in position

↳ First of all steam is passed from inlet and out by passing tube bundles.

↳ That fluid should be entered which we want to heat from upside and the fluids pass externally to tube bundles and release heat.

[DEPTH OF BIOLOGY]

↳ Heat gets absorbed by the cold fluid and pass out from outlet at downside.

↳ Used for high pressure applications.

Baffles :-

[DEPTH OF BIOLOGY]

- Creates turbulance in flow of heat that prevents resistance or decrease resistance in heat transfer.