BT1010

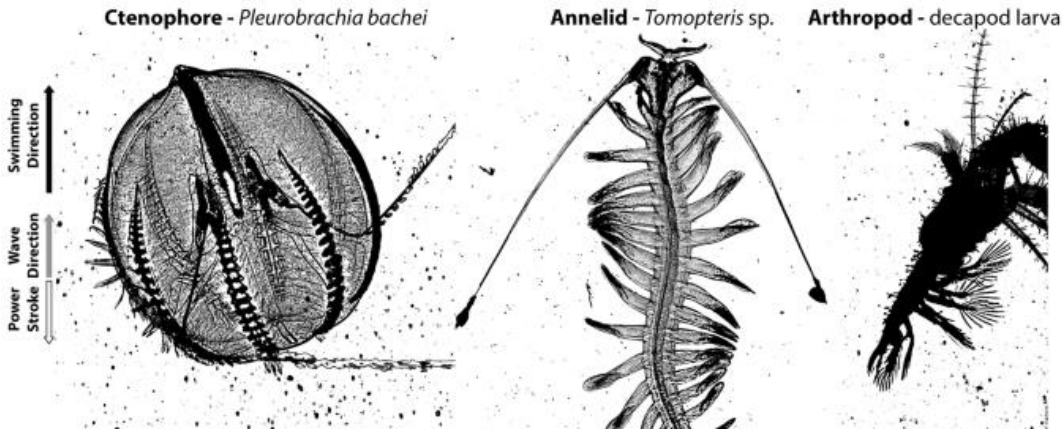
ASSIGNMENT–1 : 2nd QUESTION

Explain the fluid dynamic of **metachronal wave** to generate thrust?

Most of the swimming animals use a common swimming strategy operated by multiple propulsors coordinated as metachronal waves. Antiplectic metachronal waves generate swimming thrust, they are present on propulsors like limbs, fin, ctenes. The force generated by the propulsors of these metachronal swimmers depends upon generating negative pressure along their surfaces and help to generate forward thrust (suction thrust).

- **Suction Thrust:**

The hydrodynamics around a moving propulsor generate a pressure field along the propulsor surface. The pressure gradient across the propulsor is the ultimate source of thrust necessary for swimming. Marine animals which move using metachronal wave generate thrust which is called as **Suction thrust.** It is the negative pressure fields aligned along the leeward side of moving propulsors that dominates the pressure field and serve to essentially pull animals through the water.

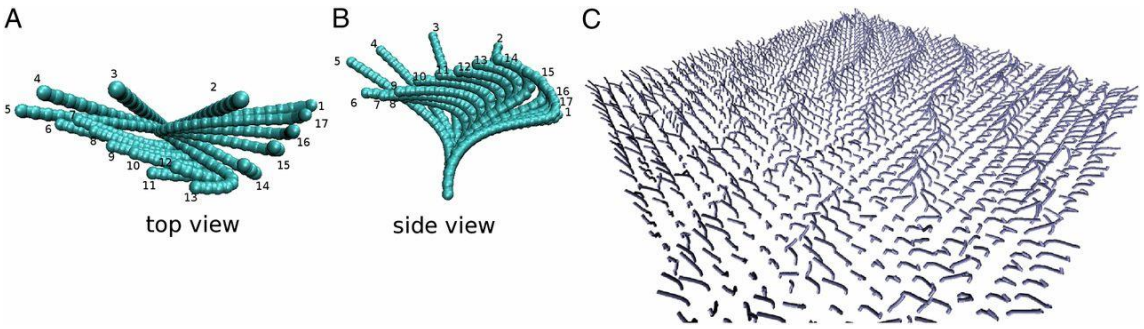


- **Antiplectic Metachronal waves movement**:

The coordination of multi-unit propulsors appears to be highly conserved as antiplectic metachronal waves among a diverse array of animals. In the entire stroke cycle metachronal swimming of multiple, closely spaced flat plate paddles about the horizontal plane generate some counter-signed vortices. These vortex interactions in metachronal paddling resulted in the thrust force by small-scale jets between paddles that coalesce to form large-scale downward jets. Decreasing the force diminishes the downward propagation of the jets away from the paddles. This phenomenon of metachronal wave swimming is capable of generating downward momentum needed for negatively buoyant crustaceans to maintain their position in the water column during hovering and fast forward swimming.

➢ Metachronal wave in cilia:

Cilia are hair-like organelles in which motile cilia moves with a metachronal wave and helps in the motion of metachronal swimmer. The beat of the cilia is non planar, involves a sideways movement in the recovery stroke. There is a clockwise rotation in the recovery stroke, the lateral inclination of the cilia in the recovery stroke is in the same direction as the propagation of the waves, and the orientation of cilia in the recovery stroke is thought to determine whether the waves move to the left or right of the direction of the effective stroke. Thus, this motion of cilia generates a pressure gradient across them aiding the metachronal waves and swimming.



➢ Conclusion:

The propulsors contain tiny organelles which uses these metachronal waves and maintain a metachronal rhythm this helps them to create a pressure gradient (negative pressure) and thus they are able to generate a forward thrust and these structures surface is so tiny that water drag effect is minimized by them and helps to move freely even under turbulence.