

# Microscopic Swimmers

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## ABSTRACT

In this study flagella and Cilia movements and their function for the cell are investigated. The locomotion of bacterial or eukaryotic cells that use natural flagella to move in a liquid is studied experimentally and theoretically. For sampling, we used two areas with natural ponds in Tehran and Mashhad, named Jajroud River in Tehran and Golestan Dam in Mashhad. The samples were immediately transferred to the laboratory for analyzing.

**Keywords :** Flagella, Cilia, Bacterial, Eukaryotic Cells

## ARTICLE INFO

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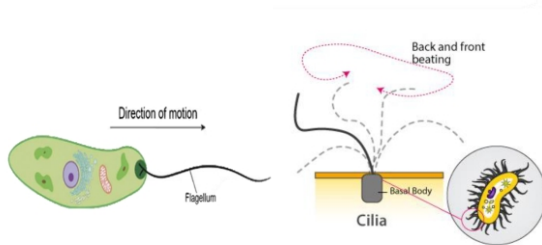
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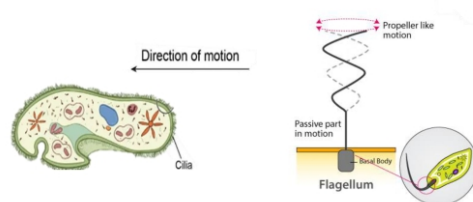
## 1. Introduction

What is flagella ? It is a hair-like organ in microorganisms and which creates the ability of movement and chemotaxis for the cell which has a wave-like movement in one direction (Fig. 1).



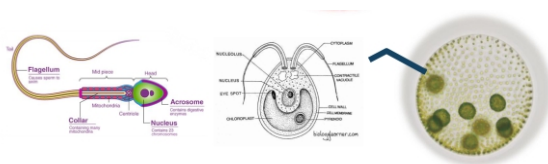
**Fig. 1:** Flagella and its movement

What is cilia and what is the difference between flagella and cilia? Its function for the cell is like a sensor which has a forward and backward movement (Fig. 2).



**Fig. 2:** Cilia and its movement

In eukaryotic cells we can find flagella like male gametes in animals, male gametes in early plants and some protozoa and algae (Fig. 3).



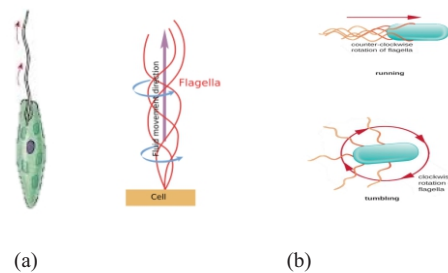
**Fig. 3:** Flagella in eukaryotic cells



**Fig. 4:** Flagella in prokaryotic cells

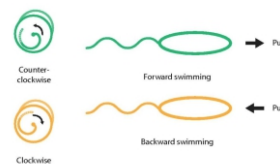
There are different types of movement in cells, whip and rotational.

Eukaryotes: The flagella has whip movement (Fig. 5a)  
 Prokaryotes: The movement of the flagellum is rotational and this rotation can be clockwise and counter clockwise (Fig. 5b).



**Fig. 5:** a) The flagella whip movement; b) The rotational movement of the flagellum

When rotation of flagella is clockwise it pulls the microorganism and has a backward movement and for counterclockwise rotation it pushes microorganism and has a forward motion (Fig. 6).



**Fig. 6:** clockwise and counterclockwise rotation

Prokaryotic cells bacteria have flagella (Fig. 4).

## 2. Experiments

In our experiments for sampling, we used two areas with natural ponds in Tehran and Mashhad, named Jajroud River in Tehran and Golestan Dam in Mashhad.

For this purpose, sterile glass containers were used and after collecting the samples, the samples were immediately transferred to the laboratory.

Microscopic studies are needed to detect all types of microorganisms (bacteria, protozoa and algae). Some of these microorganisms require their own staining methods for better identification under the microscope.

After staining the target microorganisms, the prepared slides are examined under the microscope with different magnifications. Also, some microorganisms can be identified completely without staining under the microscope (Fig. 7).



Fig. 7: Staining and studying the samples under the microscope

For paramecium staining, first we poured the sample on the slide and then Janus green, Methylene blue and neutral red colors are used for staining. In this staining, pulsating vacuoles and food vacuoles are seen in red and cilia in light blue.

In the microscopic study of the samples, several characteristics were investigated: the movement of bacteria, the possible presence of protozoa and stained paramecium slides. Also we did this experiment with raw milk and found bacteria that are swimming in the raw milk (Fig. 8).

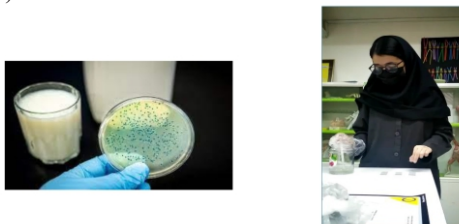


Fig. 8: Bacteria are swimming in the raw milk

Three sample were taken from jajroud river : surface ,middle and bottom of the river. We know that microorganisms use cilia, flagella and Pseudopod to swim in the liquid and you can see Paramecium Cillia and bactria using flagella , sperm using flagella and Pseudopod Amoeba (Fig. 9).

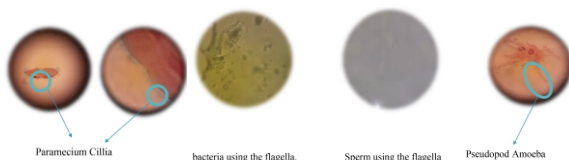


Fig. 9: Swimming of microorganisms in liquids

We used tracker to track The movement of one of the bacteria and the results showed the speed of bacteria is unstable and when it has purposeful movement we can see swimming and tumbling (Fig. 10).

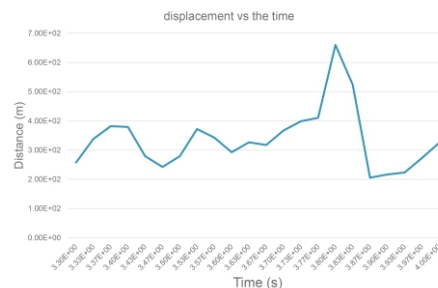
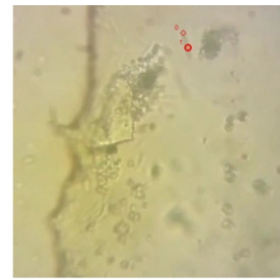


Fig. 10: Tracking the movement of one of the bacteria

### 3. Results and Conclusion

Based on our tests and experiments the bacteria have two kinds of movement (Fig 11).

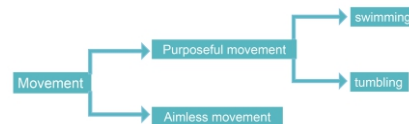


Fig. 11: Movement of bacteria

Also a wide range of microorganisms (prokaryotes and eukaryotes) have flagella. These creatures can swim using flagella because of their living conditions in water and humid environments.

A large number of microorganisms without flagella are able to move and swim using other structures.

### References

- [1] Bacterial Flagella Stain Protocol by Jay Mellies , 08 September 2008
- [2] The surprisingly diverse ways that prokaryote move by Ken F. Jarrell\*and Mark J. McBride / June 2008
- [3] Tracking the Movement of a Single Prokaryotic Cell in Extreme Environmental Conditions
- [4] The surprisingly diverse ways that prokaryotes move7
- [5] <https://www.britannica.com/science/cilium>