

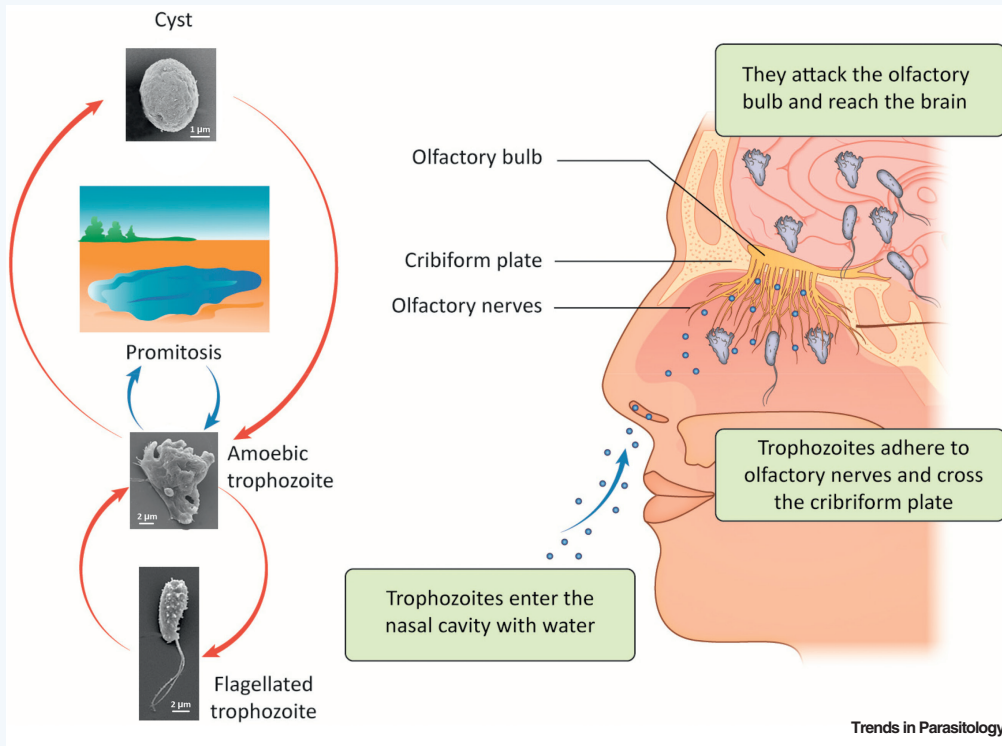
Naegleria fowleri

Jose E. Piñero,^{1,*} Bibiana Chávez-Munguía,² Maritza Omaña-Molina,³ and Jacob Lorenzo-Morales^{1,*}

¹Instituto Universitario de Enfermedades Tropicales y Salud Pública de Canarias, Departamento de Obstetricia, Ginecología, Pediatría, Medicina Preventiva y Salud Pública, Toxicología, Medicina Legal y Forense y Parasitología, Universidad de La Laguna, La Laguna, Tenerife, Spain

²Departamento de Infectómica y Patogénesis Molecular, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (Cinvestav), Ciudad de México, Mexico

³UNAM FES Iztacala Carrera de Medicina Los Reyes Iztacala, Tlalneapantla, Estado de México



KEY FACTS:

N. fowleri has been isolated from both soils and different types of water bodies, such as swimming pools, thermal waters, tap water, and lakes.

N. fowleri can cause an aggressive infection of the human central nervous system (CNS), which is called primary amoebic meningoencephalitis (PAM).

Most reported cases of PAM patients present a history of contact with *N. fowleri*-contaminated water bodies in the week prior to the appearance of the first symptoms.

DISEASE FACTS:

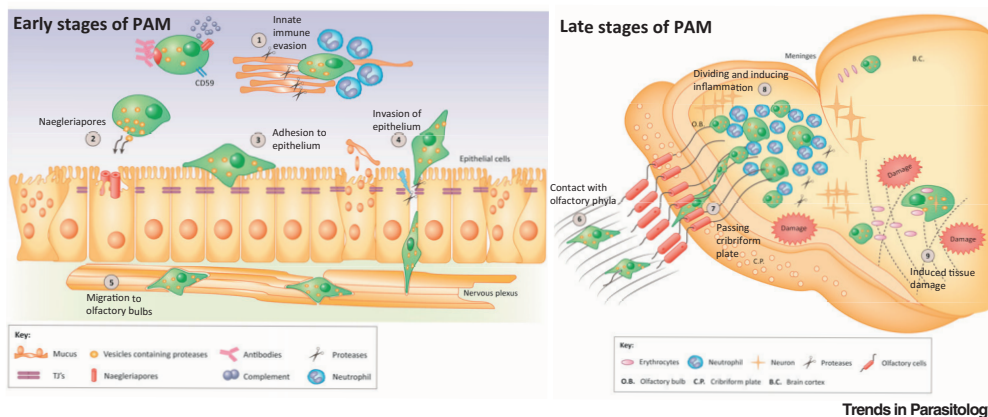
N. fowleri penetrates through the nasal passage, where it adheres to the olfactory nerves and makes its way to the brain through the cribriform plate.

The amoeba attacks the olfactory bulb, producing an inflammatory process and leading to brain infection, which is fatal in more than 97% of cases.

Naegleria fowleri, also known as the ‘brain-eating amoeba’, is a free-living amoeba capable of living in the environment, especially in bodies of warm water. Three distinct life stages exist: amoeboid trophozoite, flagellated trophozoite, and cyst. In the amoeboid trophozoite phase cell division occurs by mitosis. The sizes of the trophozoite forms range from 15 to 25 µm. Like most protists, the trophozoites form cysts under unfavorable conditions. The cysts measure between 7 and 10 µm and are covered by a thin double wall with one or two pores. It is possible that all three phases of *N. fowleri* reach or invade the human nasal mucosa, but only the trophozoite amoeboid form has been isolated in cerebrospinal fluid or tissue. It is feasible that, upon reaching the nasal area, the cyst quickly becomes a trophozoite and forms flagella before it invades the nasal and olfactory nerve tissue. Infection occurs when individuals swim or dive in *Naegleria*-contaminated warm freshwater bodies such as lakes or rivers.

Clinical symptoms are characterized by the sudden onset of bifrontal or bitemporal headache, high fever, stiff neck, followed by nausea, vomiting, and irritability. In advanced stages of the infection, photophobia and neurological alterations are observed, such as lethargy, seizures, confusion, coma, diplopia, or strange behavior, which leads to death within a week.

The treatment is based on the use of amphotericin B in combination with other drugs such as rifampin, fluconazole, azithromycin, miltefosine, and dexamethasone.



TAXONOMY AND CLASSIFICATION:

- PHYLUM:** Percolozoa
- CLASS:** Heterolobosea
- ORDER:** Schizopyrenida
- FAMILY:** Vahlkampfiidae
- GENUS:** *Naegleria*
- SPECIES:** *N. fowleri*

*Correspondence:

jpintero@ull.edu.es (J.E. Piñero) and jmlorenzo@ull.edu.es (J. Lorenzo-Morales).



Acknowledgments

This work was supported by grant PI18/01380 of Instituto de Salud Carlos III and FEDER. The figure showing the early and late stages of PAM was adapted from Martínez-Castillo *et al.*, *J. Med. Microbiol.*, 2016 (Literature No. 4) with permission.

Resources

www.cdc.gov/dpdx/freelivingamebic/
www.cdc.gov/parasites/naegleria/general.html
www.jordansmelskifoundation.org/

Literature

1. Bellini, N.K. *et al.* (2018) The therapeutic strategies against *Naegleria fowleri*. *Exp. Parasitol.* 187, 1–11
2. Cooper, A.M. *et al.* (2019) Killer amoebas: Primary amoebic meningoencephalitis in a changing climate. *JAAPA* 32, 30–35
3. Garcia, D.S. *et al.* (2018) Outbreaks associated with untreated recreational water – United States, 2000–2014. *Morbil. Mortal. Wkly Rep.* 67, 701–706
4. Martínez-Castillo, M. *et al.* (2016) *Naegleria fowleri* after 50 years: is it a neglected pathogen? *J. Med. Microbiol.* 65, 885–896
5. Marciano-Cabral, F. (1988) Biology of *Naegleria* spp. *Microbiol. Rev.* 52, 114–133
6. Siddiqui, R. *et al.* (2016) Biology and pathogenesis of *Naegleria fowleri*. *Acta Trop.* 164, 375–394
7. Visvesvara, G.S. (2010) Free-living amebae as opportunistic agents of human disease. *J. Neuroparasitol.* 1, N100802