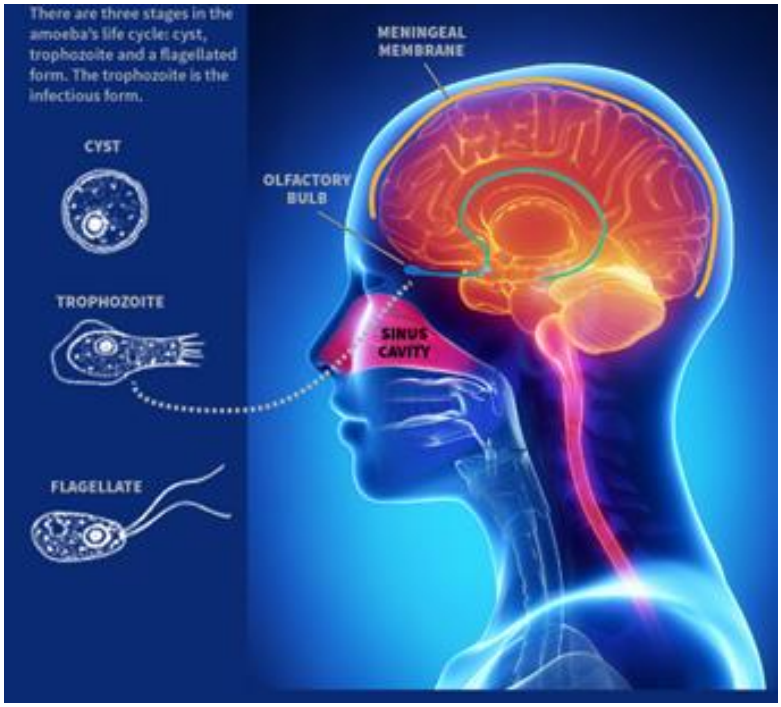
Brain Eating Amoeba

Naegleria fowleri

Brain Eating Amoeba is a single-celled organism from the species of Naegleria. The Naegleria fowleri is known to cause human disease. They belong to a group of Heterolobosea. The amoeba is known to travel up the nose and into the brain, causing the disease called primary amebic meningoencephalitis, or **PAM.**



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History

It was first identified in Australia in 1965 .These amoeba-flagellates were identified by two physicians M. Fowler and R. F. Carter whose work provided an example of how protozoa can freely live in the environment and human host.

Pathogenisis

This organism causes primary amoebic meningoencephalitis, a fatal disease of the central nervous system.

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Invasion of the central nervous system by N. fowleri starts when it enters the nose of the human host, entering through the olfactory mucosa and cribriform palate of the nasal tissue.
Hemorrhaging and necrosis of the olfactory bulbs occurs during the initial penetration of the amoeba.

N. fowleri gets attracted on the chemicals of the nerve cells that are used for communication. The *amoeba* feeds,"EATS" on the brain tissues and slowly destroys it. The amoeba takes on a protective coat for protection against the immune system of the body.
The organism "**eats"** the brain cells slowly through the distinctive sucking structure from their cell surface.

Prevalence:

There are several types of N. fowleri, which can be distinguished based on the length of the internal transcribed spacer 1 and a one bp transition in the 5.8S rDNA.
Seven of the eight known types have been detected in Europe. Three types are present in the USA. Only one of the eight types occurs in Oceania (Australia and New Zealand) and Japan. In mainland Asia (India, China and Thailand) the two most common types are found, which are also present in Europe and the USA.

The risk of this organism entering the brain is potential higher in people who dive, water ski and perform other water sports, that may force the water into the nose of an individual. Dipping one's head under warm water bodies may place the individual at risk.

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Symptoms

The onset of symptoms manifest usually two to fifteen days after invasion.

The symptoms are similar to that of meningitis. Infection from N. fowleril is fatal and death occurs within 3 to 7 days after onset of symptoms.

The initial symptoms of primary amoebic meningoencephalitis include:

- Distortion in taste
- Change in sense of smell
- Headache
- Fever
- Nausea and vomiting
- Stiff neck

Secondary symptoms of primary amoebic meningoencephalitis include:

- Ataxia or loss of muscle movement coordination
- Confusion
- Hallucination
- Seizure

Primary amoebic meningoencephalitis is a rare illness. The mortality rate of people infected is extremely high.

Habitat

Naegleria fowleri is found warm, stagnant water such as freshwater lakes, ponds and rivers. It can also be found in wells or in places with minimal chlorination.

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http://cdn.isciencetimes.com/data/images/full/2013/08/16/4828-swimming-hole.jpg

They can survive in water as hot as 45 degrees Celsius.

They can also thrive in soil near warm water discharges of industrial plants where waste water is disposed.

http://mw2.google.com/mw-panoramio/photos/medium/55947311.jpg

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Naegleria fowleri

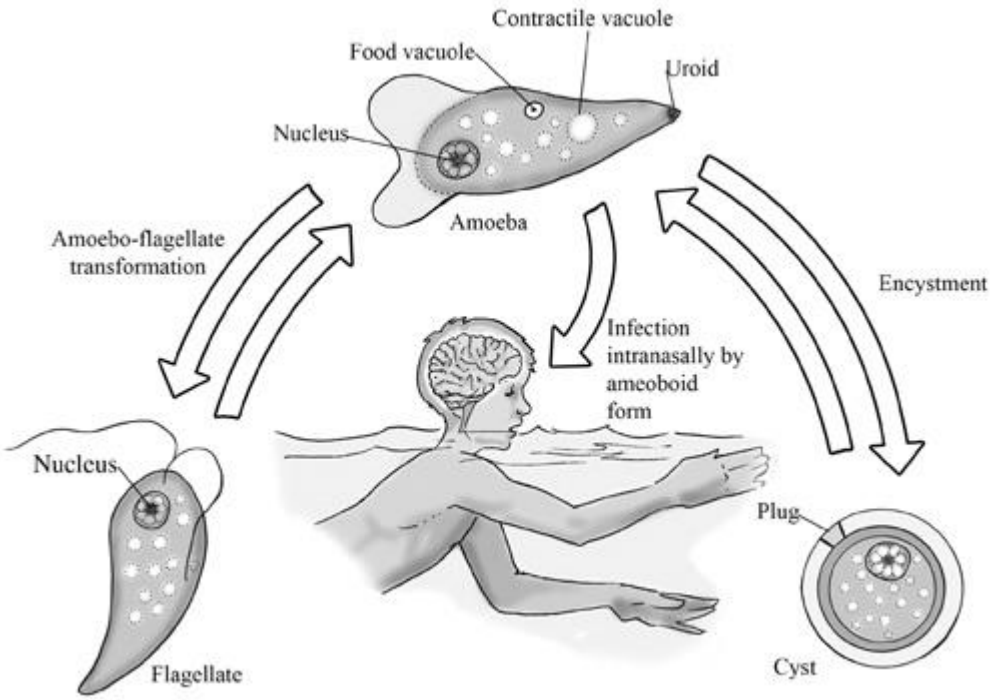
Life Cycle

The life cycle of *N. fowlerii* has three stages: During the **amoeboid** trophozite stage, this organism feeds on bacteria and replicates (binary fission). If there is a change in the ionic concentration of the water or nutrients are low, the trophozite can temporarily change into the **flagellate** form.

As soon conditions are restored it reverts to the trophozite stage.

When conditions are very unfavourable the trophozite will encyst forming a **cyst.**

In PAM, the amoeboid trophozite is found in the tissue and cerebral spinal fluid. Occasionally the flagellate form can be found in the cerebral spinal fluid.



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Brain Eating Amoeba Life cycle

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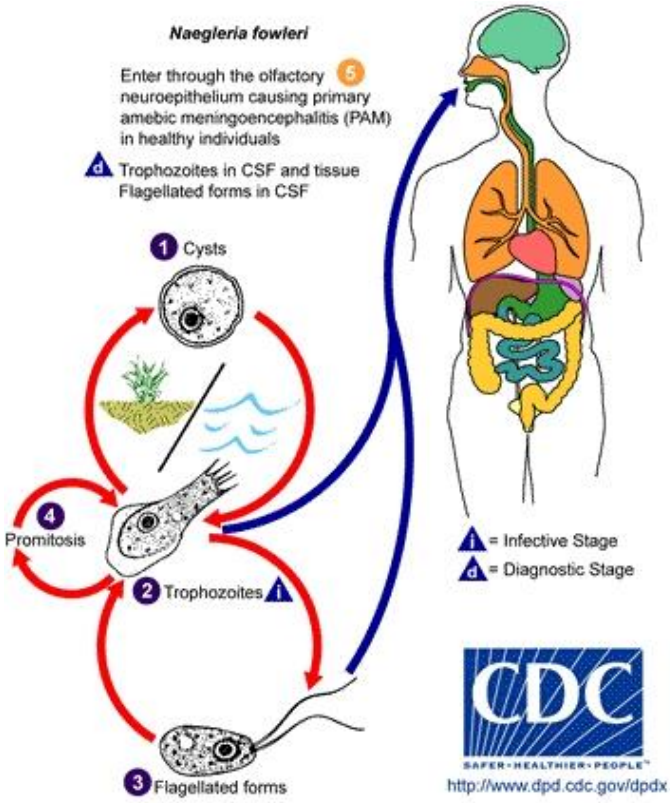
Naegleria fowleri



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Laboratory Diagnosis:

Detection of N. fowleri can be attained through collection of spinal fluid by doing spinal tap. The diagnosis is imperative as the infection is rapid. CSF studies show the following:

- Sanguinopurulent or bloody CSF, showing a nonspecific polymorphonuclear (PMN) neutrophil – predominant neutrophilia
- Increased opening pressure
- PMN pleocytosis
- Elevated RBC count or frank hemorrhagic CSF
- Normal-to-low CSF glucose level
- Elevated protein level

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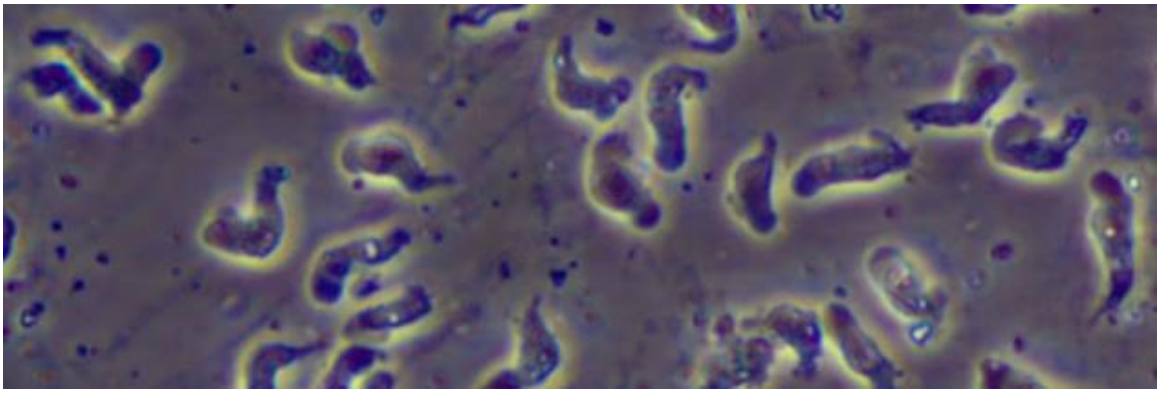
Direct wet-mount microscopy

The CSF is centrifuged at 150 xg for 5 minutes.

The supernatant is aspirated, and the sediment is suspended in the remaining fluid. A drop of sediment suspension is kept on a slide and mounted with a coverslip and is examined with compound light microscopy using 10X and 40X objectives. The specimen is best examined with phase contrast microscopy. This may show trophozoites with lobopodia extension and retraction.

The amebae are detected based on their active directional movements. Close observation is vital because PAM can be diagnosed based on the observation of trophozoites; however, these have been confused with WBCs in reported cases. Cyst are not found in CSF samples.



http://steamregister.com/wp-content/uploads/2015/07/071315-brain-eating-amoebas-630x210.jpg

A wet mount of Naegleria fowleri trophozoites cultured , viewed using phase contrast microscopy. Magnification: 600x.

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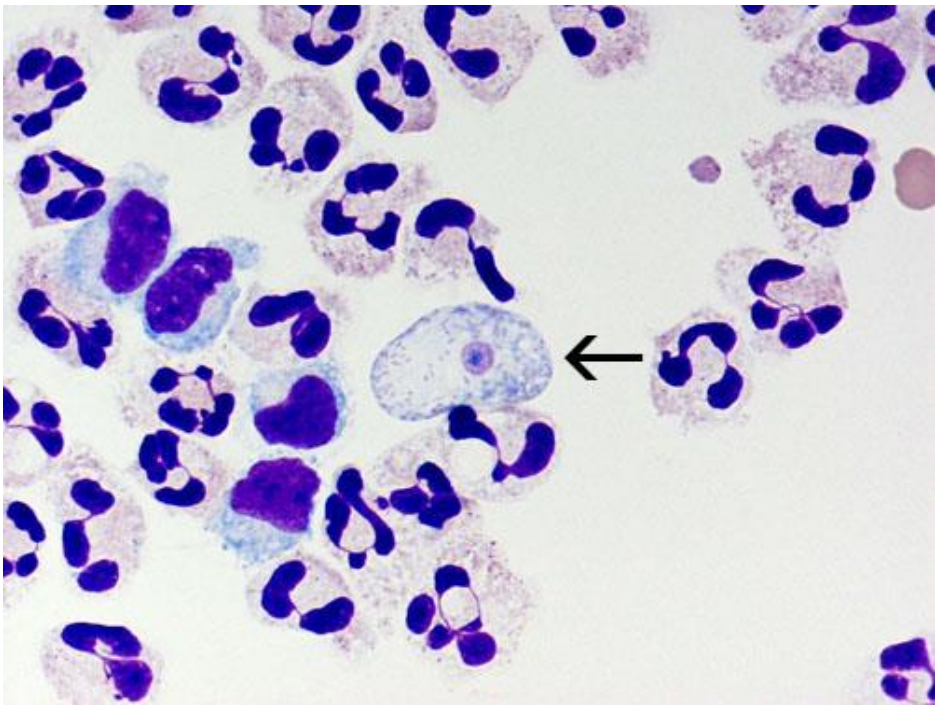
http://www.cdc.gov/parasites/images/naegleria/home_page_image_naegleria-vjf5-a.jpg

Examination of stained CSF smear

CSF Gram stain findings are usually negative. RBCs are present. Wright-Giemsa–stained CSF may show trophozoites with large karyosome and may show a contractile vacuole. Direct fluorescent antibody staining of CSF smears is useful for demonstrating *N fowleri* in the CSF.



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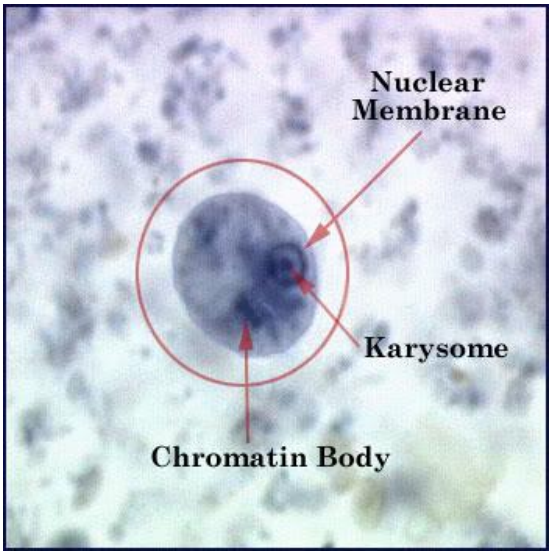

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Molecular diagnosis

PCR is available at research sites using numerous primers. Molecular classification of strains is useful in tracking infections to a source and in identifying potential risks for swimmers or bathers in particular locales. A species-specific DNA probe is available to identify *N fowleri* in environmental samples, followed by restriction fragment length polymorphism (RFLP) analyses of whole-cell DNA for confirmation.

Epidemiologic typing of *N fowleri* was used in an analysis of the 5.8S rRNA gene and the internal transcribed spacer (ITS) of clinical isolates.

Recently, flow cytometry has been used for the diagnosis of *N fowleri* infection.

A real-time PCR using hybridization fluorescent-labelled probes, targeting the *N fowleri* Mp2Cl5 gene sequence, has been developed.

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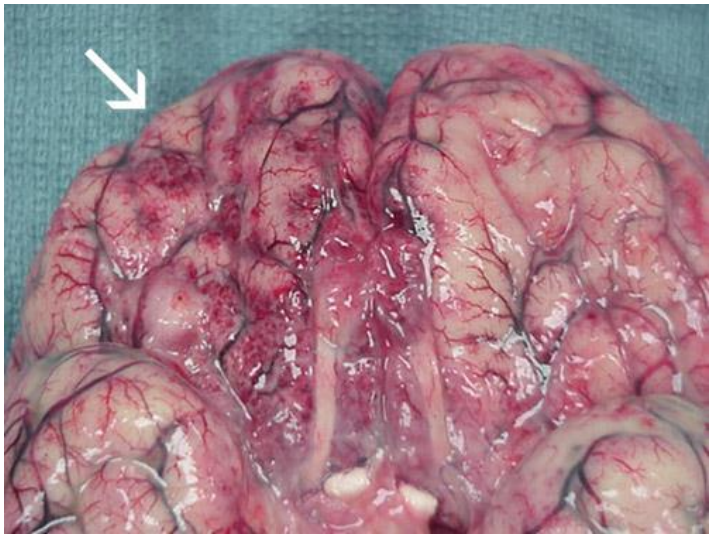
Histology

N fowleri infection produces lesions mainly in the base of the brain, brain stem, and cerebellum. The olfactory mucosa and bulbs are the most commonly affected areas. The lesions consist of an acute necrotizing meningoencephalitis associated with moderately purulent exudates.

Only trophozoites are found in the CNS lesions, not cysts. Both immunofluorescence and immunoperoxidase methods are useful for demonstrating *N fowleri* trophozoites in the histologic sections of the brain.



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Culture

N. fowleri can be grown in several kinds of axenic media or on non-nutrient agar plates coated with bacteria.

Escherichia coli can be used to overlay the non-nutrient agar plate and a drop of cerebrospinal fluid sediment is added to it.

Plates are then incubated at 37°C and checked daily for clearing of the agar in thin tracks, which indicate the trophozoites have fed on the bacteria.

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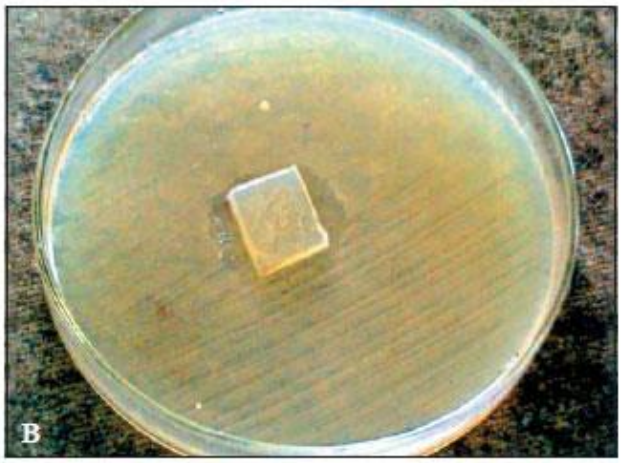

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Detection in water is performed by centrifuging a water sample with *E. coli* added, then applying the pellet to a non-nutrient agar plate. After several days, the plate is microscopically inspected and *Naegleria* cysts are identified by their morphology. Final confirmation of the species' identity can be performed by various molecular or biochemical methods.

Confirmation of *Naegleria* presence can be done by a so-called flagellation test, where the organism is exposed to a hypotonic environment (distilled water).

Pathogenicity can be further confirmed by exposure to high temperature (42°C): *Naegleria fowleri* is able to grow at this temperature.

Treatment

Survival rate is at 1% making the mortality rate of 99%.

An effective agent against N. fowleri is Amphotericin B which is an antifungal drug administered intravenously.

Drugs such as miltefosine, rifampin and voriconazole used in combination with Amphotericin B have actions against N. fowleri although the therapy is best administered on the early stage of infection.

Prevention

The only way one can prevent from harboring the fatal amoeba is by avoiding aspiration of fresh water in the nose. It can possibly be done by avoiding water sports activities or other activities involving use of water. Water in the pool must be properly chlorinated to eradicate amoeba. Activities near thermally polluted water must be avoided and untreated water must not be used in irrigating nor forced into the nose.

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