

**Institute for Microbiology, Medical Faculty of Masaryk University
and St. Anna Faculty Hospital in Brno**

Agents of neuroinfections

Central nervous system infections

- **relatively rare**
- **can have a very serious course**
- **Incidence**
bacterial meningitis: 2/100.000/year
viral meningitis: 10/100.000/year
- **Lethality**
bacterial meningitis, non-treated: >70 %
treated: ~10 %

Penetration into CNS

- **From a peripheral focus:**
 - by means of blood** (meningococci)
 - per continuitatem** (pneumococci or haemophili from the middle ear)
 - along nerves** (HSV, rabies virus)
- **Directly:**
 - after an injury** (pneumococci, staphylococci, nocardiae, aspergilli)



Severe headache



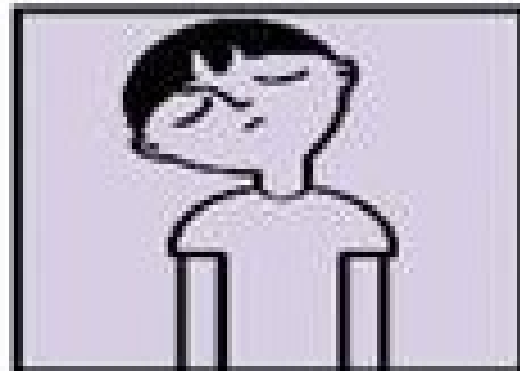
Stiff neck



Dislike of
bright lights



Fever/vomiting



Drowsy and less
responsive/
vacant



Rash (develops
anywhere on
body)

Etiology of CNS infections

...depends on the **type** and the **duration** of the disease, different in....

1. **meningitis**

- acute bacterial (purulent)/viral (aseptic)
- chronic

2. **encephalitis**

- ## 3. **brain abscess** – acute or chronic

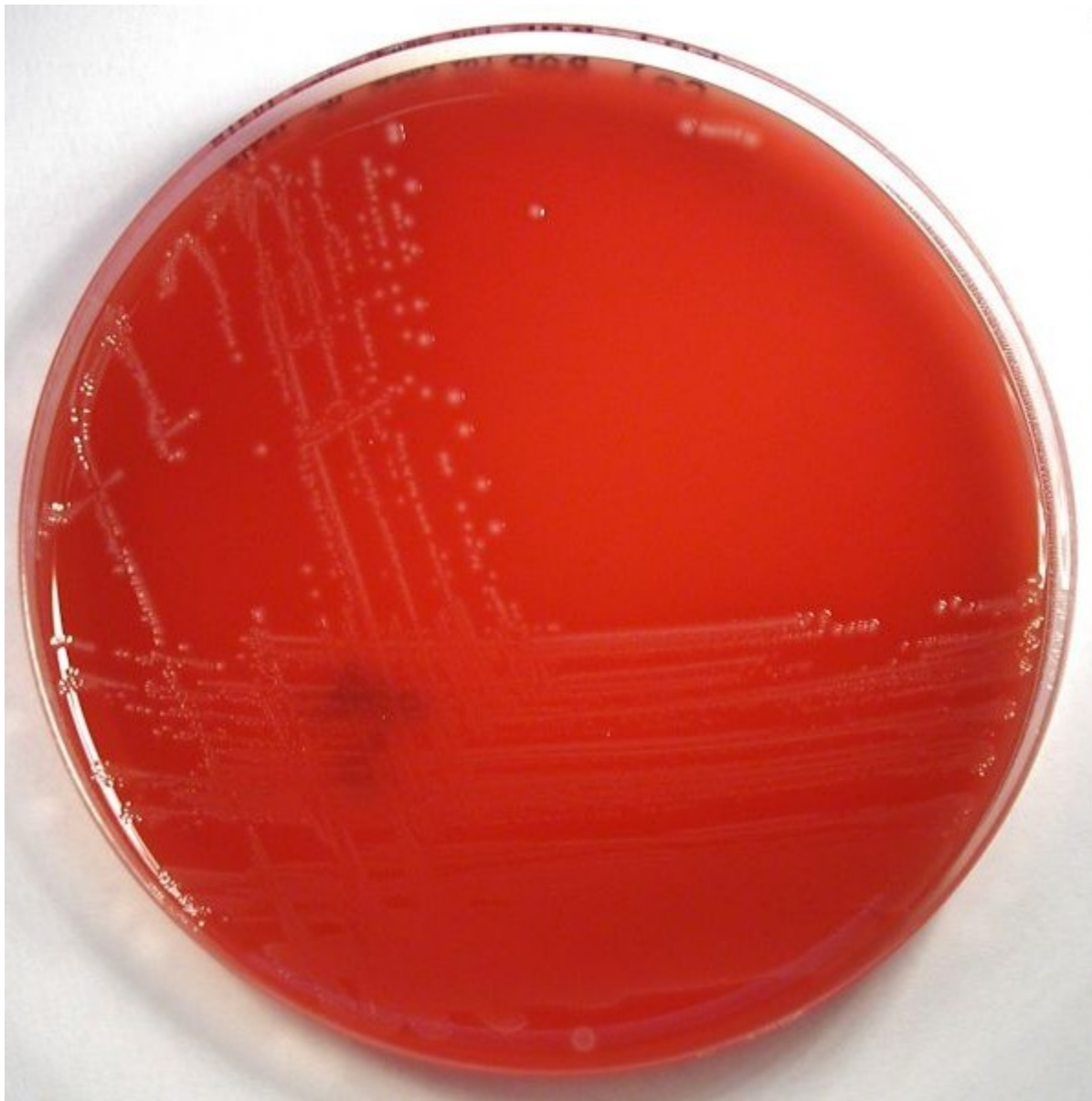
Cytology and biochemistry of CSF

| marker | norm | purulent meningitis | aseptic meningitis |
|----------|-----------------|---------------------|--------------------|
| cells | 0-6/ μ l | ↑↑↑ (>1000) | ↑↑ (100-500) |
| proteins | 20-50 mg/100 ml | ↑↑ (>100) | ↑ (50-100) |
| glucose | 40-80 mg/100 ml | ↓ (<30) | ~ (30-40) |

Etiology of acute meningitis – I

Etiology of purulent meningitis by the age in %

| age | GBS | | | | | |
|--------|-----|--|--|--|--|--|
| 0-1 m. | 50 | | | | | |
| 1-4 y. | | | | | | |
| 5-29 | | | | | | |
| 30-59 | | | | | | |
| ≥60 | | | | | | |

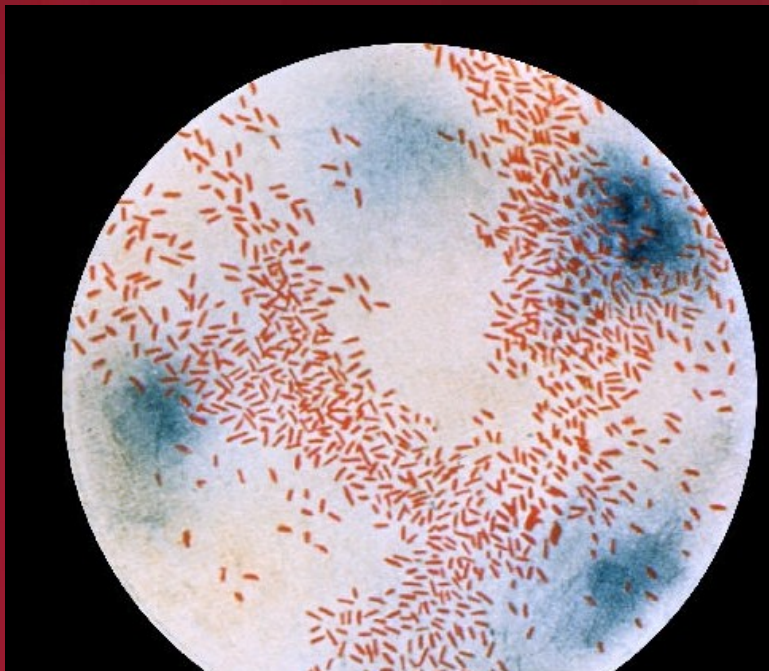
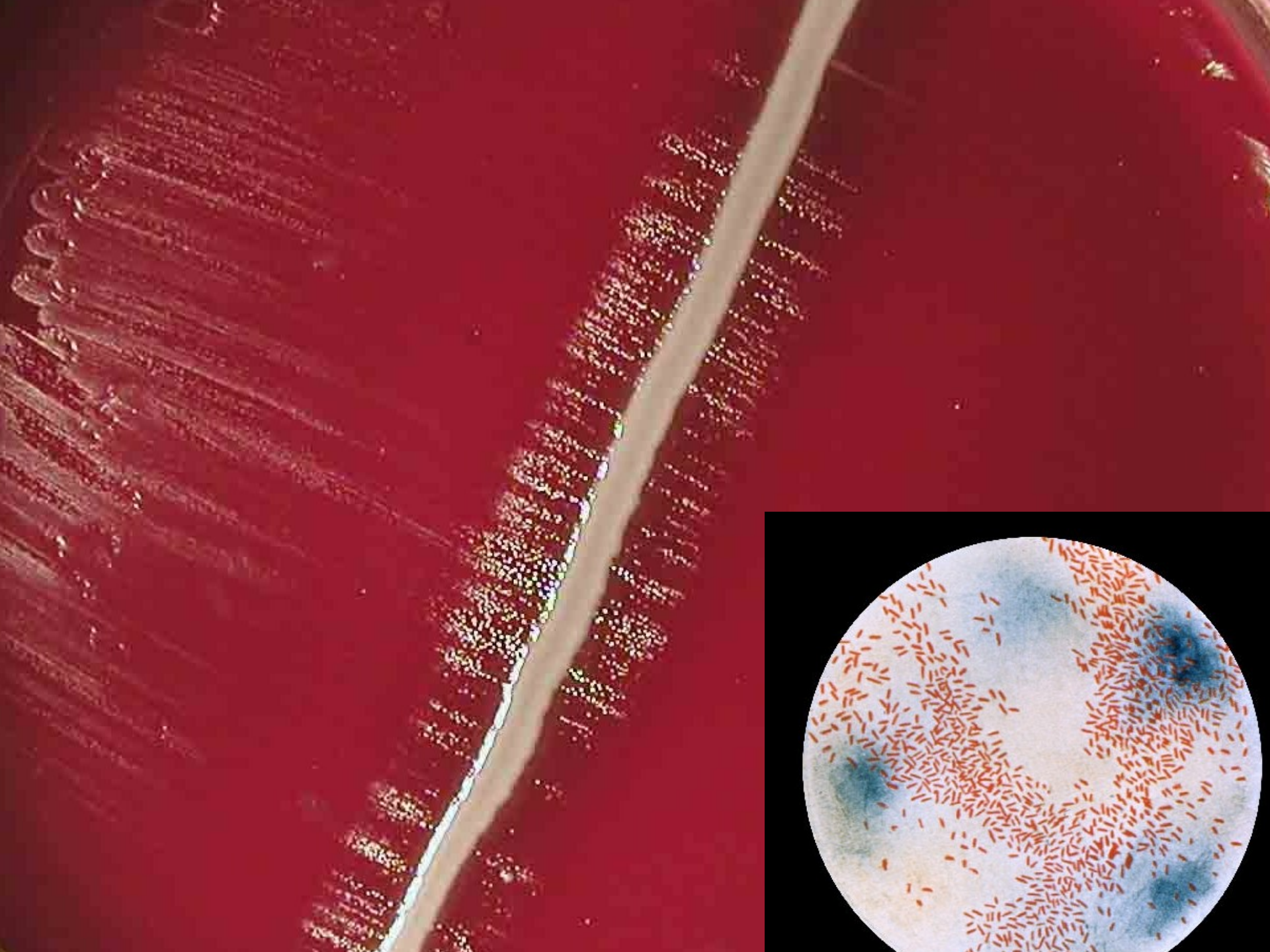


www.bakteriologieatlas.de

Etiology of acute meningitis – II

Etiology of purulent meningitis by the age in %

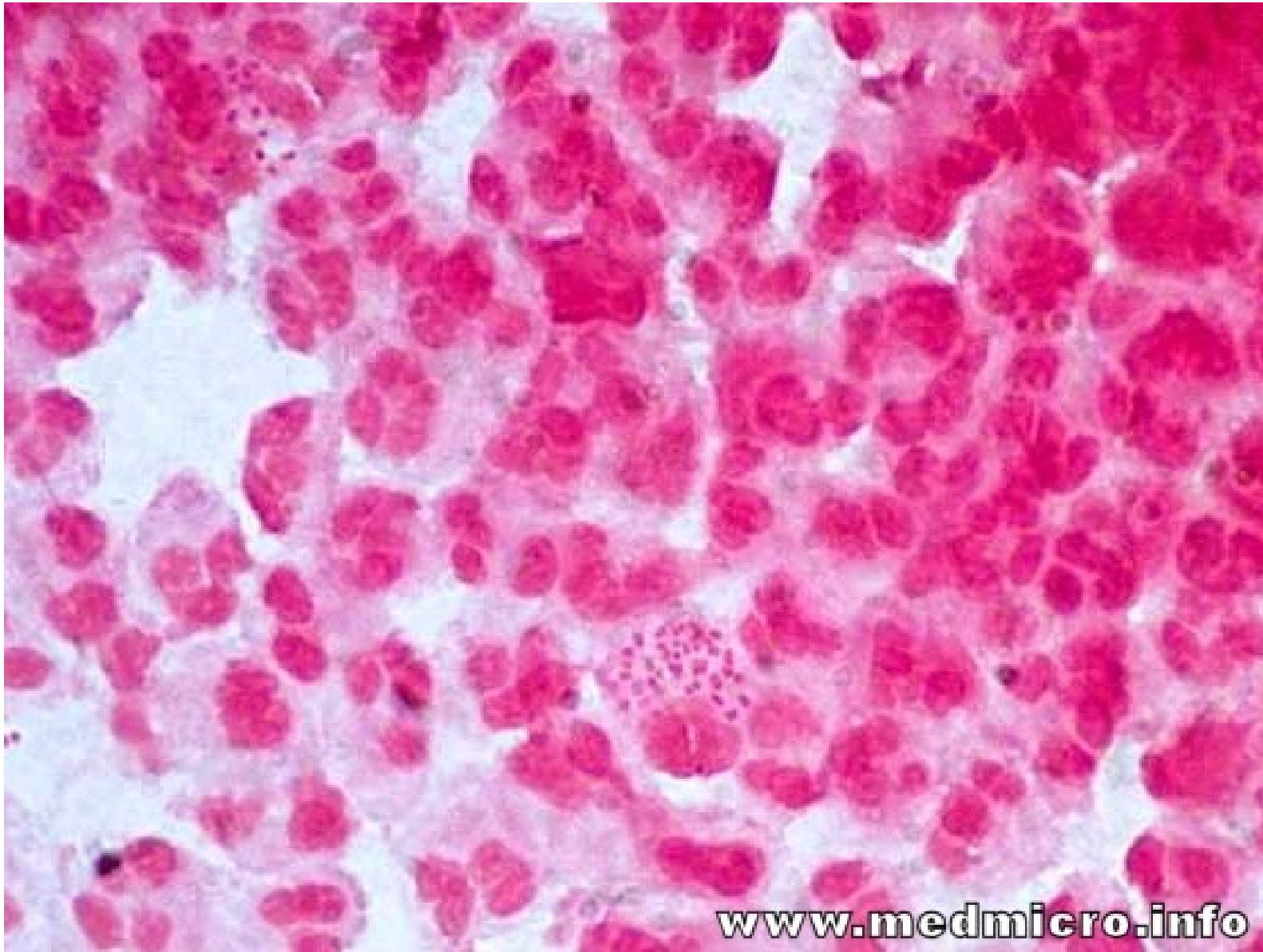
| age | GBS | Haem. infl. b | | | | |
|--------|-----|------------------|--|--|--|--|
| 0-1 m. | 50 | | | | | |
| 1-4 y. | | 70 | | | | |
| 5-29 | | | | | | |
| 30-59 | | | | | | |
| ≥60 | | | | | | |



Etiology of acute meningitis – III

Etiology of purulent meningitis by the age in %

| age | GBS | Haem. infl. b | Neiss. men. | | | |
|--------|-----|---------------|-------------|--|--|--|
| 0-1 m. | 50 | | | | | |
| 1-4 y. | | 70 | | | | |
| 5-29 | | | 45 | | | |
| 30-59 | | | | | | |
| ≥60 | | | | | | |





Etiology of acute meningitis – IV

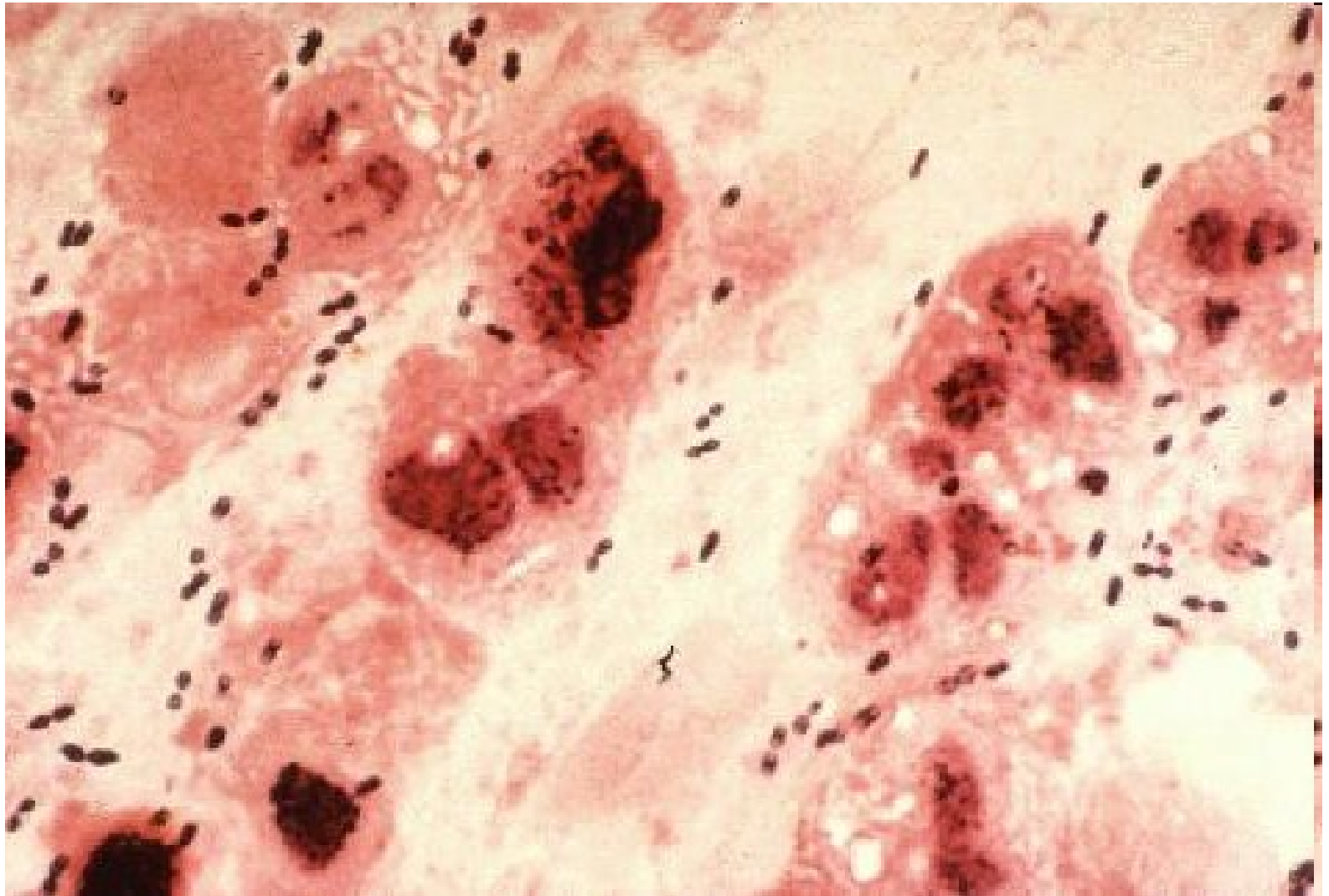
Etiology of purulent meningitis by the age in %

| age | GBS | Haem. infl. b | Neiss. men. | other | | |
|--------|-----|---------------|-------------|-------|--|--|
| 0-1 m. | 50 | | | | | |
| 1-4 y. | | 70 | | | | |
| 5-29 | | | 45 | | | |
| 30-59 | | | | 40 | | |
| ≥60 | | | | | | |

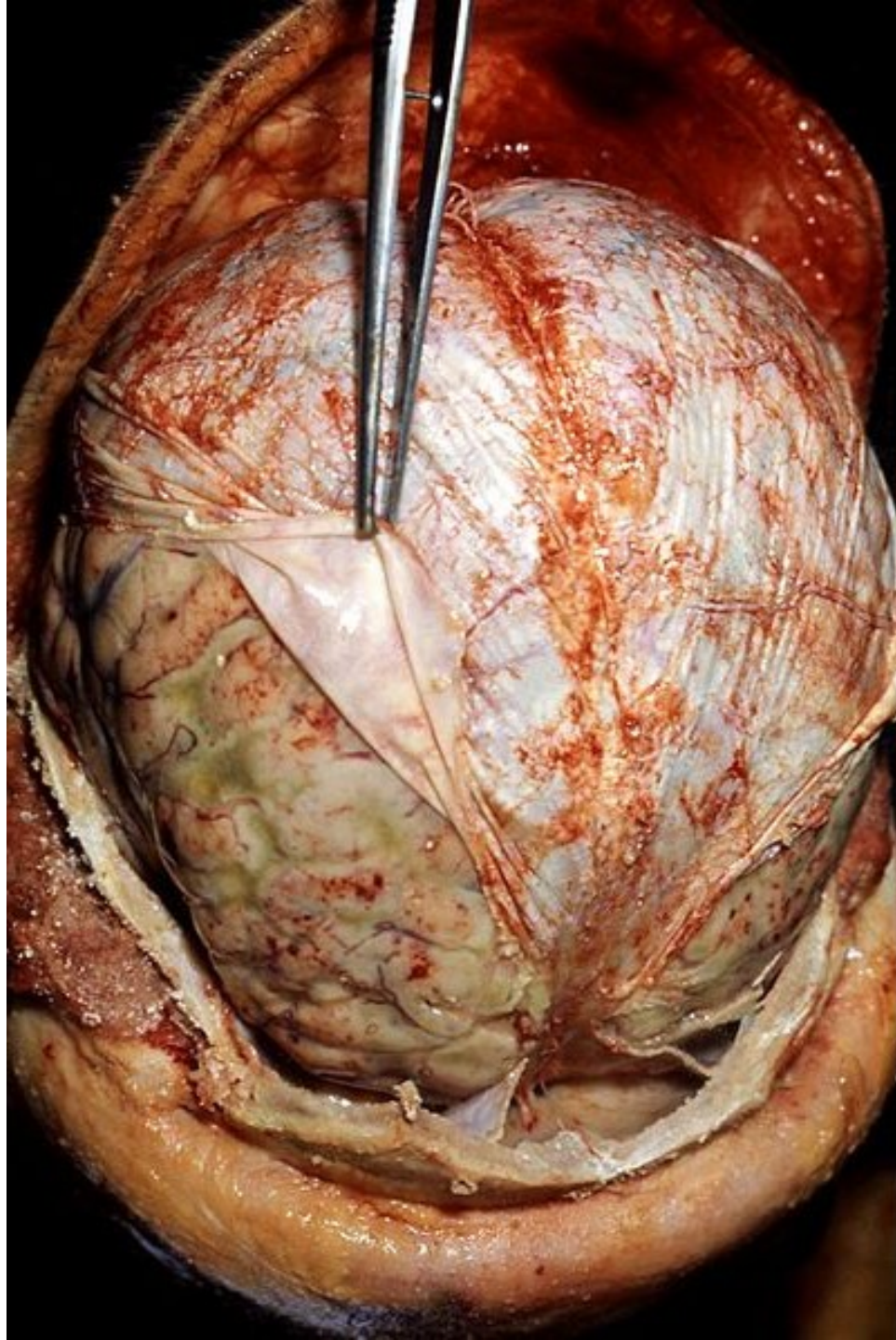
Etiology of acute meningitis – V

Etiology of purulent meningitis by the age in %

| age | GBS | Haem. infl. b | Neiss. men. | other | Str. pneu. | |
|--------|-----|---------------|-------------|-------|------------|--|
| 0-1 m. | 50 | | | | | |
| 1-4 y. | | 70 | | | | |
| 5-29 | | | 45 | | | |
| 30-59 | | | | 40 | | |
| ≥60 | | | | | 50 | |



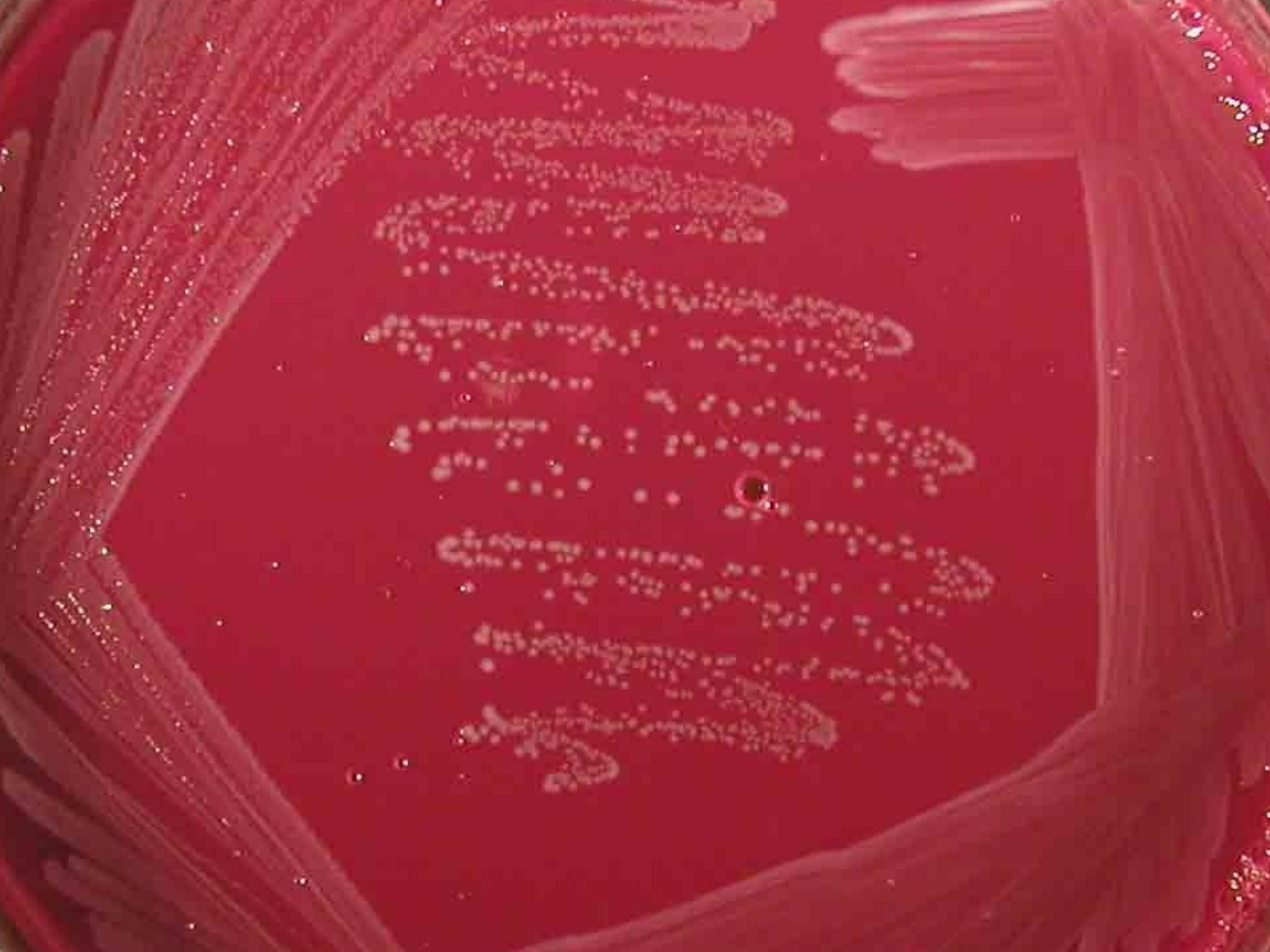
<http://bioinfo.bact.wisc.edu>



Etiology of acute meningitis – VI

Etiology of purulent meningitis by the age in %

| age | GBS | Haem. infl. b | Neiss. men. | other | Str. pneu. | List. mono. |
|--------|-----|---------------|-------------|-------|------------|-------------|
| 0-1 m. | 50 | | | 33 | | 10 |
| 1-4 y. | | 70 | 15 | | 10 | |
| 5-29 | | | 45 | 25 | 20 | |
| 30-59 | | | 10 | 40 | 33 | |
| ≥60 | | | | 25 | 50 | 15 |



Lethality and sequelae of purulent meningitis

....according to etiology

| importance | GBS | Haem. infl. b | Neiss. men. | other | Str. pneu. | List. mono. |
|------------|-----|---------------|-------------|-------|------------|-------------|
| lethality | | | | | † | † |
| sequelae | | +++ | | + | + | + |

Aseptic (viral) meningitis

mumps virus (CNS infection is clinically silent)

enteroviruses: echoviruses (30 serotypes)

coxsackieviruses (23 + 6 serotypes)

tick-borne encephalitis virus (TBEV)

rarely **HSV** and **VZV** and other neuroviruses

rarely some bacteria

leptospirae, borreliae, M. tuberculosis

Etiology of chronic meningitis

Bacteria: *Mycobacterium tuberculosis*
(meningitis basilaris)

Moulds and yeasts:
aspergilli
Cryptococcus neoformans



Etiology of encephalitis

Encephalitis – only **acute**, of **viral** origin:

- **tick-borne encephalitis**
- **HSV**
- **enteroviruses**
- **mumps**



Mumps parotitis with cervical and presternal edema and erythema

Cystic lesions resulting from accumulation of organisms in perivascular spaces

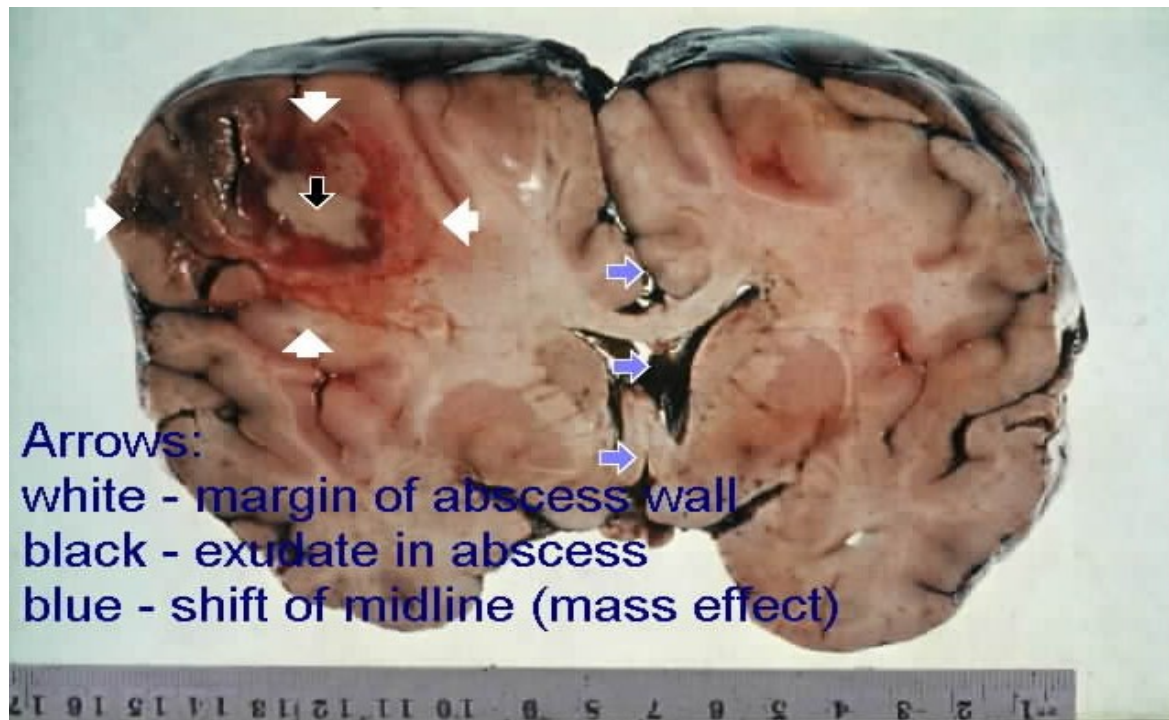


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Etiology of acute brain abscess

.....always **bacterial**:

- **mixed** anaerobic and aerobic **flora**
- **staphylococci** (both *S. aureus* and coagulase negative staphylococci)
- group A and D **streptococci**



Etiology of chronic brain abscess

Bacteria:

Mycobacterium tuberculosis

Nocardia asteroides

Mycotic organisms:

Cryptococcus neoformans (yeast)



Parasites:

Cysticercus cellulosae (tissue form of pork tapeworm *Taenia solium*)

10 cm



www.medicine.cmu.ac.th



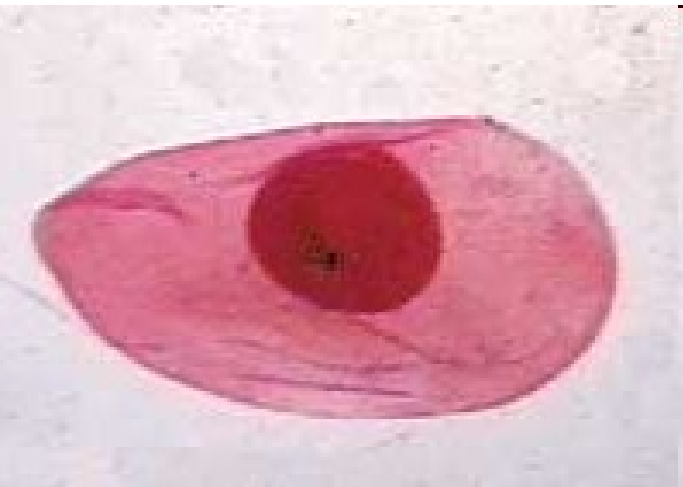
Top: *Taenia solium cysticerci* in the brain of a nine-year-old girl who died during cerebrospinal fluid extraction to diagnose her headaches.

This was in the 1970s - if it had happened 10 years later, noninvasive computerized tomography would have given an accurate diagnosis, and the parasites could have been killed with drugs.

(Image courtesy of Dr. Ana Flisser, National Autonomous University of Mexico.)

Left: A pork tapeworm (*T.solium*) cysticercus, the form in which the tapeworm is found in an infected brain.

(Colorized image by P. W. Pappas and S. M. Wardrop, courtesy of P. W. Pappas, Ohio State University.)



Leonardo da Vinci (1452-1519): Fetus in the Womb (between 1510-1512)

