MICROBIOLOGY

INTRODUCTIOM TO MEDICAL MIKROBIOGY,

BASIC DISCIPLINES. ROLE IN HEALTH CARE SYSTEM. CHARACTERITICS OF MICROORGANISM - BACTERIA, VIRUSES, FUNGI AND PARASITES

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Institute for Imunology and Microbiology
1st Faculty of Medicine, Charles University

PRACTICAL BLOCKS GENERAL MEDICINE summer semester 2020 groups time schedule

Start: 8 a.m.

GEN MED MICROBIOLOGY I - 2020			
		ALEK	8.30
Week	**Date**	**Work group**	**Teacher**
1	**24.02.2020**	2051	Petříčková
3	**09.03.2020**	2051+52	Pavlík
4	**16.03.2020**	2053	Bobek
5	**23.03.2020**	2053	Pavlík
6	**30.03.2020**	2054	Bobek
12	**11.05.2020**	2055	Petříčková
13	**18.05.2020**	2056	Petříček
14	**25.05.2020**	2056 + XXXX	Petříčková

PRACTICAL BLOCKS

Rescheduling due to illness is possible only

as agreed with dr. Jan Bobek

(jan.bobek@lf1.cuni.cz)

EXAMS, PREREQUISITES, ETC.

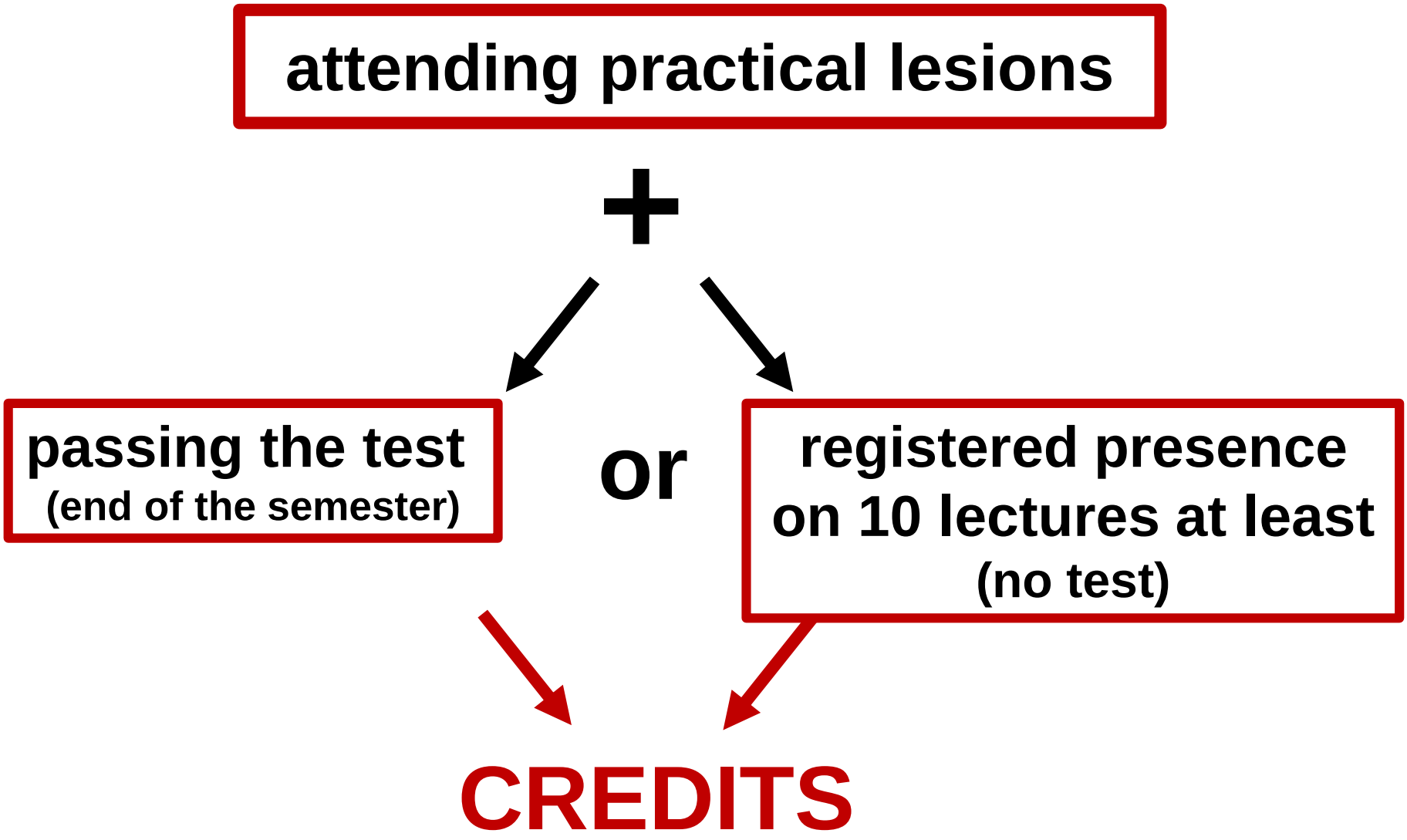
Mgr. Kateřina Petříčková, Ph.D.

(katerina.petrickova@lf1.cuni.cz)

MUDr. Emil Pavlík, CSc.

(pavlik.emil@seznam.cz)

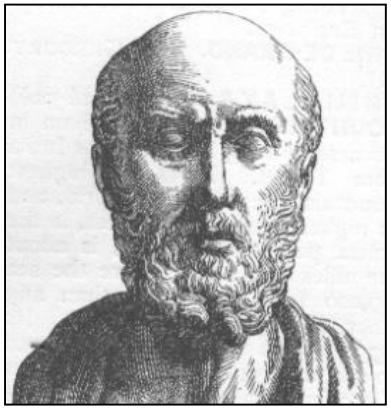
RULES


attending practical lesions
+
passing the test
(end of the semester)
or
registered presence
on 10 lectures at least
(no test)
CREDITS

HISTORY

c. 4 BC — **Fundamental medical procedures**

till 15th century — lack of information on causes of infectious diseases (e.g., in cholera, black death it was assumed to be caused by miasma = a noxious form of „bad air“)



Hippocrates (born 460 BC, Kos, Greece)
Father of Medicine - founder of the Hippocratic School of Medicine

Source: https://en.wikipedia.org/wiki/Miasma_theory

A representation by Robert Seymour of the cholera epidemic of the 19th century depicts the spread of the disease in the form of poisonous air.

HISTORY

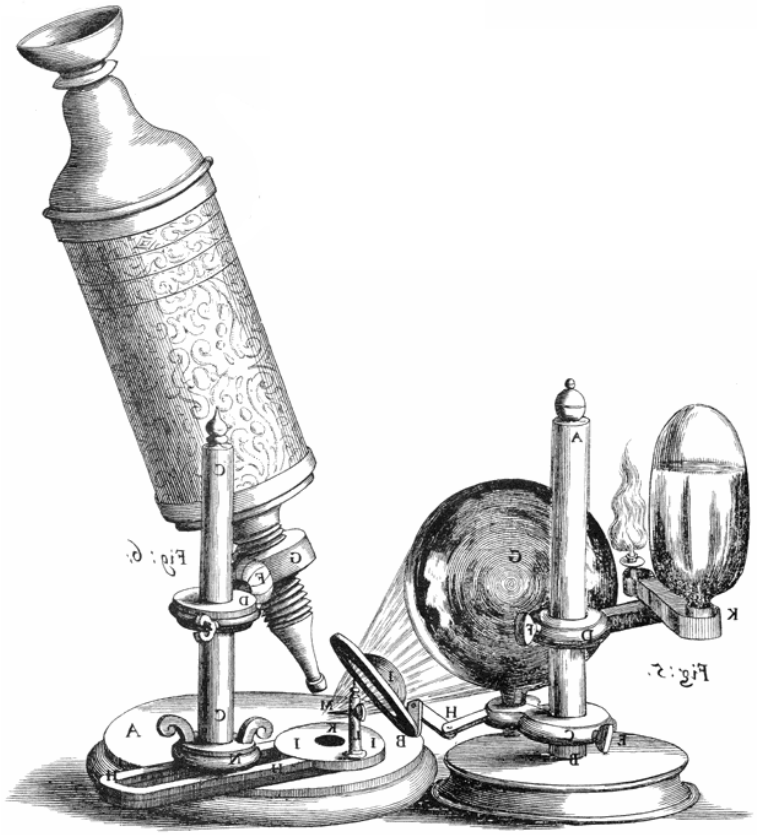
4. st. BC	**Fundamental medical procedures**
till 15th century	lack of information on causes of infectious diseases (e.g., in cholera, black death it was assumed to be caused by miasma = a noxious form of „bad air“)
1553	G. Fracastoro: a hypothesis on epidemic diseases are caused by small particles or „spores“ which spread by • direct contact • indirect contact • without direct contact for long distances

Girolamo Fracastoro
1478-1553

Robert HOOKE

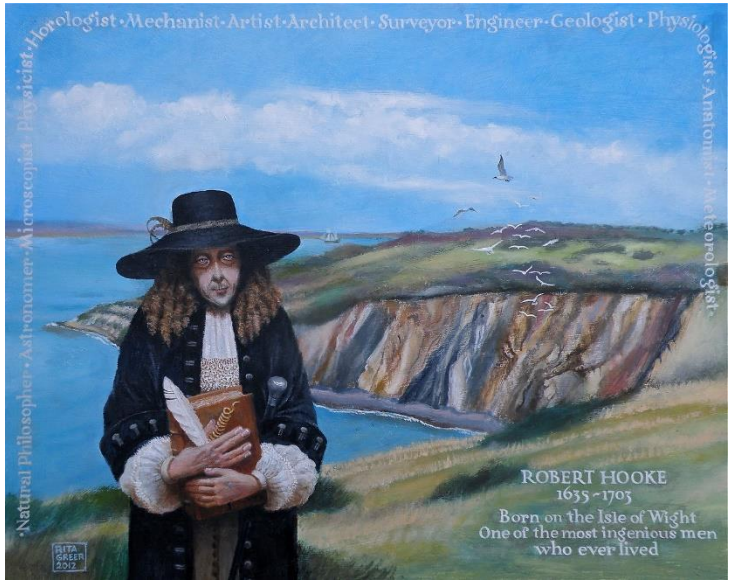
(1632-1723)

Probably, the first observer of microorganisms.



Hooke's microscope, from an engraving in *Micrographia*.

Source: https://en.wikipedia.org/wiki/Robert_Hooke



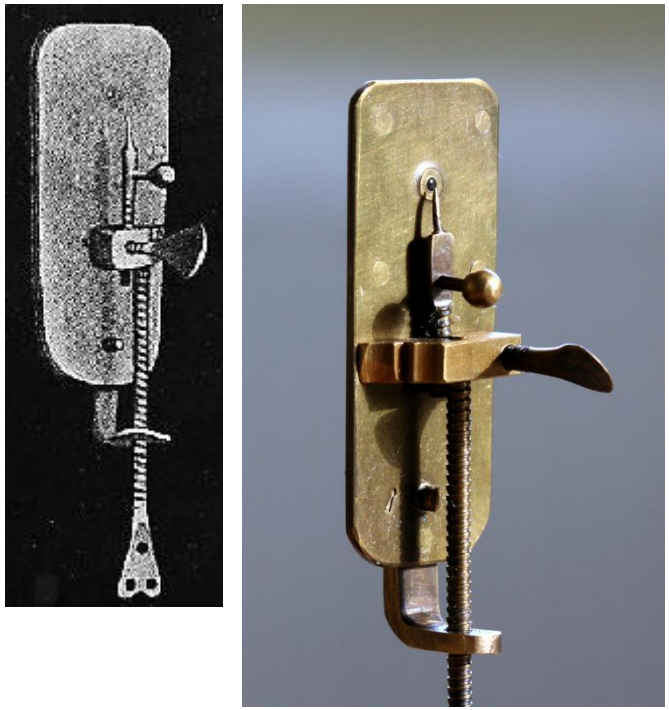
Memorial portrait of Robert Hooke at Alum Bay, Isle of Wight, his birthplace, by Rita Greer (2012).

Source:https://en.wikipedia.org/wiki/Robert_Hooke#/media/File:Memorial_portrait_of_Robert_Hooke_at_Alum_Bay,_IoW_for_Carisbrooke_Museum.JPG

Antonie van LEEUWENHOEK

(1635-1703)

Often considered to be the first acknowledged microscopist and microbiologists. He is best known for his pioneering work in the field of microscopy.



A replica of a microscope by van Leeuwenhoek.

Sources:
https://en.wikipedia.org/wiki/Antonie_van_Leeuwenhoek#/media/File:Leeuwenhoek_Microscope.png

BACTERIOLOGY

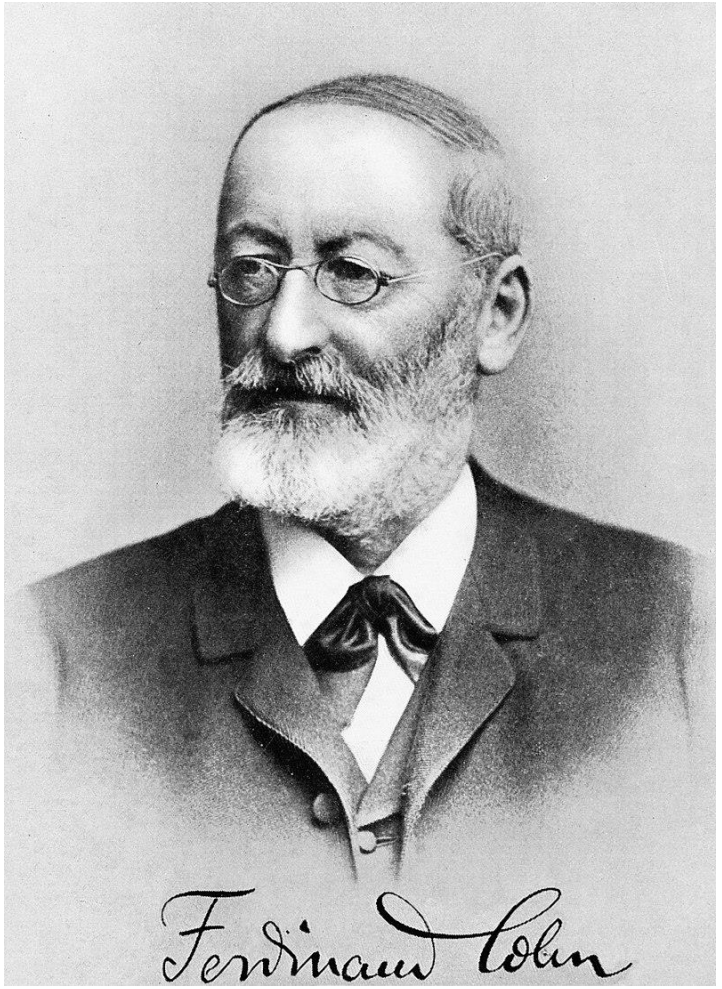
Ferdinand Julius COHN

(1828 -1898)

- the first who classify algae as plants, and defined what distinguishes them from green plants

- established classification of bacteria into four groups based on shape (sphericals, short rods, threads, and spirals) – still in use today

- described the life-cycle of *Bacillus* spp.

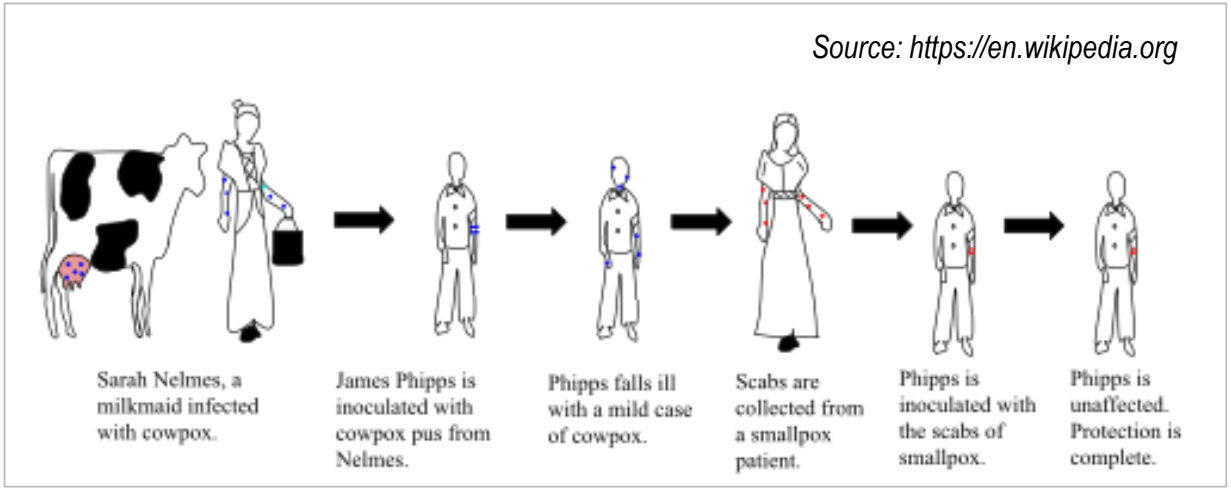


Source: https://en.wikipedia.org/wiki/Ferdinand_Cohn#

Edward JENNER

(1749 -1823)

Source:http://wellcomeimages.org/indexplus/obf_images/63/06/f922c4b86c952df78a555cd9eba8.jpg



The steps taken by Edward Jenner to create vaccination, the first vaccine for smallpox. Jenner did this by inoculating James Phipps with cowpox, a virus similar to smallpox, to create immunity, unlike variolation, which used smallpox to create an immunity to itself.

The terms "vaccine" and "vaccination" are derived from *Variolae vaccinae* (small-pox of the cow), the term devised by Jenner to denote cowpox. He used it in 1796 in the long title of his *Inquiry into the Variolae vaccinae known as the Cow Pox*, in which he described the protective effect of cowpox against smallpox.

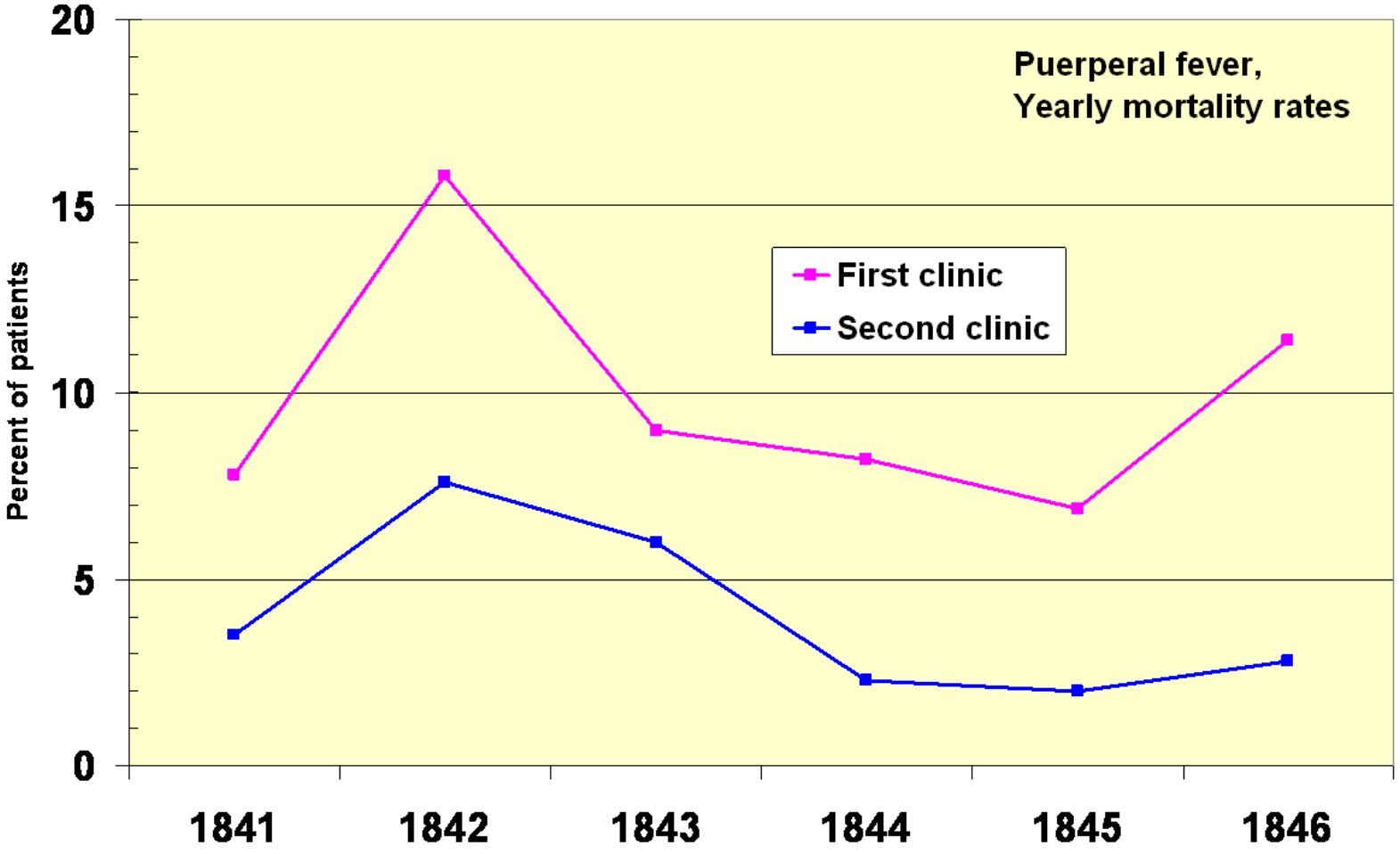
Ignác Fülöp **SEMMELWEIS**

Ignaz Philipp Semmelweis
(1818-1865)

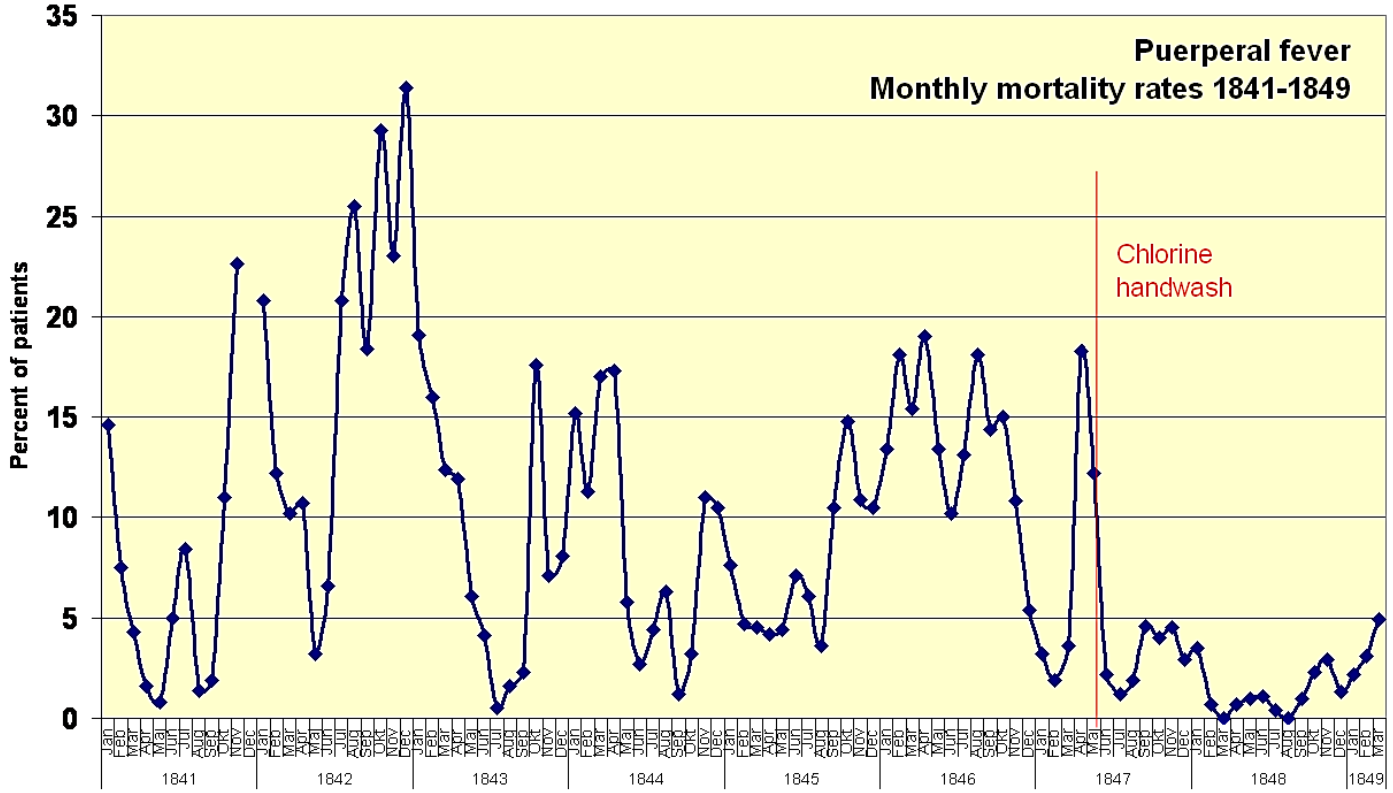
Source: https://en.wikipedia.org/wiki/

An early pioneer of antiseptic procedures.

- discovered that the incidence of puerperal fever (also known as "childbed fever") could be drastically cut by the use of hand disinfection in obstetrical clinics.



Puerperal fever yearly mortality rates for the First and Second Clinic at the Vienna General Hospital 1841-1846. The First Clinic evidently has the larger mortality rate.



Puerperal fever monthly mortality rates for the First Clinic at Vienna Maternity Institution 1841–1849. Rates drop markedly when Semmelweis implemented chlorine hand washing mid-May 1847.

Zdroj: Wikipedia

Louis PASTEUR

(1822-1895)

Source: https://cs.wikipedia.org/wiki/Louis_Pasteur

He is regarded as one of the three main founders of bacteriology together ith F. Cohn and R. Koch.

Remembered for his remarkable discoveries of the principles of vaccination, microbial fermentation and pasteurization, i.e. for breakthroughs in the causes and prevention of diseases.

- **Provided direct support for the germ theory of diseases and its application in clinical medicine.**
  - **principles of vaccination**
  - **remarkable breakthroughs in the causes and prevention of diseases**
  - **reduced mortality from puerperal fever**
  - **created of the first vaccines for rabies and anthrax**
- **discovered pasteurization (warming of milk - to stop the bacterial contamination)**
  - **prevention for TBC, samonellosis, brucellosis, diphteria, etc.**
- **discovered microbial fermentation**

GERM THEORY OF DISEASE

bacteria, protists, fungi, viruses, prions, viroids

Many diseases are caused by microorganisms (to small to see without magnification) which invade:

humans
animals
other living hosts

that cause disease = pathogens

infectious disease

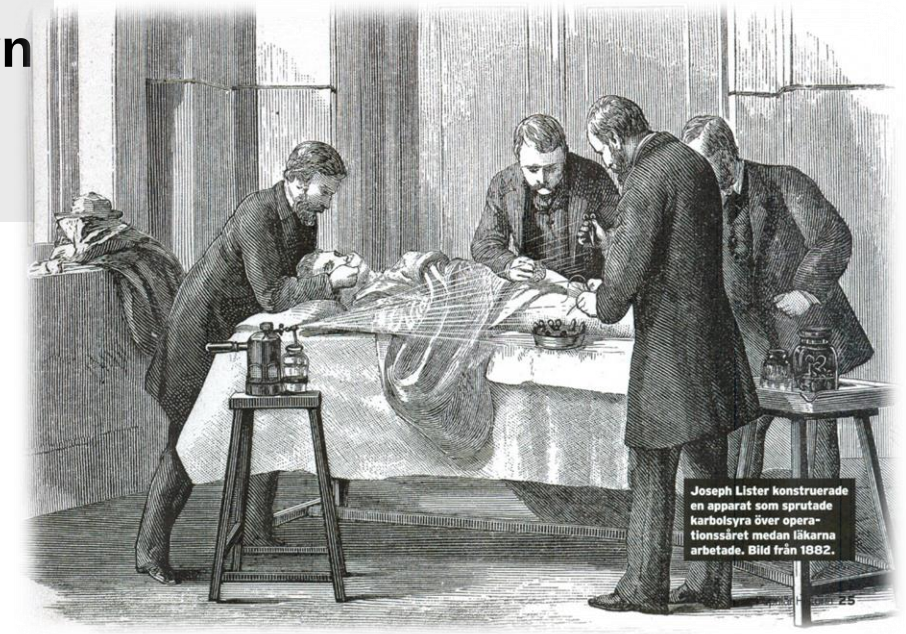
Although pathogens are the principal cause of diseases, environmental and hereditary factors often influence the severity of the disease, and whether a potential host individual becomes infected when exposed to the pathogen.

Joseph LISTER

(1827-1912)

Pioneer of antiseptic surgery.

Championed the use of carbolic acid as an antiseptic, so that it became the first widely used antiseptic in surgery, i.e. he successfully introduced carbolic acid (now known as phenol) to sterilize surgical instruments and to clean wounds.



Lister spraying phenol over patient.

Source of pictures: https://en.wikipedia.org/wiki/Joseph_Lister

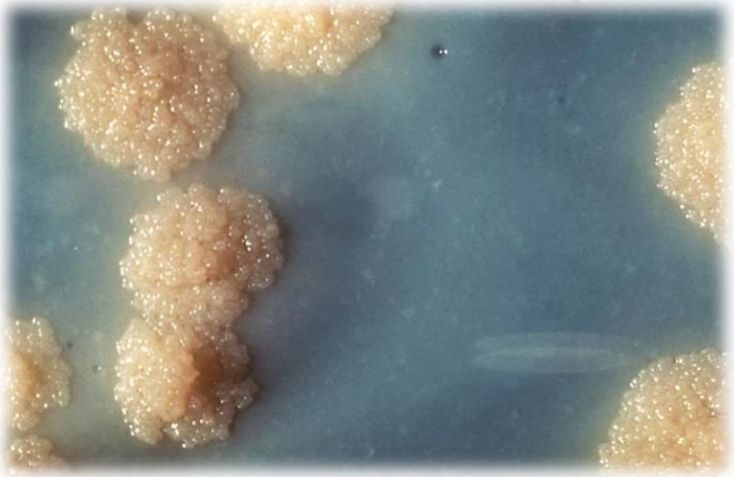
Heinrich Hermann **Robert KOCH**

(1843-1910)

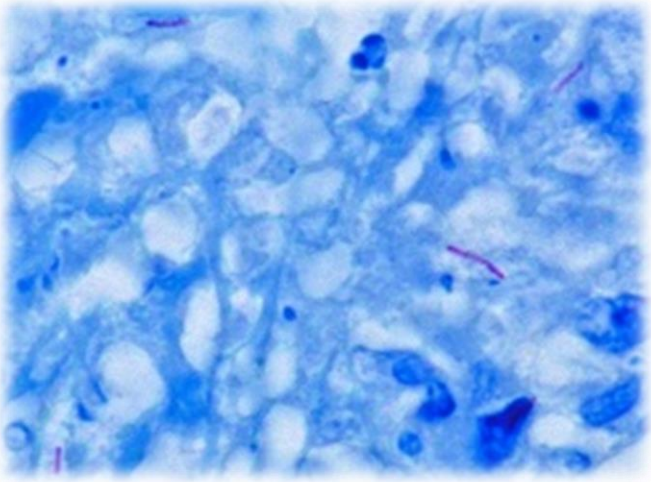
Source: wikimvisua.com

1892: Identification and cultivation of the causative agents tuberculosis (TB)

Mycobacterium tuberculosis



Mycobacterium tuberculosis



M. tuberculosis in the tissue

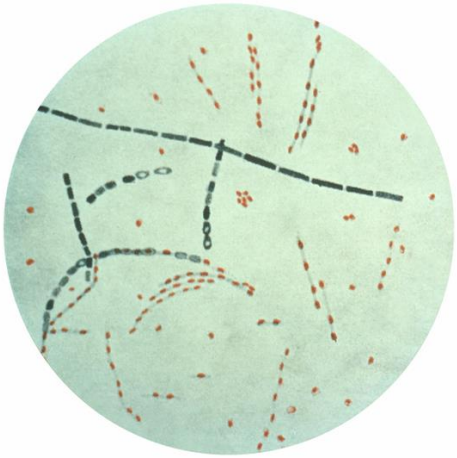
Source of pictures: Wikipedia.org

Heinrich Hermann **Robert KOCH**

(1843-1910)

1876:

Identification of *Bacillus anthraxis* - causative agent of anthrax



Source: Wikipedia

http://textbookofbacteriology.net/Anthrax.html

Heinrich Hermann **Robert KOCH**

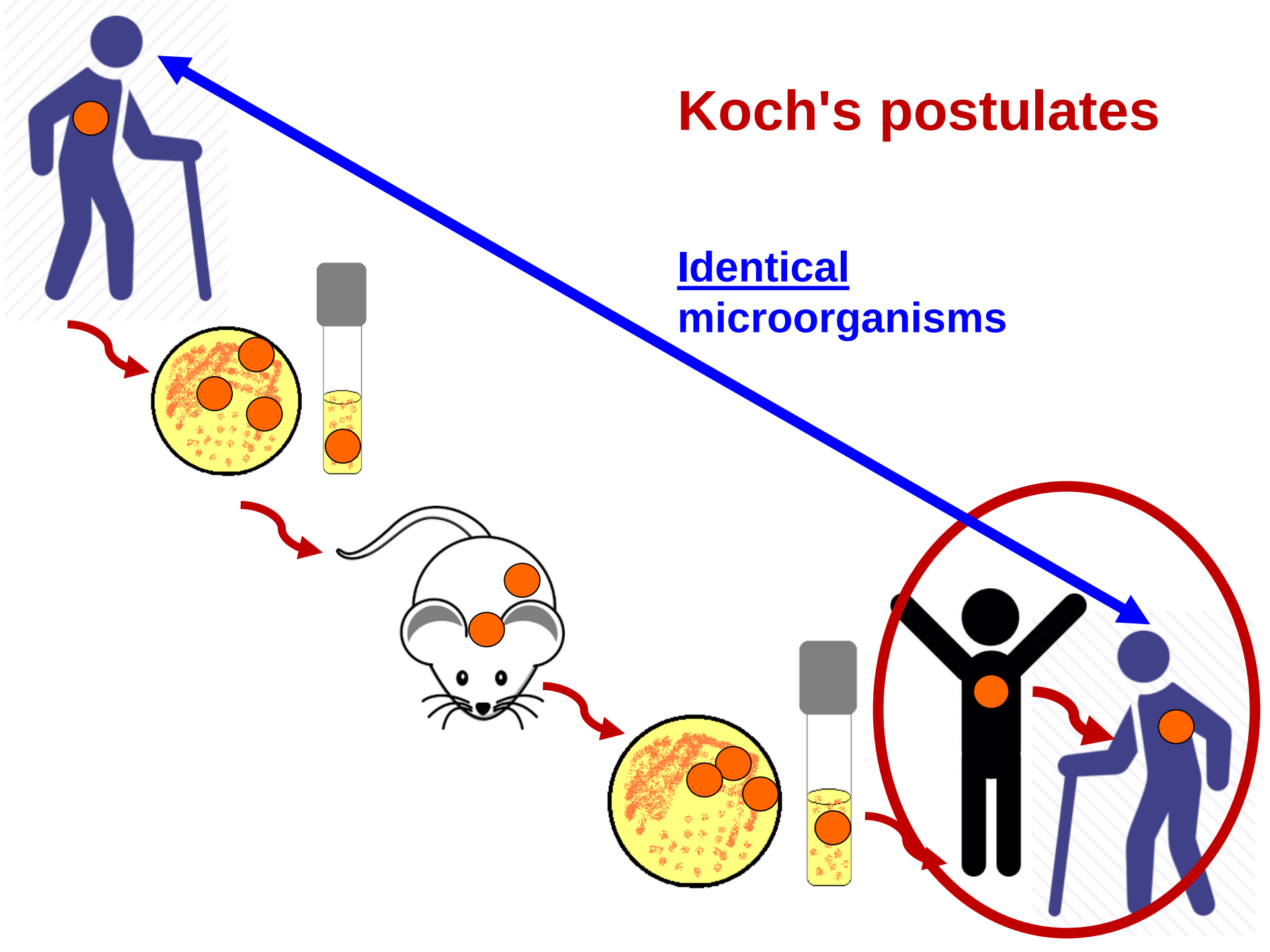
(1843-1910)

- began to utilize **agar** to grow and isolate pure bacterial cultures
- implemented the staining of bacteria by aniline
- performed the first photos of bacteria

- **his research led to the creation of Koch's postulates (series of four generalized principles linking specific microorganisms to specific diseases)**

Koch's postulates

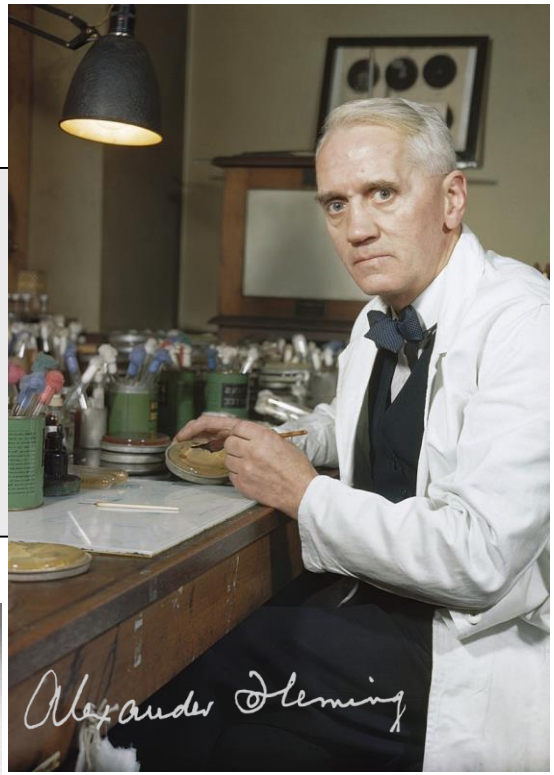
Identical
microorganisms



Alexander FLEMING

(1881-1955)

Scottish physician, microbiologists and pharmcologists
Saint Mary's, London;coworker: A.Wright
1922: baktericide enzyme - lysozyme
1928 Discovery of benzyl peniciline (Peniciline G) – from the mould of *Penicillium chrysogenum* (syn. *P. notatum*)



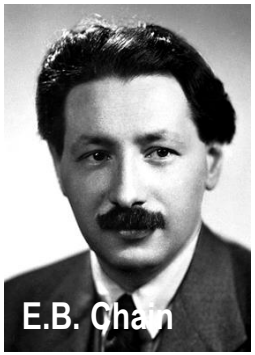
Sourcej: www.herbarium.usu.edu

Howard Walter FLOREY

(1989-1968)

Ernst Boris CHAIN

(1906-1979)



1940: isolation and concentration of **the germ-killing agent in penicillin.**

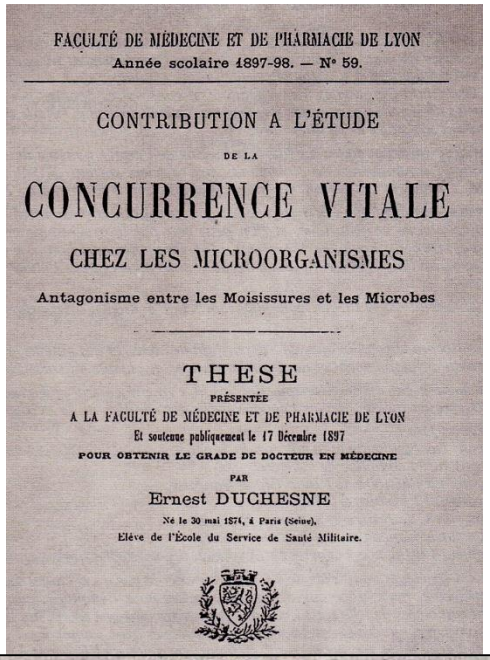
Since 1941: PNC aplication in treatment

In the CR: after 2nd World War

Sources:
https://upload.wikimedia.org/wikipedia/commons/,
www.heritage.anu.edu.au

ERNEST DUCHESNE

(30.5.1874 – 12.4.1912)



FACULTÉ DE MÉDECINE ET DE PHARMACIE DE LYON
Année scolaire 1897-98. — N° 59.

CONTRIBUTION A L'ÉTUDE

DE LA

CONCURRENCE VITALE

CHEZ LES MICROORGANISMES

Antagonisme entre les Moisissures et les Microbes

THESE

PRÉSENTÉE

A LA FACULTÉ DE MÉDECINE ET DE PHARMACIE DE LYON

Et soutenue publiquement le 17 Décembre 1897

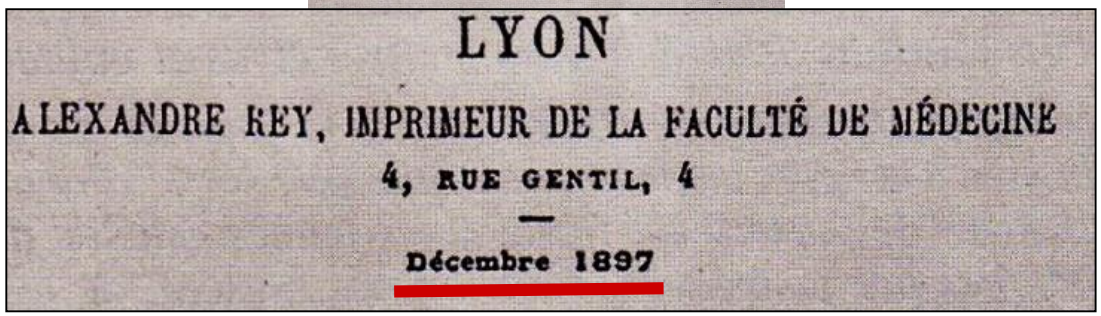
POUR OBTENIR LE GRADE DE DOCTEUR EN MÉDECINE

PAR

Ernest DUCHESNE

Né le 30 mai 1874, à Paris (Seine),

Elève de l'École du Service de Santé Militaire.



LYON

ALEXANDRE REY, IMPRIMEUR DE LA FACULTÉ DE MÉDECINE

4, RUE GENTIL, 4

—

Décembre 1897

In 1987, 32 years before A. Fleming, discovered the antibiotic properties of penicilin, but his research went unnoticed.

VIROLOGY

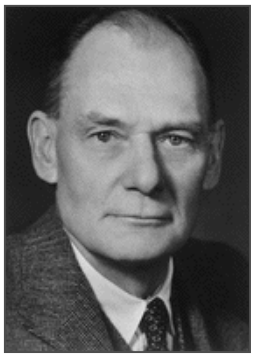
1915, Frederick W.TWORT
1917, Félix d,HÉRELLE

Discovery of viruses that infect of bacteria
= bacteriophages

→ **1930:** cultivation of viruses – experimental animals

1931: cultivation on chicken embryos

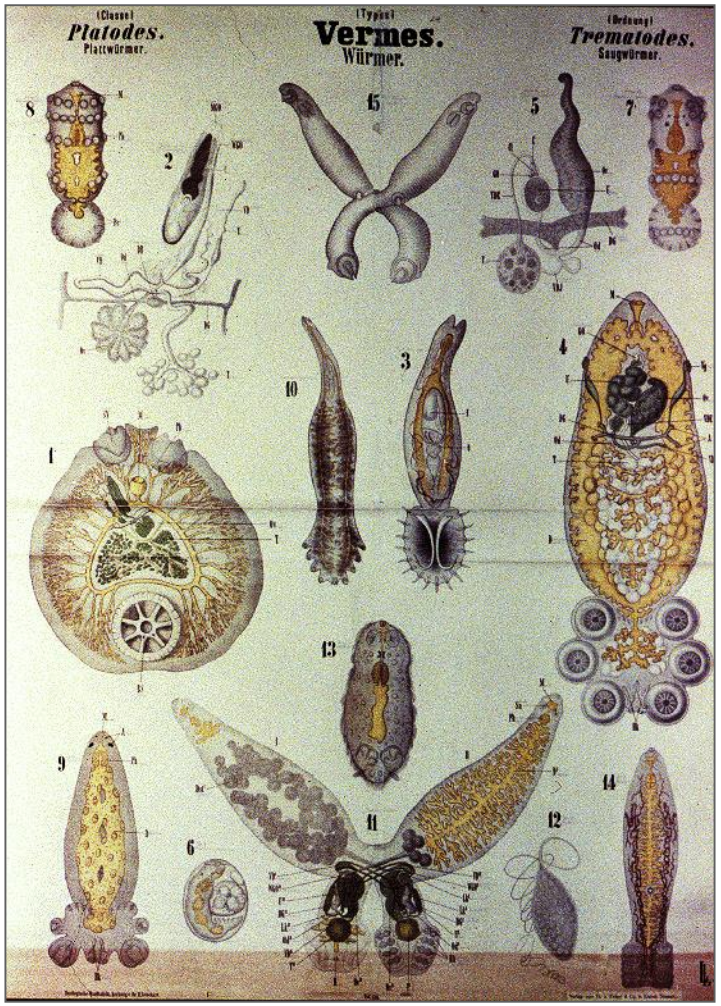
1949: J.F.ENDERS, **T.H.WELLER**, **F.Ch.ROBBINS**:
discovery that poliomyelitis virus is capable of growing in cultures of different tissues



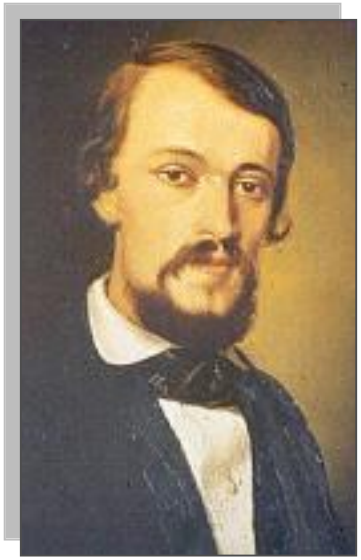
PARASITOLOGY

Karl Georg Friedrich Rudolf LEUCKART

(1822-1898)



Source: 2006 MBLWHOI Library



Theodor Maximilian BILHARZ

(1825 – 1862)

Identified the agent of urogenital schistosomiasis.

Patrick MANSON

(1844-1922)

Manson in the Albert Dock Seamen's Hospital 1901

Under studies on filariases suggested that malaria is transmitted by mosquitoes.

Source: Wikipedia


Source: Wikipedia

William Boog LEISHMAN

(1865-1925)

With Ch. Donovan identified causative agent of kala-azar (Leishman-Donovan bodies – protists *Leishmania* spp.).

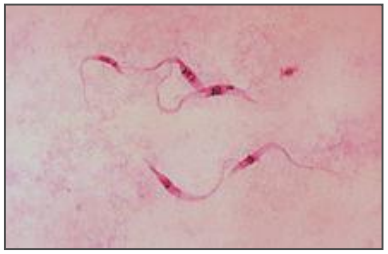

Source: Wikipedia


Source: Biblioteca Virtual Carlos Chagas

Carlos Justiniano Ribeiro CHAGAS

(1879-1934)

Working in primitive conditions, described in detail a previously unknown infectious disease (Chagas disease = American trypanosomiasis) – identified its pathogen, vector (bugs, Triatominae), clinical manifestations and epidemiology.



Source: Wikipedia

CZECH REPUBLIC

August Josef CORDA

(1809-1849)

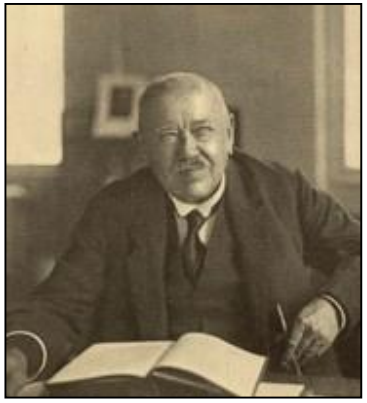
- under the microscope, observed algae, ciliates under and fungi

Vilém Dušan LAMBL

(1824-1895)

- identified *Giardia lamblia*

Giardia lamblia



Jaroslav HLAVA

(1855-1924)

Founder of Czech bacteriology

Ivan HONL

(1866 – 1936)

Besides other things, one of the early researchers on antibiotics and serological examinations.

INFECTIOUS DISEASES AND PATHOGENS

PATHOGEN

Germ that that can produce a DISEASE

PATHOGENICITY the ability of an organism to cause disease and harm the host

- **ability represents a genetic component of the pathogen**
  - **pathogenic species**
  - **non-pathogenic species**

- **the overt damage done to the host is a property of the host-pathogen interactions**

- **lack of ability to cause disease in primarily healthy individuum is typical for**
  - **commensals**
  - **opportunistic pathogens**

PATHOGENICITY AND VIRULENCE OF MICROORGANISMS

PATHOGEN

Germ that that can produce a DISEASE

PATHOGENICITY the ability of an organism to cause disease and harm the host

determined by

VIRULENCE FACTORS

i.e., pathogen abilities to infect or damage a host

Molecules produced by particular agent that add to their effectiveness and enable them to achieve the following:

- **to settle („colonization“) at the host niche (this includes attachment to cells)**
- **immunoevasion, evasion of the host's immune response**
- **immunosuppresion, inhibition of the host's immune response**
- **entry into and exit out of cells (if the pathogen is an intracellular one)**
- **obtain nutrition from the host**

INNATE PATHOGENICITY

Includes mode of transmission which is necessary for natural spreading of a disease in a population

- **obligate (primary)** pathogen: induce a disease in a healthy individual
- **facultative (opportunistic)** pathogen: induce a disease under particular (i.e., defined) conditions only

OBLIGATE PATHOGENS

- **Causal agent of „classical“ infections**: *Corynebacterium diphtheriae* (diphteria); *Salmonella* Typhi (typhoid fever); *Neissseria gonorrhoeae* (gonorrhoea)…

- **Differences between various species/strains** (*Yersinia pestis* is more pathogenic than *Streptococcus pyogenes*)

- **Host specificity – specilization on**

  •• **one** host species only (e.g., *Shigella* spp., gonococci – humans only)

  •• **various** host species (stafylococci, Lyssavirus virus – humans as well as other vertebrates)

FACULTATIVE PATHOGENS

INDUCTION OF INFECTION IS BASED ON PARTICULAR CONDITIONS

- **change of natural occurrence** (*Escherichia coli*: intestine x urogenital tract, blood system…)

- **immunosuppresion**

  (diabetes, corticosteroids, antibiotics, tumours, presence of strange units)

COLONIZATION

The presence of pathogenic bacteria on a body surface (like on the skin, mouth, intestines or airway) **without causing clinical evidence** of infection in the person.

Example: *S. aureus* on the skin

PATHOGENS

INFECTIOUS AGENTS THAT CAUSE DISEASE

- viroids
- prions
- viruses

} subviral particles

- bacteria
- yeast cells
- protists

} **PROKARYOTE** - lack of membrane-bound nucleus, mitochondria

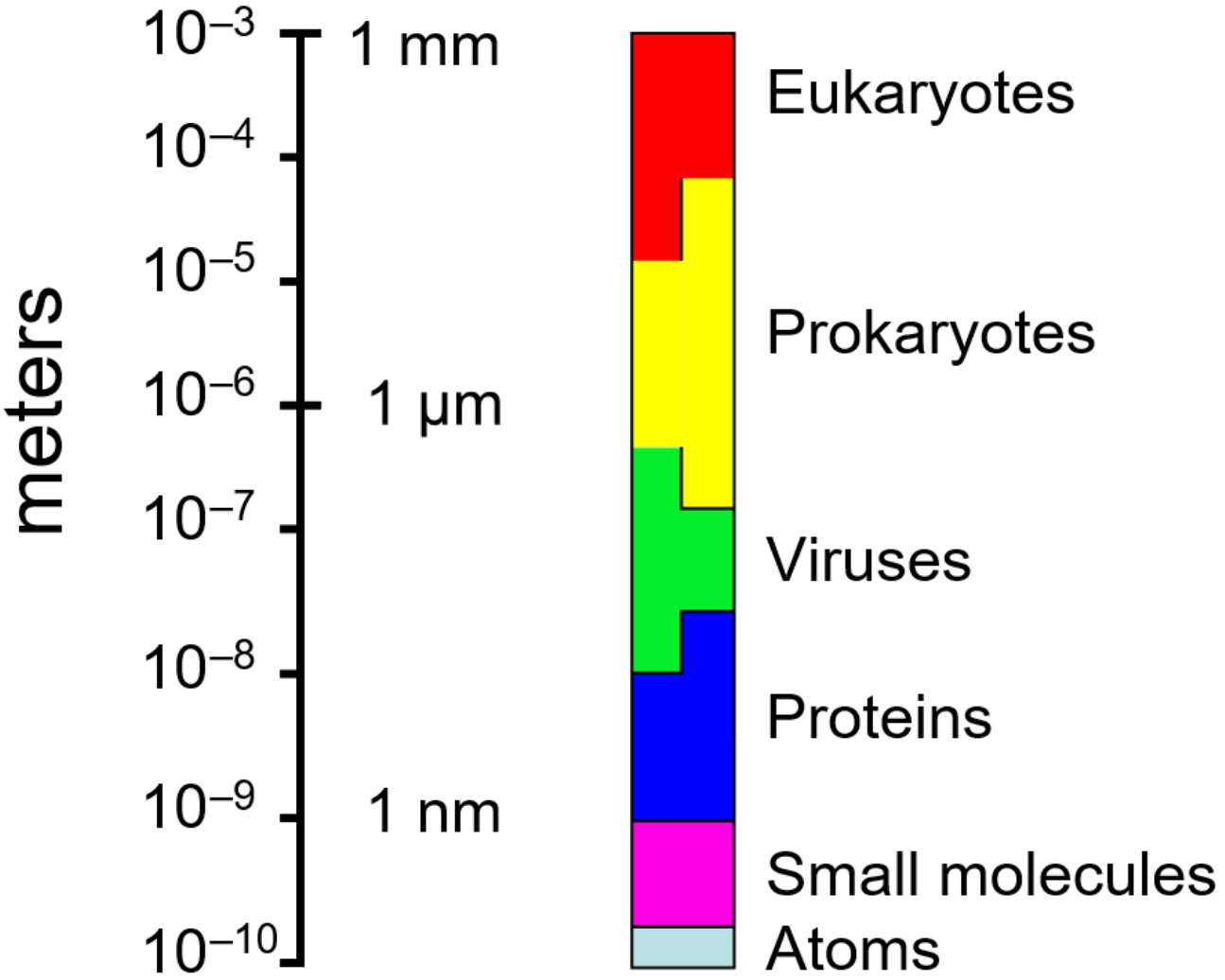
} **EUKARYOTE** - nucleus and other organelles enclosed within membranes

} UNICELLULAR ORGANISMS

- helmints
- arthropods

} MULTICELLULAR ORGANISMS

THE RANGE OF SIZES SHOWN BY PROKARYOTES, RELATIVE TO THOSE OF OTHER ORGANISMS AND BIOMOLECULES



Source: Wikipedia.org, Author: Tom Vickers

DIFFERENCES BETWEEN MICROOGRANISMS

I. NUTRITION

- autotroph
- heterotroph

II. OXYGEN REQUIREMENTS

- aerobes
- facultative aerobes
- microaerophiles
- aerotolerant
- obligate anerobes

III. METABOLISM

- fermentation
- aerobic respiration
- anaerobic respiration

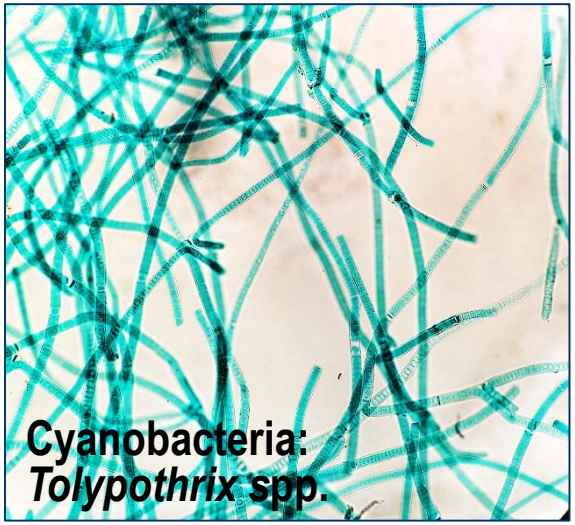
IV. TEMPERATURE REQUIREMNTS

- psychrophiles
- mesophiles
- thermophiles

= factors influencing the settlement in a par-ticular host organism

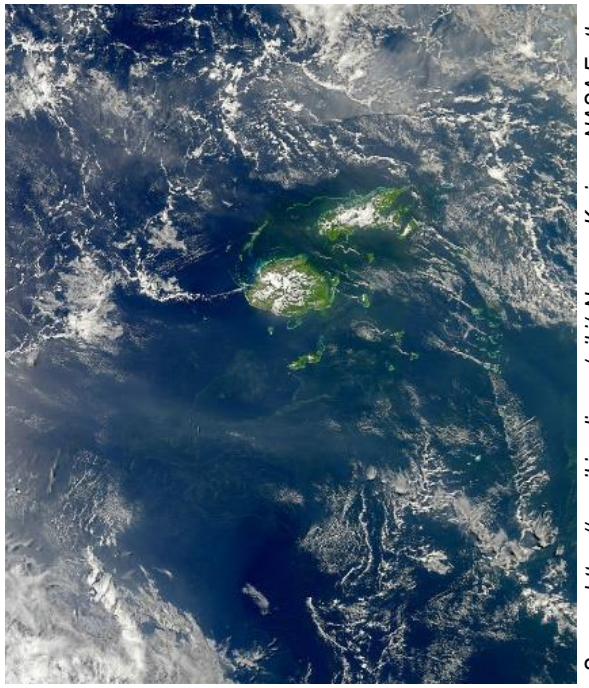
NUTRITION

- **autotrophs** („self-feeding“ organisms) produce organic compounds from simple anorganic substances present in its surrounding; they do not need a living source of energy or organic carbon (e.g., algae, come bacteria



Source: https://en.wikipedia.org/wiki/;Matthewiparker

- **heterotrophs** – inable to produce organic compounds from anorganic; their nutrition depends on the existence of autotroph organisms



Source: https://en.wikipedia.org/wiki/; Norman Kuring – NASA Earth Observatory

Cyanobacterial bloom near Fiji.

GROUPS OF ORGANISMS AND THEIR METABOLISMS

GROUP OF ORGANISMS	OXYGEN REQUIREMENTS	METABOLISM
obligate aerobes	survive and grow only in an oxygenated environment	aerobic respiration
facultative aerobes	can tolerate different concentration of oxygen, but in the presence of oxygen grow better	aerobic and anaerobic respiration, fermentation
microaerophiles	require oxygen for energy production, but in lower than atmospheric concentration	aerobic respiration
facultative anaerobes	do not use oxygen, but are not harmed by it	fermentation
obligate anaerobes	do not use oxygen which can kill them	fermentation or anaerobic respiration

TEMPERATURE

Psychrophiles

- survive under temperatures of below 20 °C

Mesophiles

- survive under temperatures of 20°- 45° C

Thermophiles

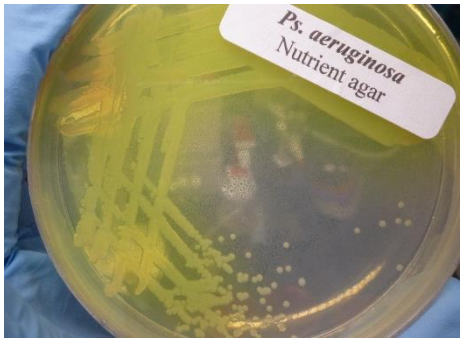
- survive under temperatures of 45° - 60 °C

PSYCHROPHILES

- survive under temperatures of below 20 °C

Toleration to extreme cold: *Athrobacter* spp., *Pseudomonas* spp. *Hypho-monas* spp., etc.

***Pseudomonas* spp.** - known for its ubiquity, can cause disease in plants and animals, including humans



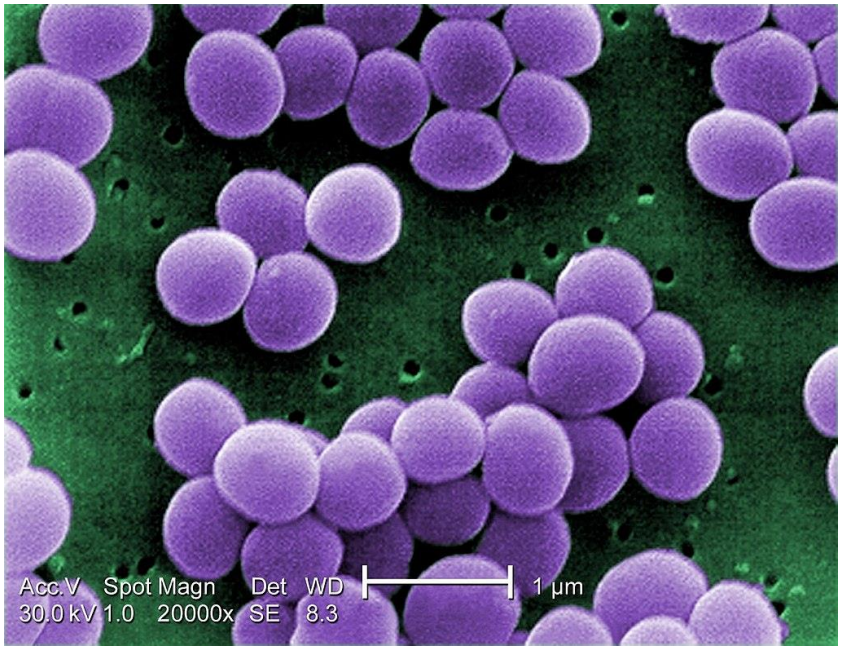
Pseudomonas aeruginosa: Gram-negative, rod shaped bacterium of medical importance – multidrug resistant pathogen associated with serious illnesses – hospital acquired infections (ventilator-associated pneumonia, various sepsis syndromes)

Sources of pictures: wikipedia.org

MESOPHILES

- survive under temperatures of 20°- 45° C;
grow optimal at 37 °C

Staphylococcus aureus



Under a very high magnification of 20,000x, this scanning electron micrograph (SEM) shows a strain of *Staphylococcus aureus* bacteria taken from a vancomycin interme-diate resistant culture (VISA).

Escherichia coli

Sources of pictures: https://en.wikipedia.org/wiki

THERMOPHILES

- survive under temperatures of 45° - 60°C

Occurrence: geothermally heated regions and deep see hydrothermal vents, as well as decaying plat matter (peat bogs, compost)

Grand Prismatic Spring and Midway Geyser Basin,
Yellowstone National Park: brigth color produced by thermophils

Sources : https://en.wikipedia.org/wiki

Why to know these properties?

REQUIREMENTS OF MICROORGANISMS

NUTRITION, ENERGY, TEMPERATURE, OXYGEN

+

OTHER FACTORS INFLUENCING GROWTH AND REPRODUCTION
(.g., hydrostatic pressure; concentration of hydrogen ions; etc.)

CULTIVATION OF MICROORGANISMS *IN VITRO*

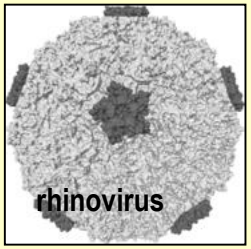
→ **IDENTIFICATION OF INFECTIOUS AGENT**

STUDY → **ADEQUATE THERAPY**
PREVENTION OF INFECTION

BASIC GROUPS OF MICROBIAL PATHOGENS

A. VIRUSES

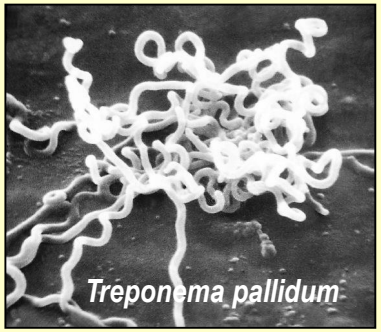
+ subviral agents (viroids)
+ prions


rhinovirus

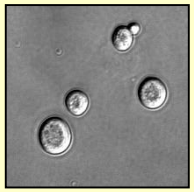

Virus tabákové mozaiky

B. BACTERIA


Escherichia coli


Treponema pallidum

C. MIKROMYCETES (YEAST CELLS)

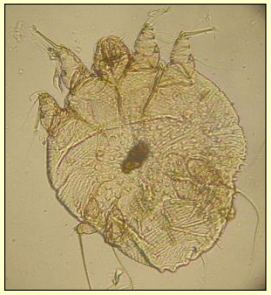

kvasinky

D. PARASITES

protists
helminths
arthropods

Giardia


mikrofilárie



PRIONS

Abnormal transmissible pathogenic agents (PrPSc)

- ability to induce abnormal folding of specific normal cellular proteins called prion proteins (PrPc)

- - abnormal folding leads to tissue-brain damage

PRIONS

Abnormal transmissible pathogenic agents (PrPSc)

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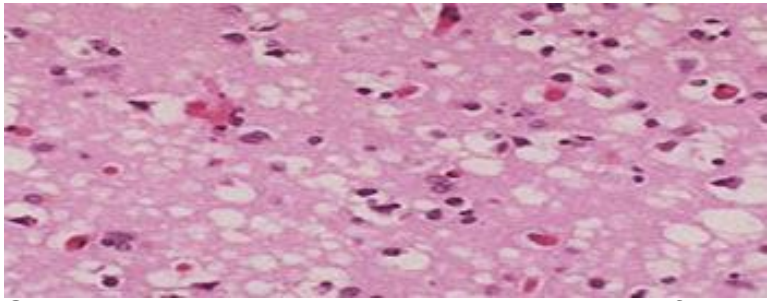
  - - abnormal folding leads to tissue-brain damage

Prion diseases (transmissible spongiform encephalopathies, TSEs)

- rare progressive neurodegenerative disorders in humans, animals
- long incubation periods
- characteristic spongiform changes associated with neuronal loss
- failure to induce inflammatory response.

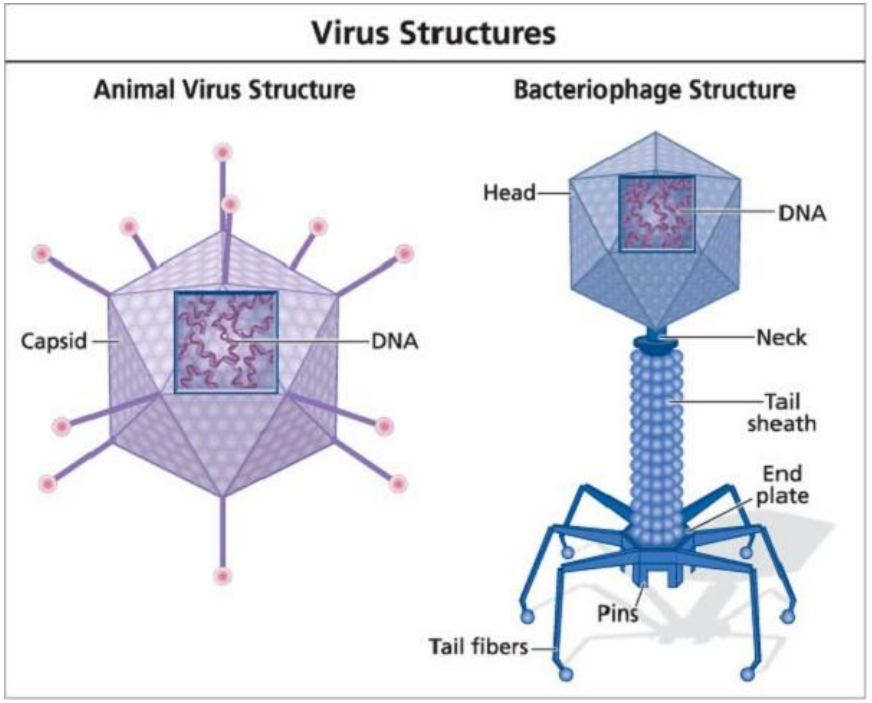


Sponge-like lesions in the brain tissue of a classic CJD patient. *Source: CDC*

Creutzfeldt-Jakob Disease (CJD)
Variant Creutzfeldt-Jakob disease (vCJD)
Bovine spongiform encephalopathy (BSE)
Chronic wasting disease (CWD)

VIRUSES

- **Small infectious agents** - most have a diameter between 20 and 300 nm (i.e., cannot be seen with optical microscope).
- **Transmission:** travelling within a fluid, such as mucus droplets from a sneeze.
- **Replication only inside the living cells**.
- **Infect all types of hosts** (animals, plants, microorganisms, including bacteria and archaea)



Source: http://www.printablediagram.com/labeled-virus-diagram/; image via imgarcarde.com

VIRUSES

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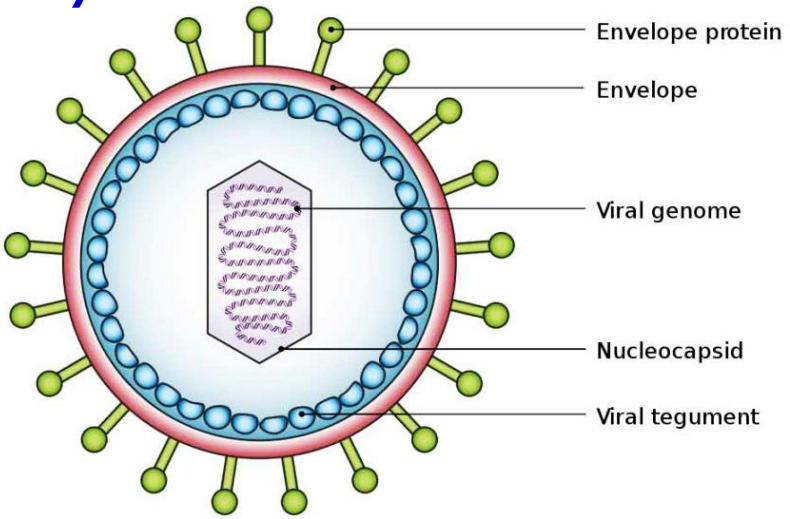
STRUCTURE OF VIRAL PARTICLES (VIRIONS)

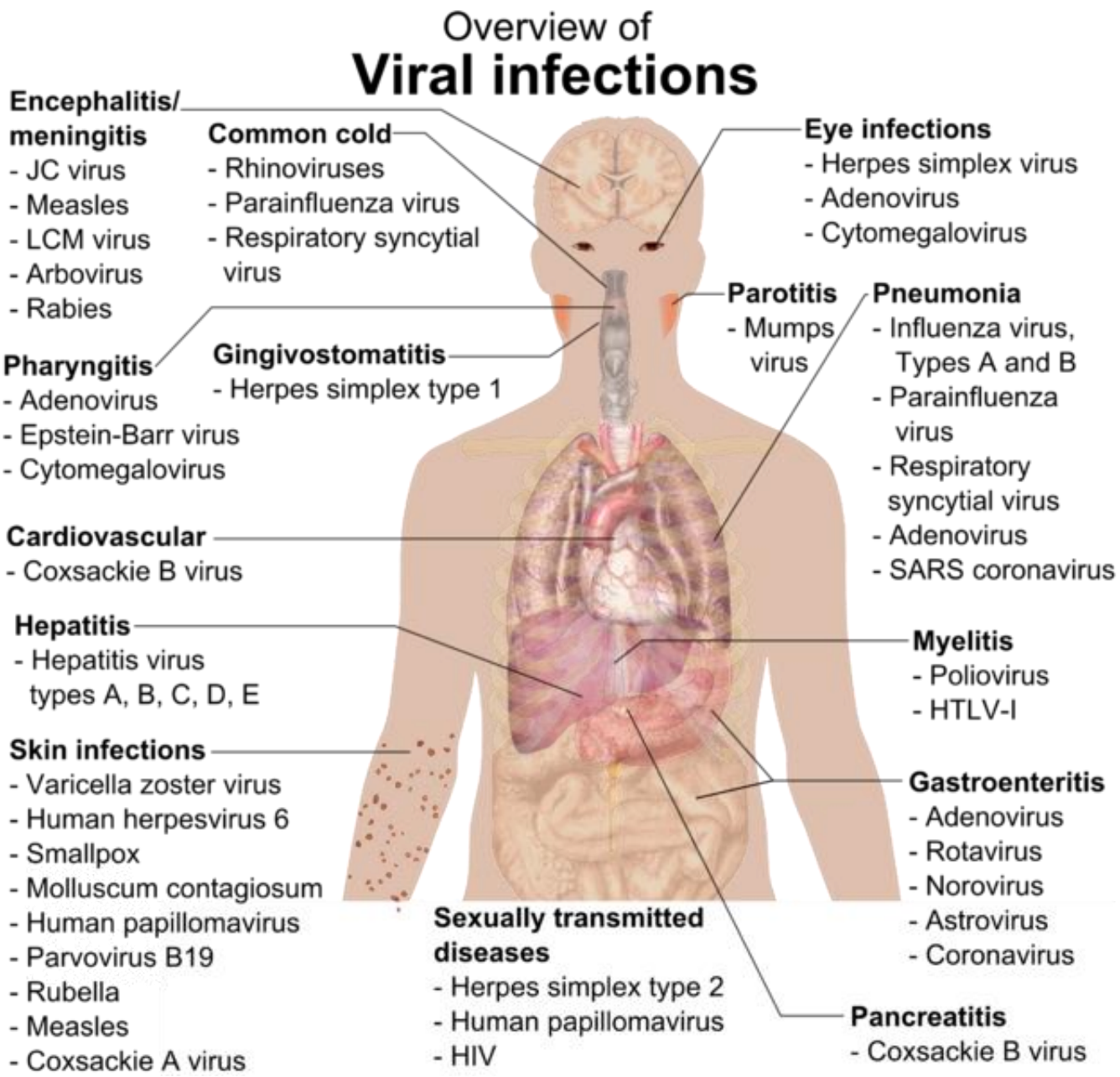
- **genetic material - DNA or RNA (long molecules that carry genetic information)**
- **protein coat (capsid) – surrounds and protect genetic material**
- **envelope of lipids in some of them**
- **shape from single helical to isohedralforms**



Source: http://www.printablediagram.com/labeled-virus-diagram/; image via pstudy.com

Genomic diversity among viruses	
Property	Parameters
Nucleic acid	- DNA - RNA - Both DNA and RNA (at different stages in the life cycle)
Shape	- Linear - Circular - Segmented
Strandedness	- Single-stranded - Double-stranded - Double-stranded with regions of single-strandedness
Sense	- Positive sense (+) - Negative sense (−) - Ambisense (+/−)

A virus has either a DNA or a RNA genome and is called a DNA virus or a RNA virus, respectively. The vast majority of viruses have RNA genomes. Plant viruses tend to have single-stranded RNA genomes and bacteriophages tend to have double-stranded DNA genomes.



Source: Häggström, Mikael (2014). "Medical gallery of Mikael Häggström 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.008. ISSN 2002-4436. Public Domain.

HERPES

Herpes labialis

Author: Metju 12

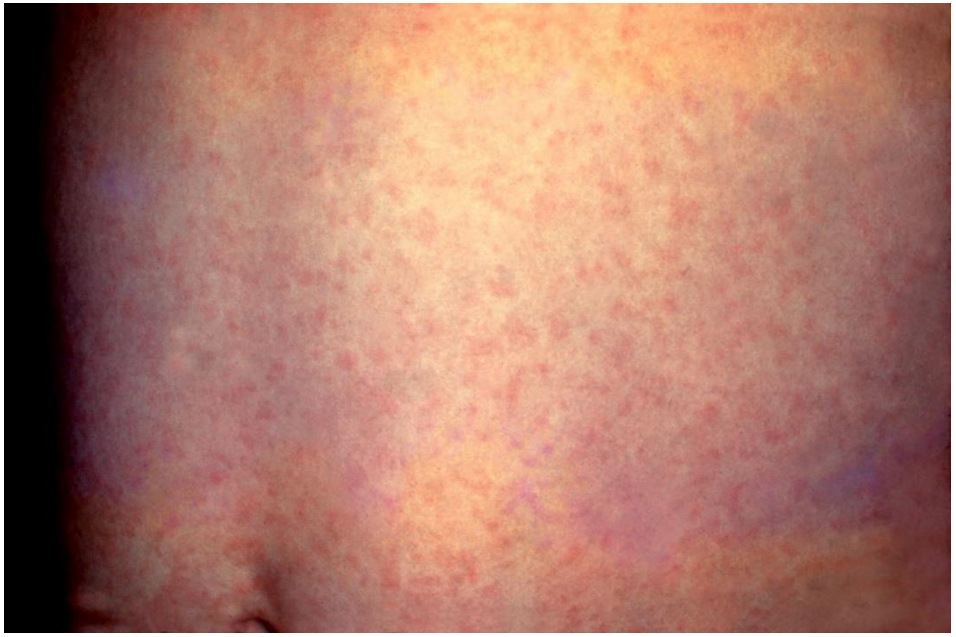
VARICELLA

Varicella zoster virus

Source: https://study.com/academy/lesson/varicella-zoster-virus-symptoms-treatment.html; author: Thomas Netsch

RUBELLA

Rubella virus (RuV)



Generalized rash on the abdomen. *Source: CDC.com*

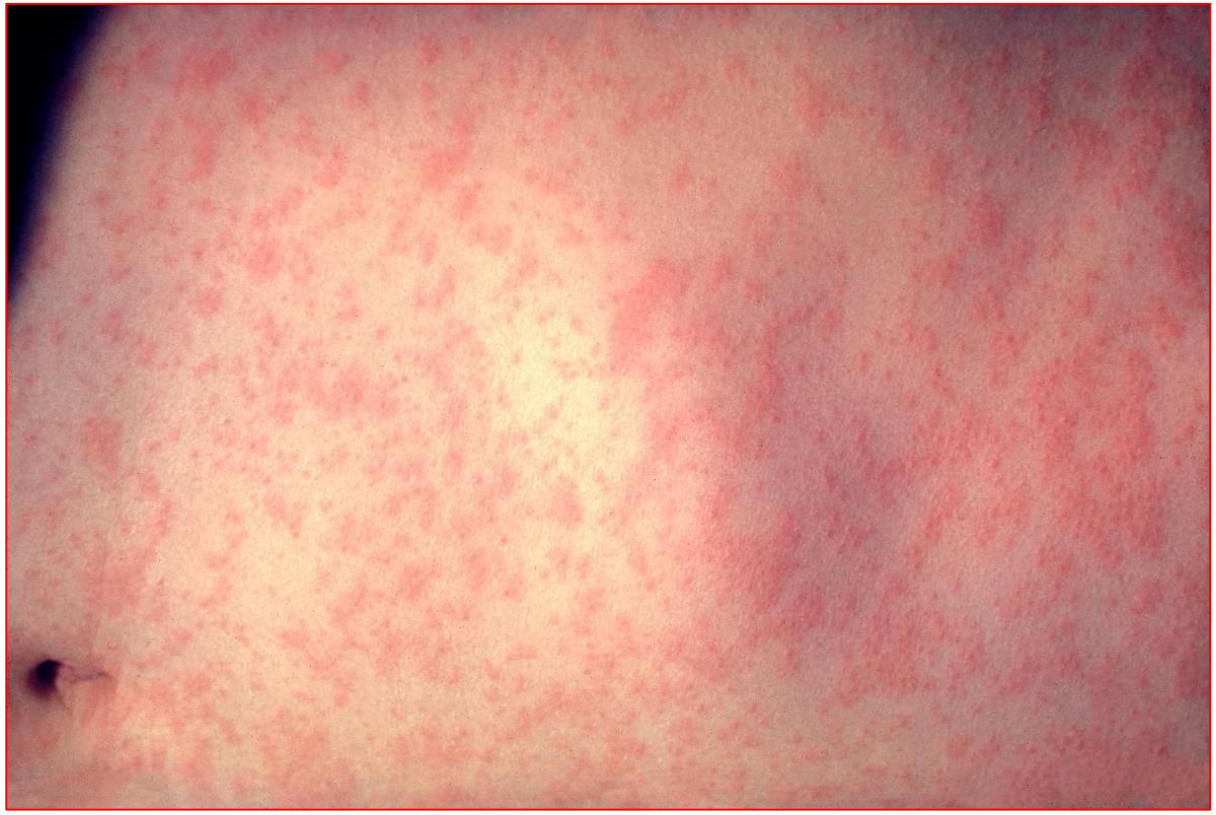
Cataracts due to congenital rubella syndrome.
Source: http://phil.cdc.gov/phil

MEASLES (Morbilli)

Causative agent: Measles virus (MeV)

A classic day-4 rash with measles.

Source: CDC/NIP/ Barbara Rice



Skin of a person after 3 days of measles infection.

Source: CDC/Dr. Heinz F. Eichenwald

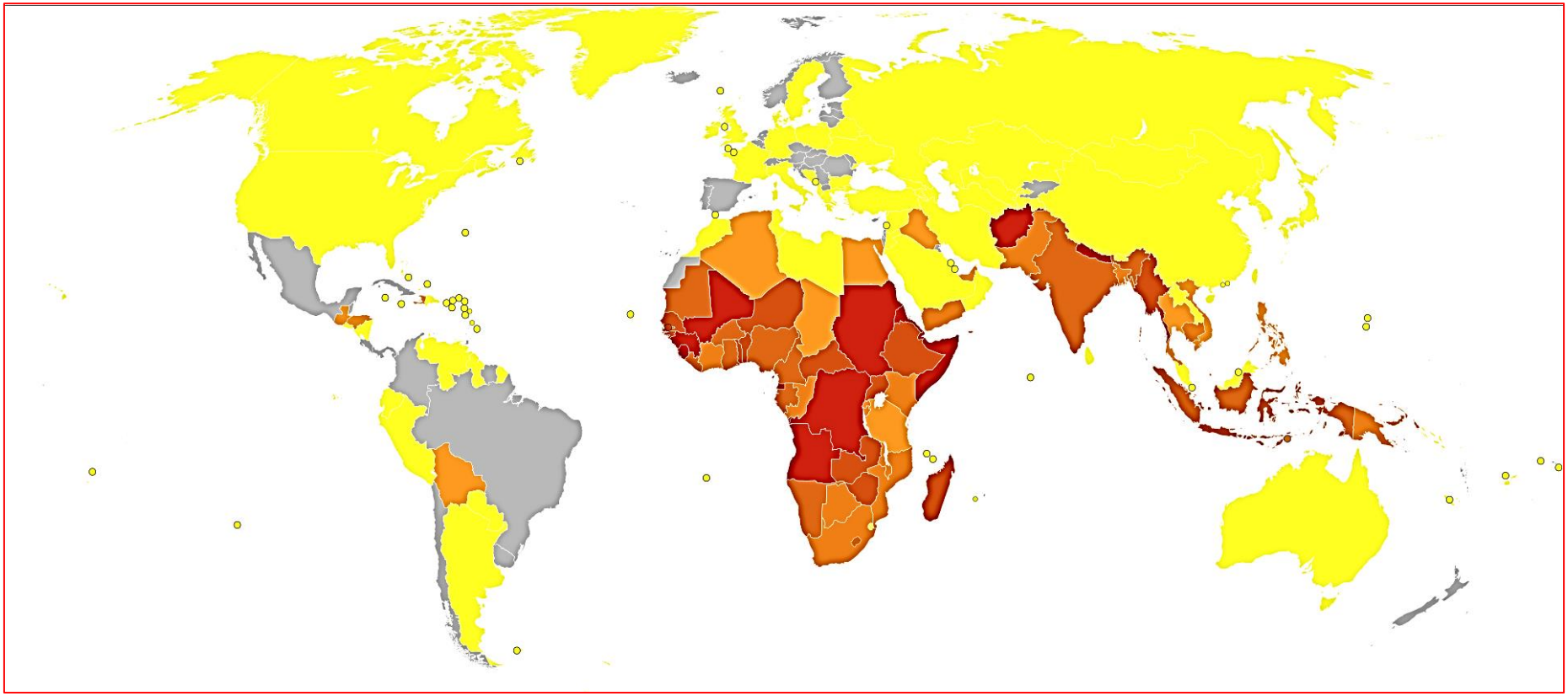
MEASLES (Morbilli)

Causative agent: Measles virus (MeV)

Kolpik's spots on the third pre-eruptive day. *Source: CDC*

Koplik's spots on the day of measles rash. *Source: Wikipedia, Dctrzl - Own work*

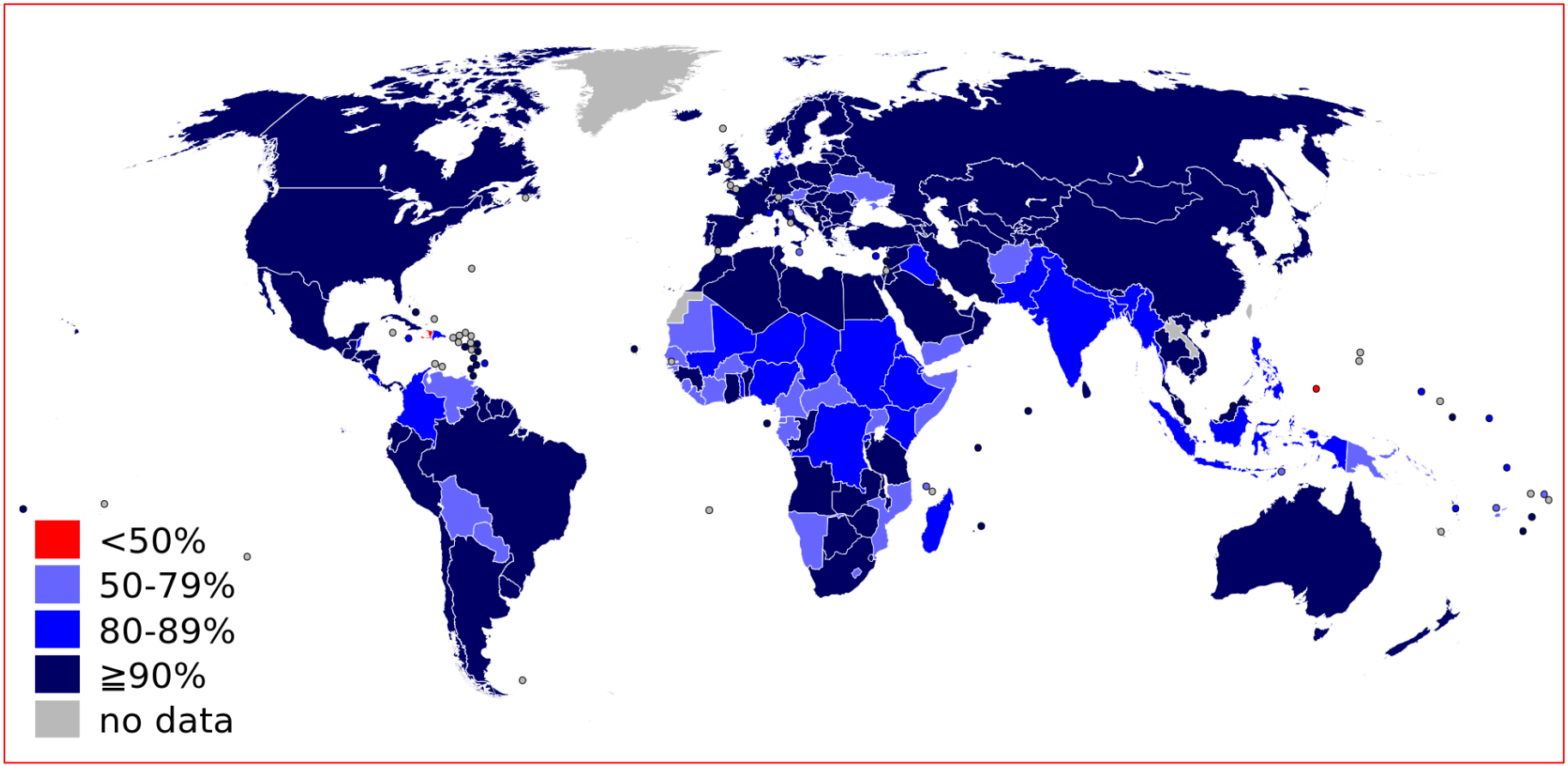
Deaths from measles per million persons in 2012



Source: WHO, Wikipedia

- 0
- 1–8
- 9–26
- 27–38
- 39–73
- 74–850

Rates of measles vaccination worldwide

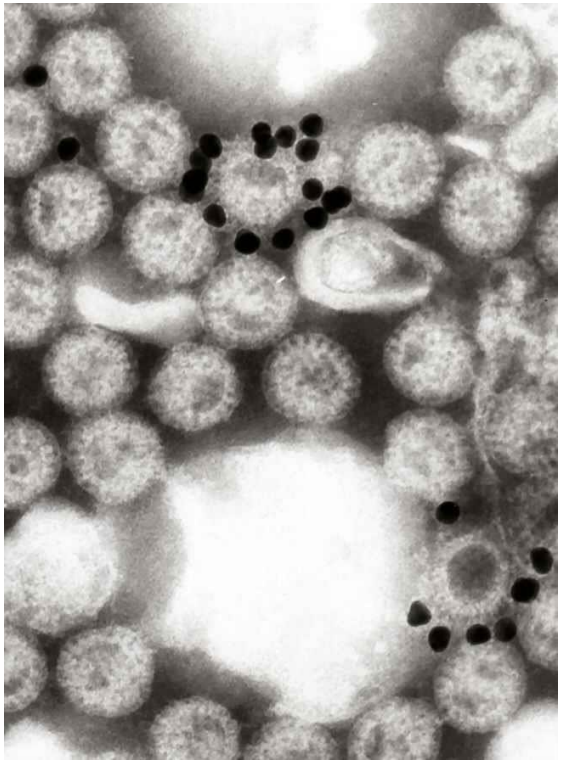


Source: Wikipedia, BlankMap-World8.svg: AMK1211

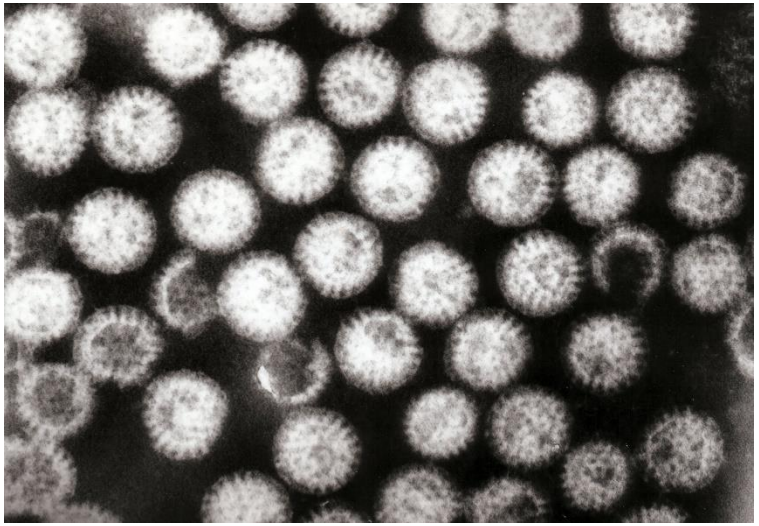
DIARRHEA

Rotaviruses

(primary human infection by species A, B and C, most commonly by species A



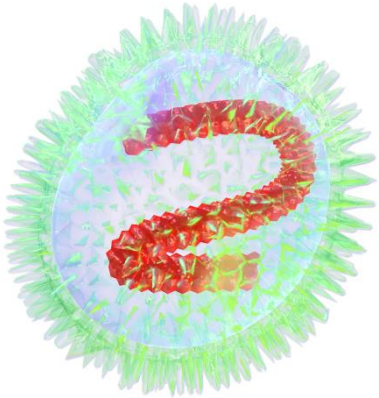
Electron micrograph of rovirus particles reacting with a monoclonal antibody specific for the viral capsid protein Vp6.
Author: Dr. Graham Beards. Source: Wikipedia.org



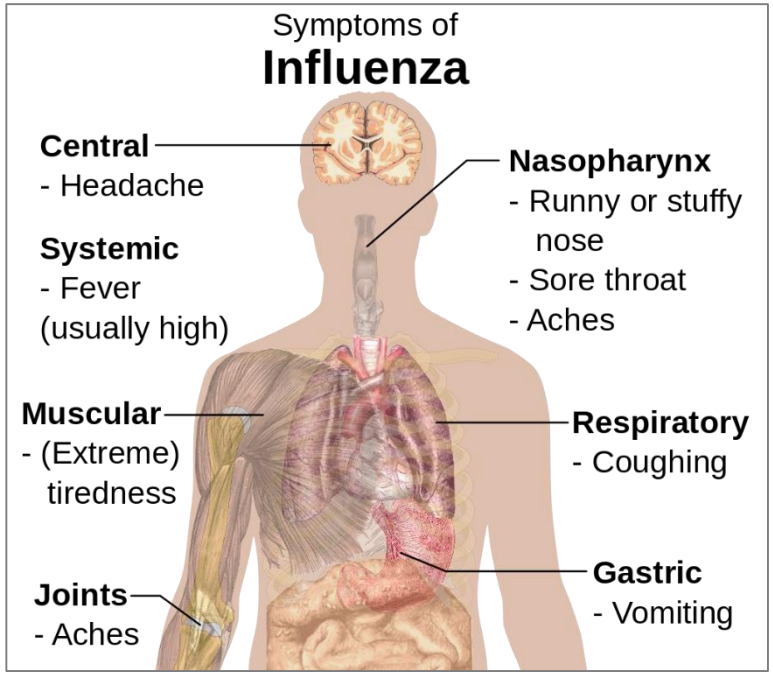
Rotaviruses in the faeces of an infected child. *Author: Dr. Graham Beards. Source: Wikipedia.org*

INFLUENZA (the flu)

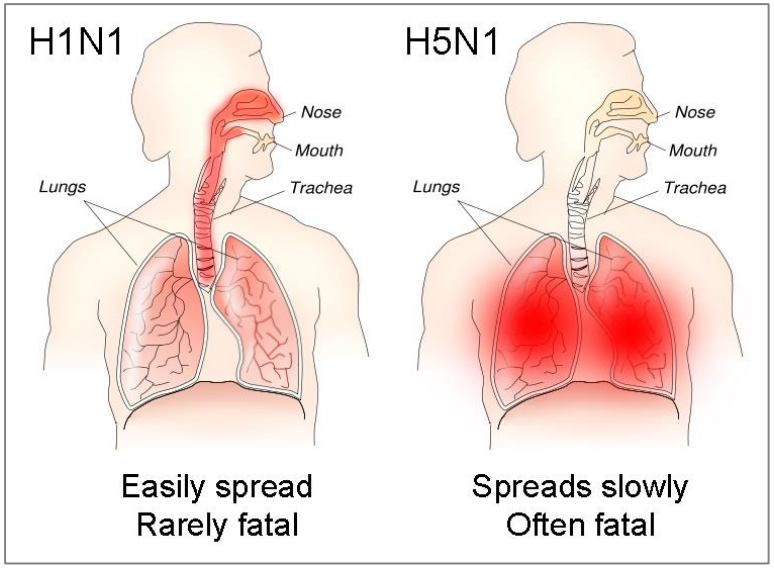
Influenza viruses



Influenza virus. *Author: BruceBlaus, Source: Wikimedia Commons*



Source: Medical gallery of Mikael Häggström 2014. WikiJournal of Medicine 1 (2). ISSN 2002-4436.



The different sites of infection (shown in red) of seasonal H1N1 versus avian H5N1.
Author: TimVickers, Source: Wikimedia Commons

CORONAVIRUS DISEASE 2019 (COVID-19)

Other names:

- 2019-nCoV acute respiratory disease
- novel coronavirus pneumonia (2019-nCoV)

CORONAVIRUS DISEASE 2019 (COVID-19)

Initial identification

Wuhan (Hubei province, China, December 2019)

CORONAVIRUS DISEASE 2019 (COVID-19)

- **infectious disease**
- causative agent: **severe acute respirátory syndrome coronavirus 2 (SARS-CoV-2)**
  (formerly 2019 novel coronavirus 2019-nCo V)
- spread: **between people via respiratory droplets**
- time from exposure – to symptoms: **generally 2-14 days**
- limitation of spread: **handwashing and other hygiene measures, wearing a surgical mask**

CORONAVIRUS DISEASE 2019 (COVID-19)

- symptoms: **the infection may initially present with few or no symptoms**
  or develop into fever, coughing, shortness of breath, pain in the muscles, tiredness
- complications: **pneumonia, ARDS, kidney failure**
- diagnostic method: **PCR testing, medical imaging**
- treatment: **symptomatic and supportive only**
  no specific antivirals available

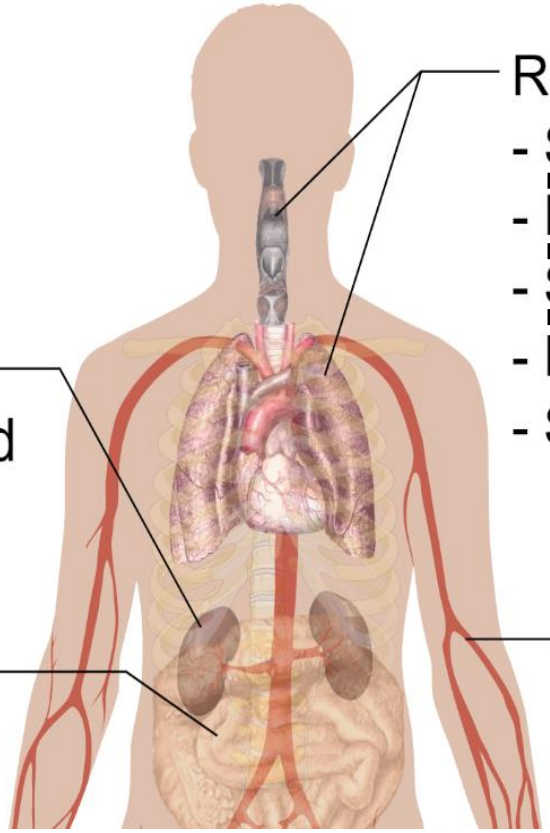
ARDS – acute respiratory distress syndrome

CORONAVIRUS DISEASE 2019 (COVID-19):
SYMPTOMS

Systemic:
- Fever
- Fatigue

Kidneys:
- Decreased function

Intestines:
- Diarrhea



Respiratory:
- Sneezing
- Runny nose
- Sore throat
- Dry cough
- Shortness of breath

Circulatory system:
- Decreased white blood cells

less frequent

CORONAVIRUS DISEASE 2019 (COVID-19):
TRANSMISSION MODES

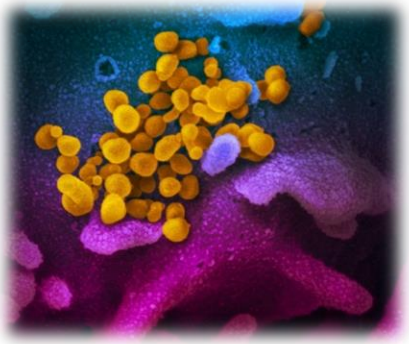
Transmission:

→ **direct**

→ **contact**

→ **aerosol**

- someone touches a surface contaminated with tainted respiratory droplets
- inhalation of air contaminated with tainted respirátory droplets



Scanning electron microscope image of SARS-CoV-2 (yellow)

CORONAVIRUS DISEASE 2019 (COVID-19):

LIMITATION OF SPREAD

- **frequent washing of hands with soap and water**
- **not touching the eyes, nose, or mouth with unwashed hands**
- **practicing good respiratory hygiene**

PREVENTION OF TRANSMISSION

- infected individuals stay at home except to get medical care
- call ahead before visiting a healthcare service
- wear a facemask (especially in public)
- cover couhgs and sneezes with a tissue
- regular wash hands with soap and water
- avoid sharing personal household items

CORONAVIRUS DISEASE 2019 (COVID-19):

LIMITATION OF SPREAD

- frequent washing of hands with soap and water
- not touching the eyes, nose, or mouth with unwashed hands
- practicing good respiratory hygiene

PREVENTION OF TRANSMISSION IN HOSPITALS

recommendations see www.who.int

HEPATITIS

	TRANSMISSION
Hepatitis A virus (HAV)	- fecal-oral
Hepatitis B virus (HBV)	- by infectious fluids (blood, mucus)
Hepatitis C virus (HCV)	- fecal-oral
Hepatitis D virus (HDV)	- by infectious fluids (blood, mucus)
Hepatitis E virus (HEV)	- by infectious fluids (blood, mucus)

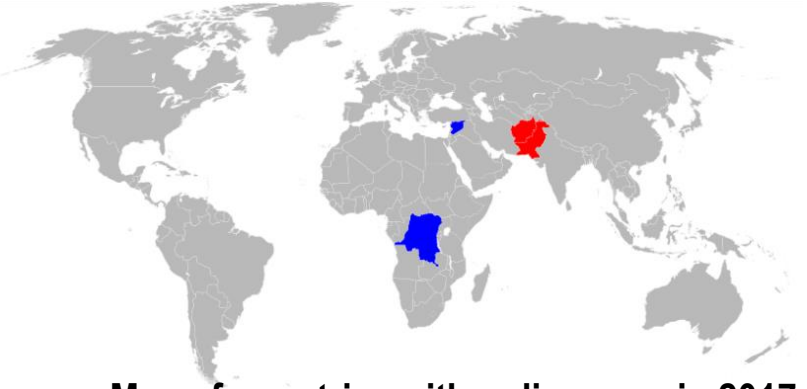
Symptoms:

Yellow discoloration of the skin and whites of the the eyes, poor appetite, vomiting, tiredness, abdominal pain, or diarrhea.

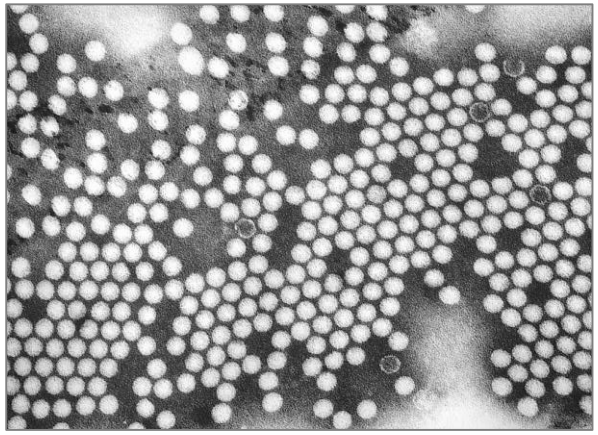
Jaundiced eyes. *Source: http://phil.cdc.gov/phil. Author: Thomas F. Sellers/Emory University Thomas F. Sellers/Emory University*

POLIOMYELITIS

Highly contagious via the fecal-oral (intestinal source) and the oral-oral (oropharyngeal source) routes.



Map of countries with polio cases in 2017.
Source:https://en.wikipedia.org/wiki/Poliomyelitis



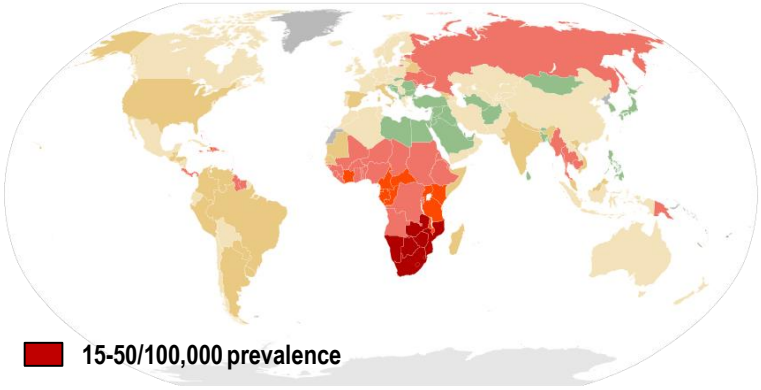
Poliovirus. TEM. *Source: https://en.wikipedia.org/wiki/Poliomyelitis*

A girl with a deformity of her right leg due to polio
Source: https://phil.cdc.gov

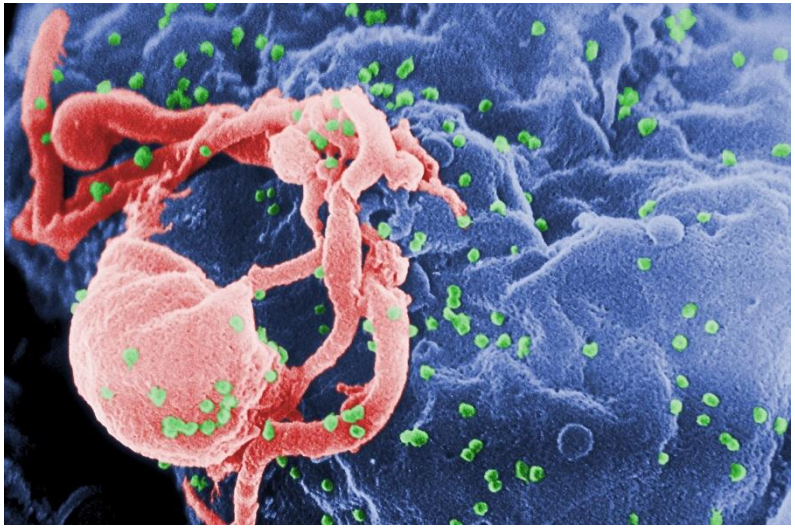
Man with atrophy and paralysis of the right leg and foot due to polio. *Source: CDC/NIP/ Barbara Rice*

HIV/AIDS

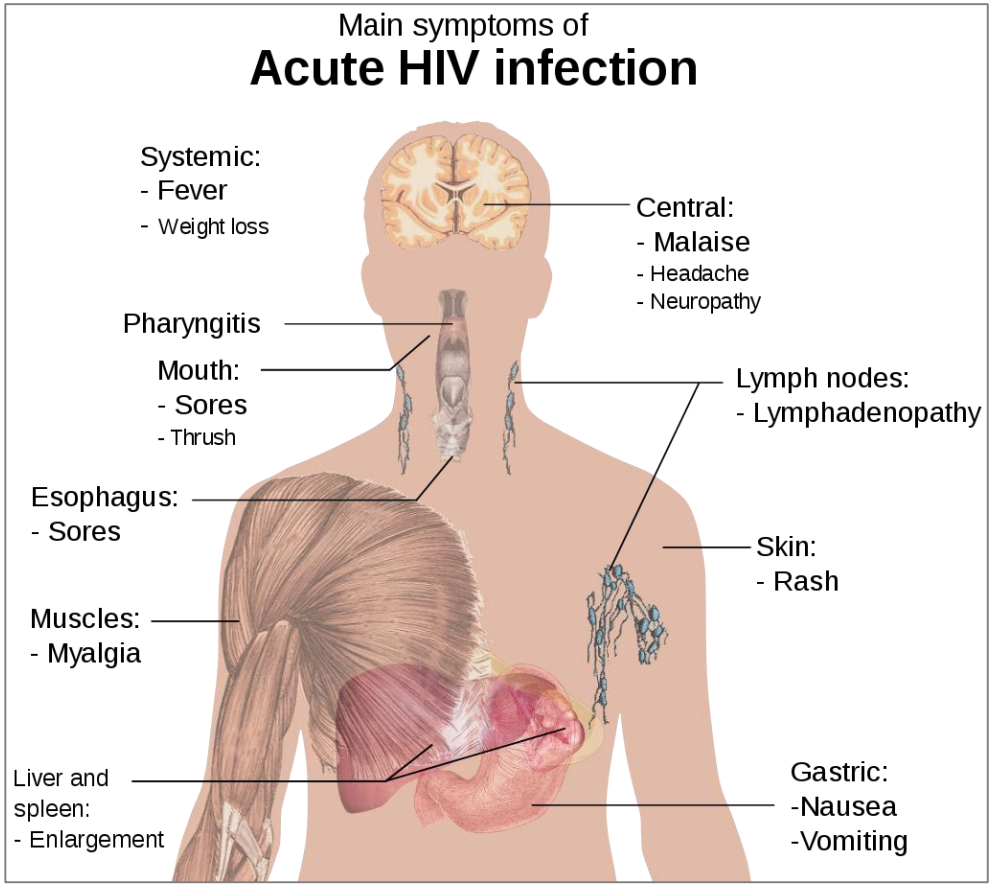
Causative agent: human immunodeficiency virus (HIV)



https://en.wikipedia.org/wiki/HIV/AIDS



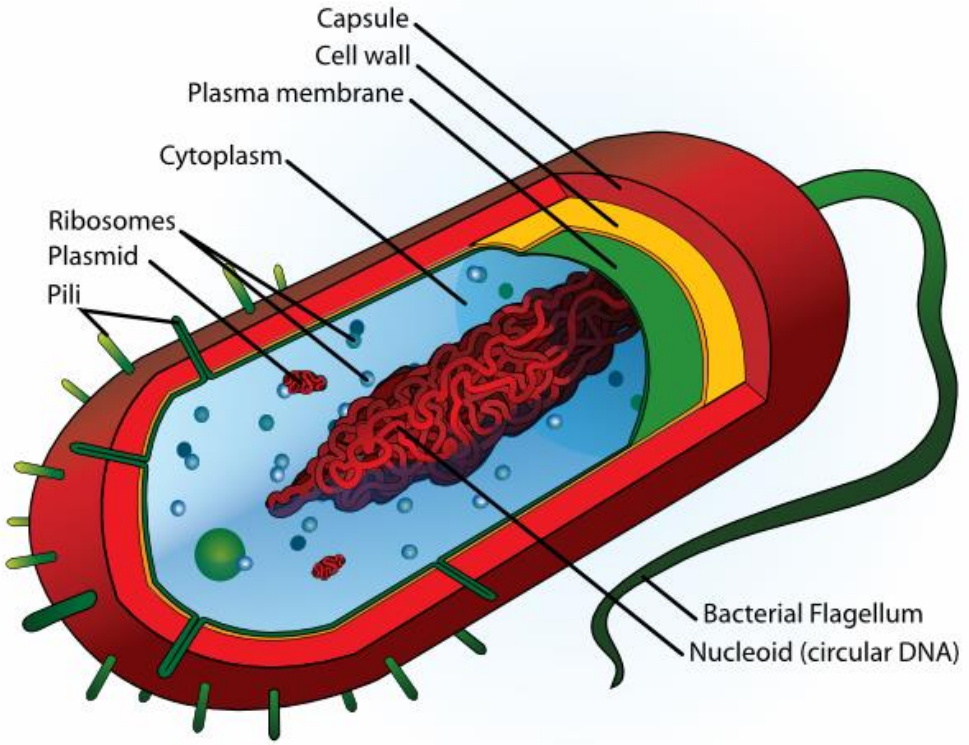
HIV-1 (colored green) budding from a cultured lymphocyte.
Source: CDC.com



Source: Medical gallery of Mikael Häggström 2014. WikiJournal of Medicine 1 (2). ISSN 2002-4436.

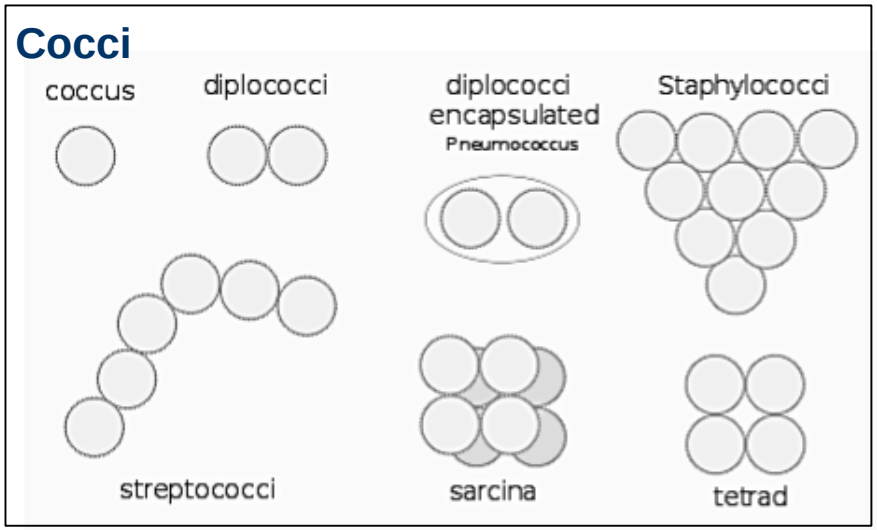
BACTERIA

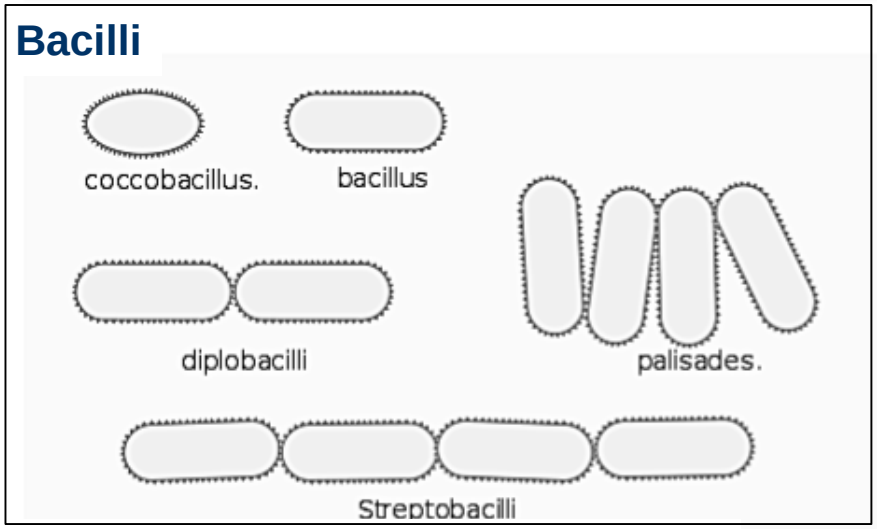
- **Wide diversity in:**
  - **sizes** (typically 0.5–5.0 μm in length)
  - **shape (cocci, bacilli, vibrio, spirilla, spirochaetes)**
- **Unicellular**
- **Lack of membrane-bound nucleus, mitochondria and membrane-bound organelles**
- **Own metabolism**

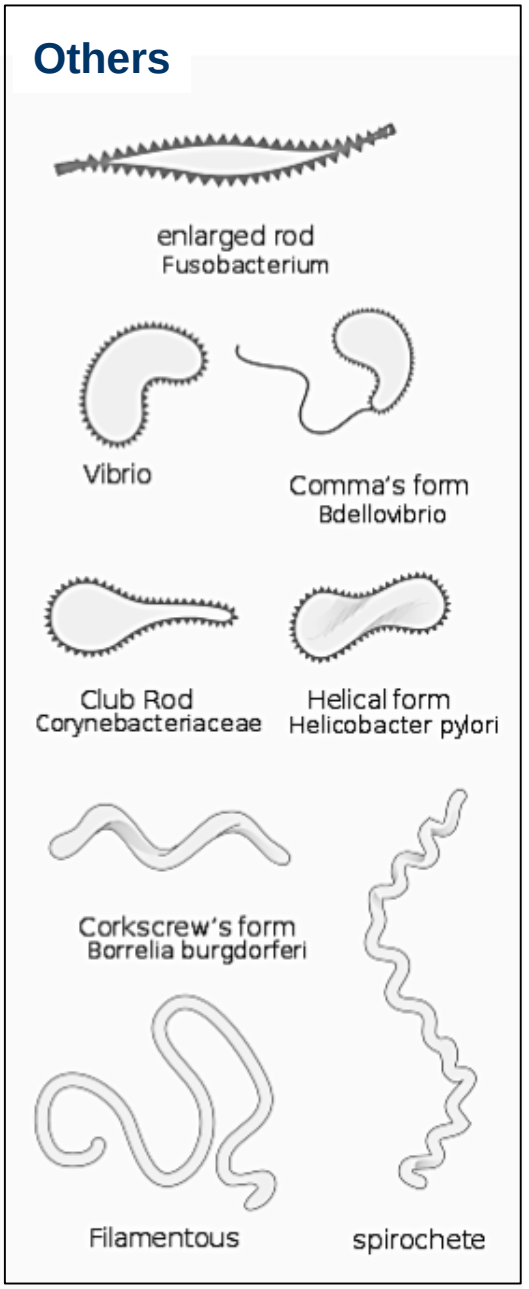


Source: http://www.printablediagram.com/bacteria

MORPHOLOGY AND ARRANGEMENT OF BACTERIA



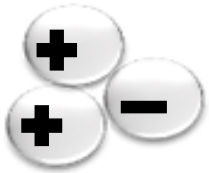
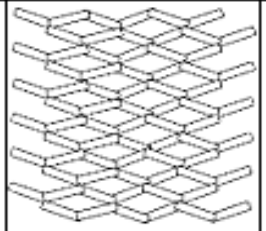
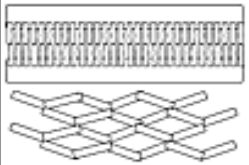
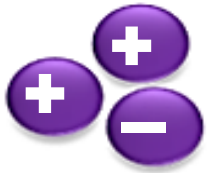
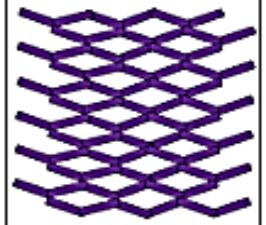
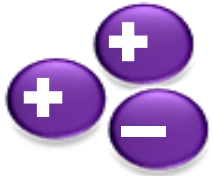
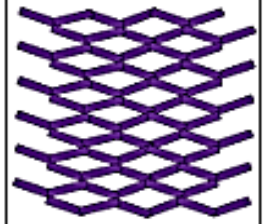
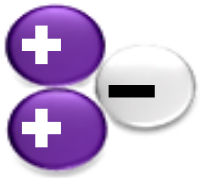
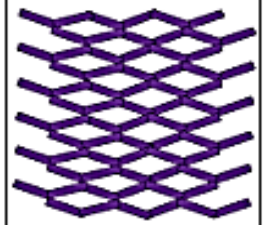
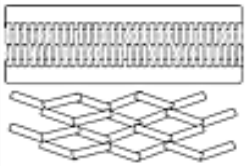
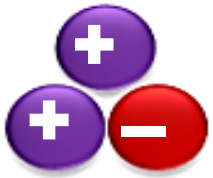
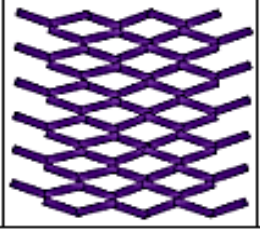
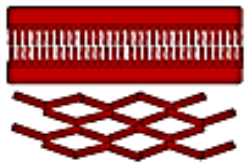




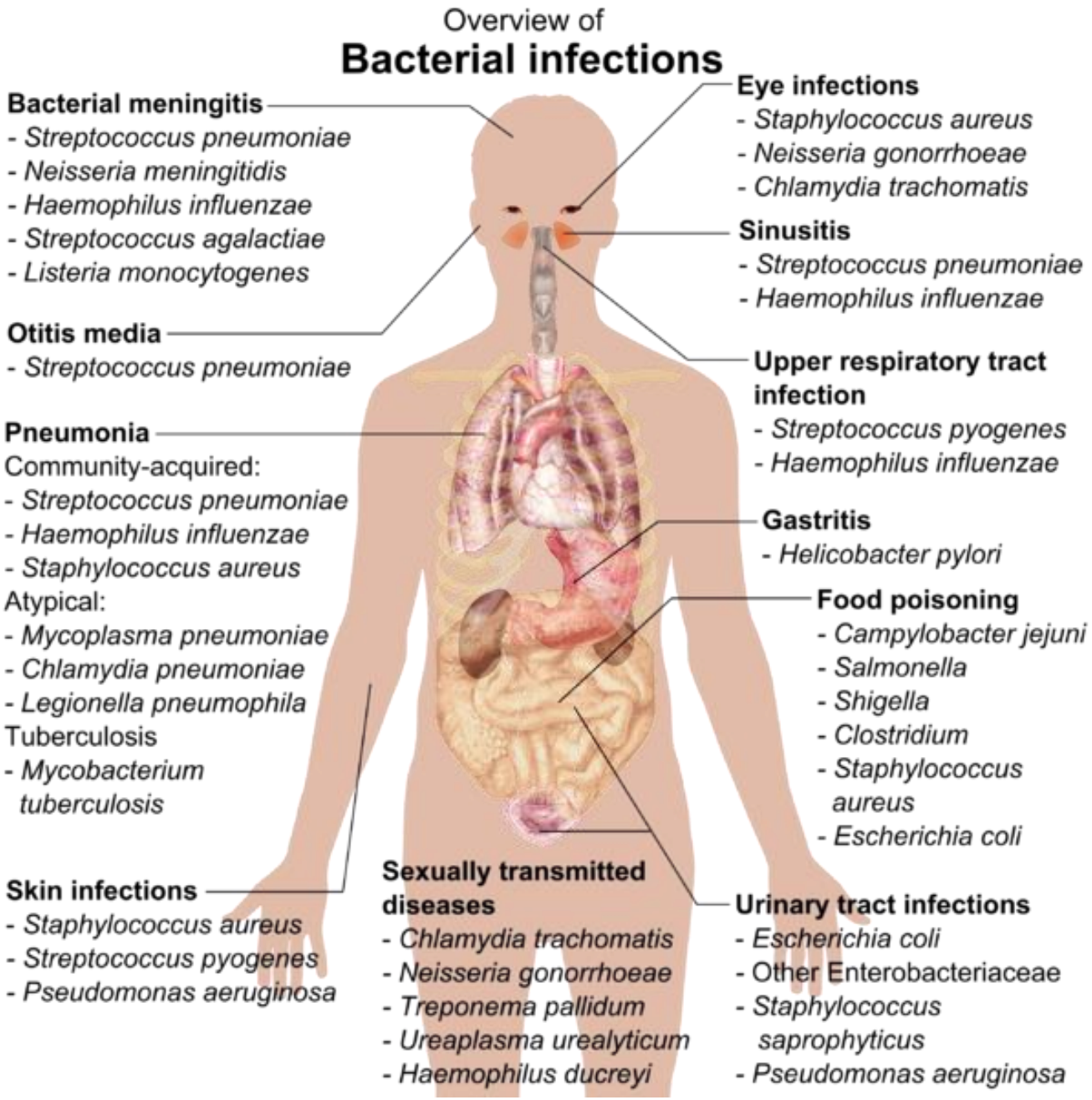
Source:: Wikipedia.org.

GRAM

STAINING

Gram staining procedure		Gram-positive cell wall		Gram-negative cell wall	
Process of test	Appearance of Cells	Effect of Step	Effect on Cell Wall	Effect of Step	Effect on Cell Wall
Step 1: Begin with heat fixed cells **fixation**		**Step 1:** Cell wall remains clear.		**Step 1:** Cell wall remains clear.	
Step 2: Flood slide with crystal violet dye for 1 min. **crystal violet**		**Step 2:** Peptidoglycan cell wall is flooded with crystal violet and appears purple.		**Step 2:** Cell wall is stained purple from the crystal violet dye.	
Step 3: Add iodine solution for 1 min. **iodine**		**Step 3:** A crystal violet – iodine complex is formed within the peptidoglycan cell wall trapping the purple stain.		**Step 3:** A crystal violet-iodine complex is formed but does not adhere to the cell wall due to the thin layer of peptidoglycan.	
Step 4: Wash slide with alcohol for 20sec. **alcohol**		**Step 4:** The crystal violet – iodine complex is trapped with the peptidoglycan cell wall and doesn't wash out.		**Step 4:** The crystal violet – iodine structure is washed out of the thin peptidoglycan layer.	
Step 5: Counter stain with safranin. **safranin**		**Step 5:** As the peptidoglycan cell wall remains stained purple the red safranin has no effect.		**Step 5:** The red safranin stains the washed gram negative cells.	

Source: https://en.wikipedia.org/wiki/Gram

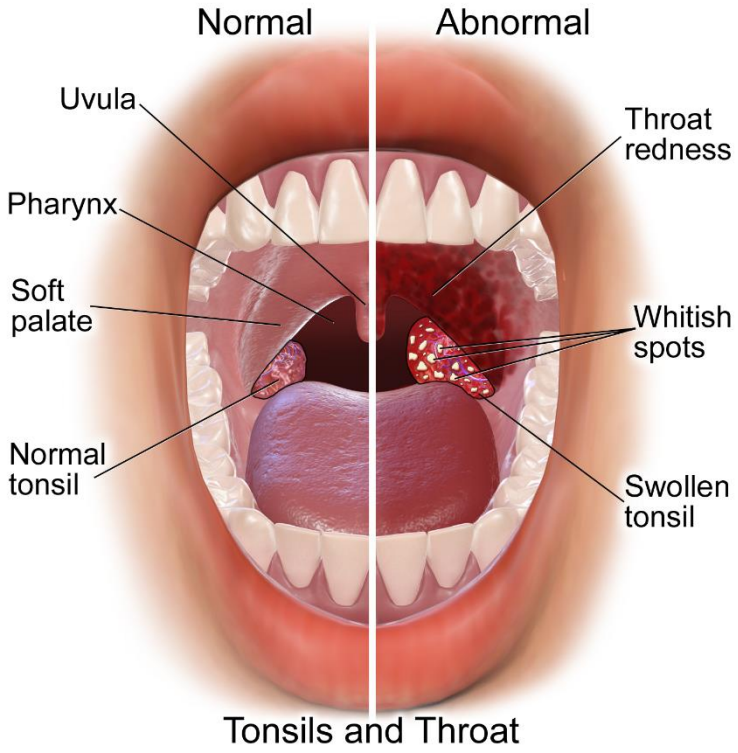


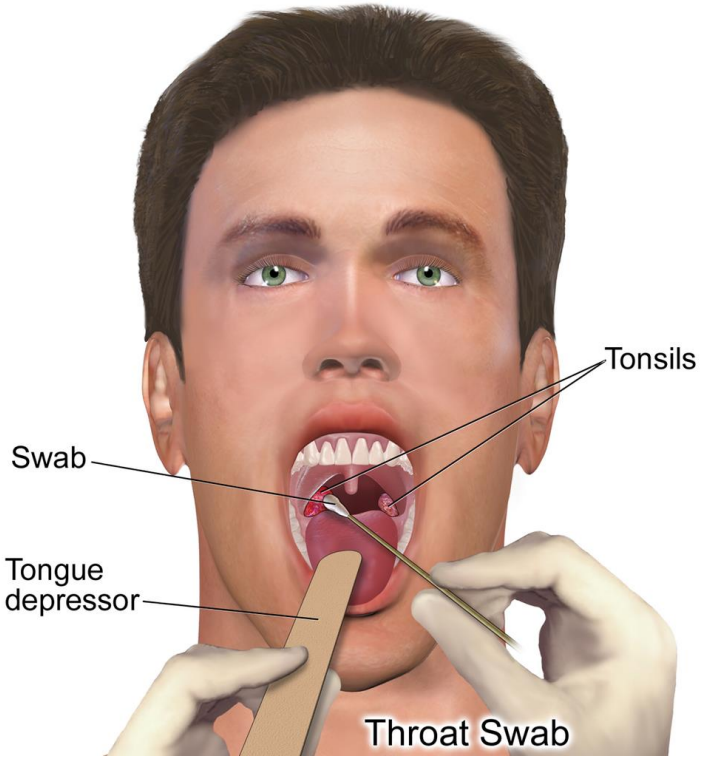
Source: Medical gallery of Mikael Häggström 2014. WikiJournal of Medicine 1 (2). ISSN 2002-4436.

TONSILLITIS

group A streptococcus (G+)

Streptococcal phyryngitis.
Source: https://commons.wikimedia.org/wiki/, author: James Heilman, MD

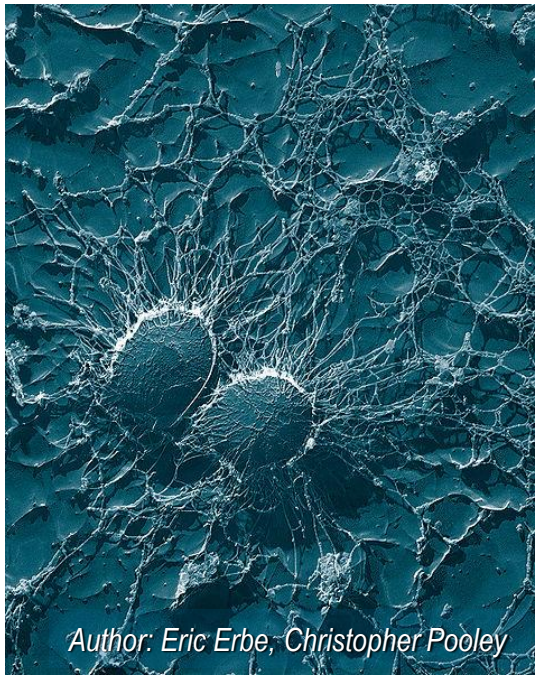




Source: Blausen.com staff (2014). Medical gallery of Blasen Medical 2014. WikiJournal of Medicine 1 (2).

PURULENT DISEASES

Staphylococcus aureus



SCARLET FEVER (SCARLATINA)

Source: a group A *streptococcus* (Group A strep) infection (G+)

Signs and symptoms: sore throt, fever, headaches, swollen lymph nodes, and a characteristic (red) rash – sandpaper; the tongue may be red and bumpy. Mostly affects children between five and 15 years of age.

Strawberry tongue seen in scarlet fever. *Source: https://en.wikipedia.org/wiki/; foto von Martin Kronawitter, Kellberg*

The rash of scarlet fever. *Source: he original uploader was Etreya at English Wikipedia. Foto: Alicia Williams.*

SCARLET FEVER (SCARLATINA)

Red cheeks and pale area around the mouth in scarlet fever.

Source: he original uploader was Etreya at English Wikipedia. Foto: Alicia Williams.

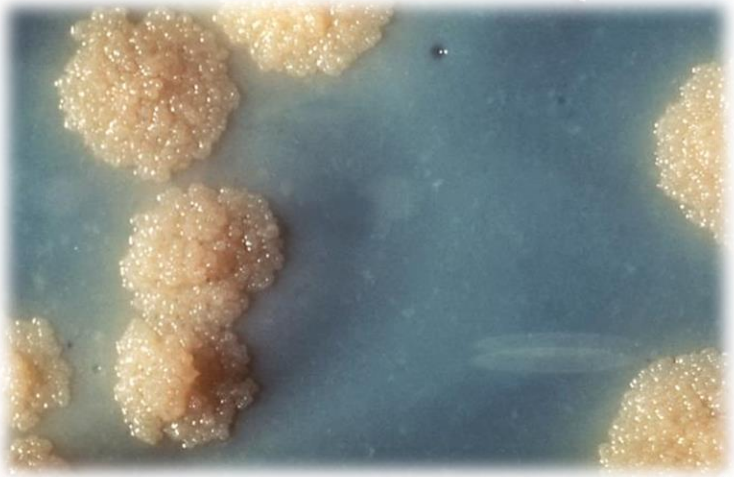
Heinrich Hermann **Robert KOCH**

(1843-1910)

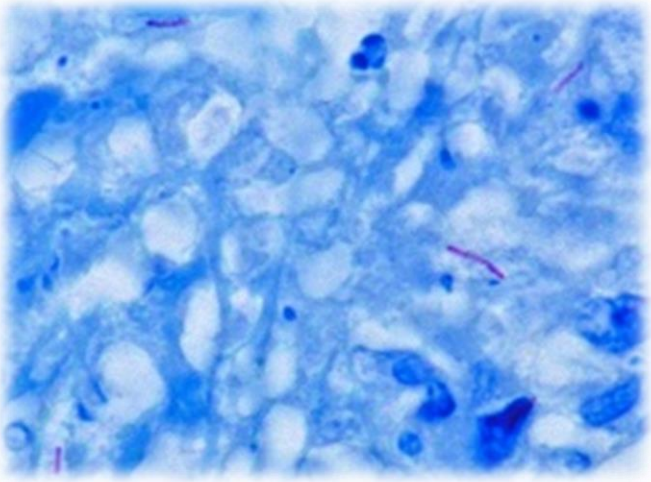
Source: wikimvisua.com

1892: Identification and cultivation of the causative agents tuberculosis (TB)

Mycobacterium tuberculosis



Mycobacterium tuberculosis



M. tuberculosis in the tissue

Source of pictures: Wikipedia.org

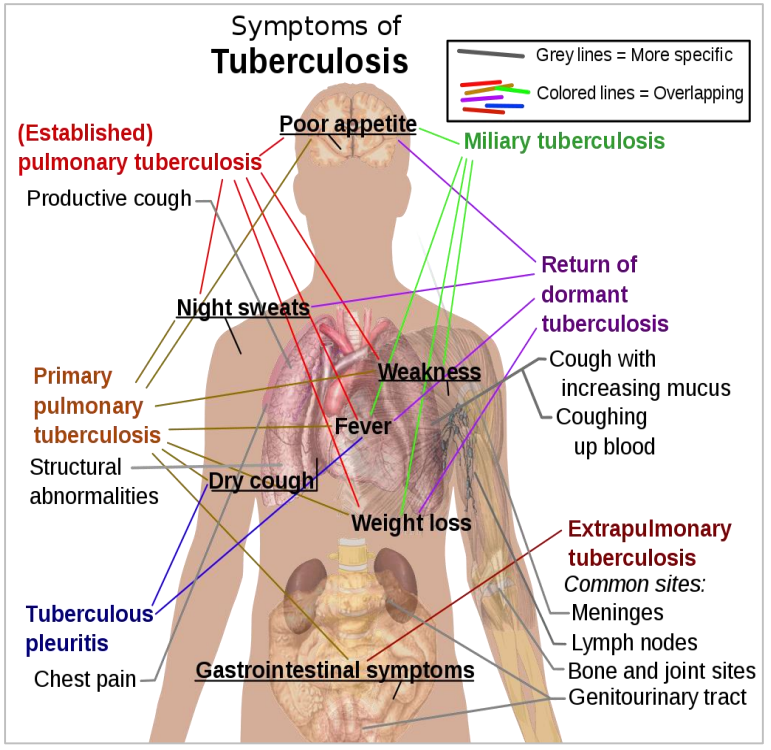
TUBERCULOSIS

Causative agent: *Mycobacterium tuberculosis* - a small, aerobic, non bacillus

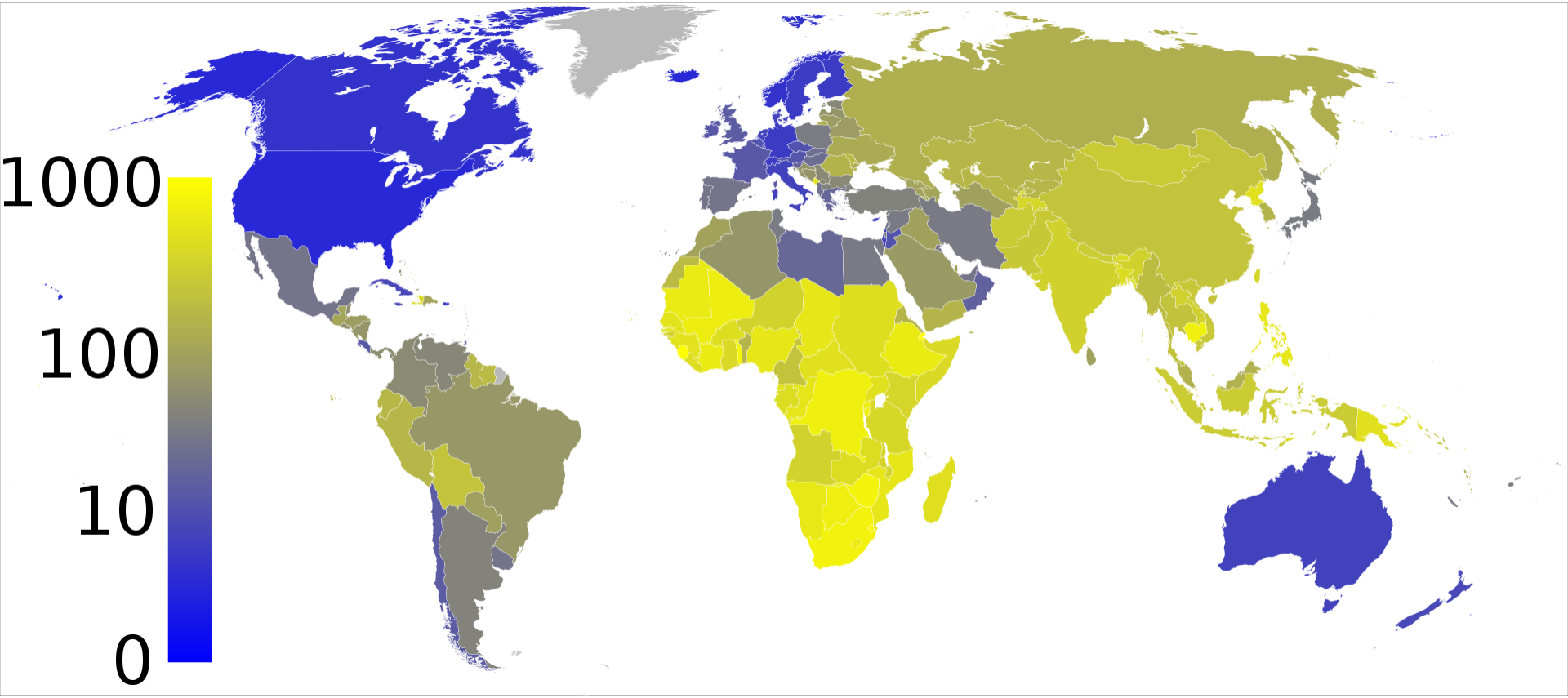
- an unusual, waxy coating on its cell surface primarily due to the presence of mycolid acid

- coating makes the cells impervious to Gram staining, and as a result, the bacteriae can appear either Gram-negative or Gram-positive.

- acid-fast stains [e.g., Ziehl-Neelsen or fluorescent stain (e.g.auramine)] are used instead to identify the bacteria microscopically

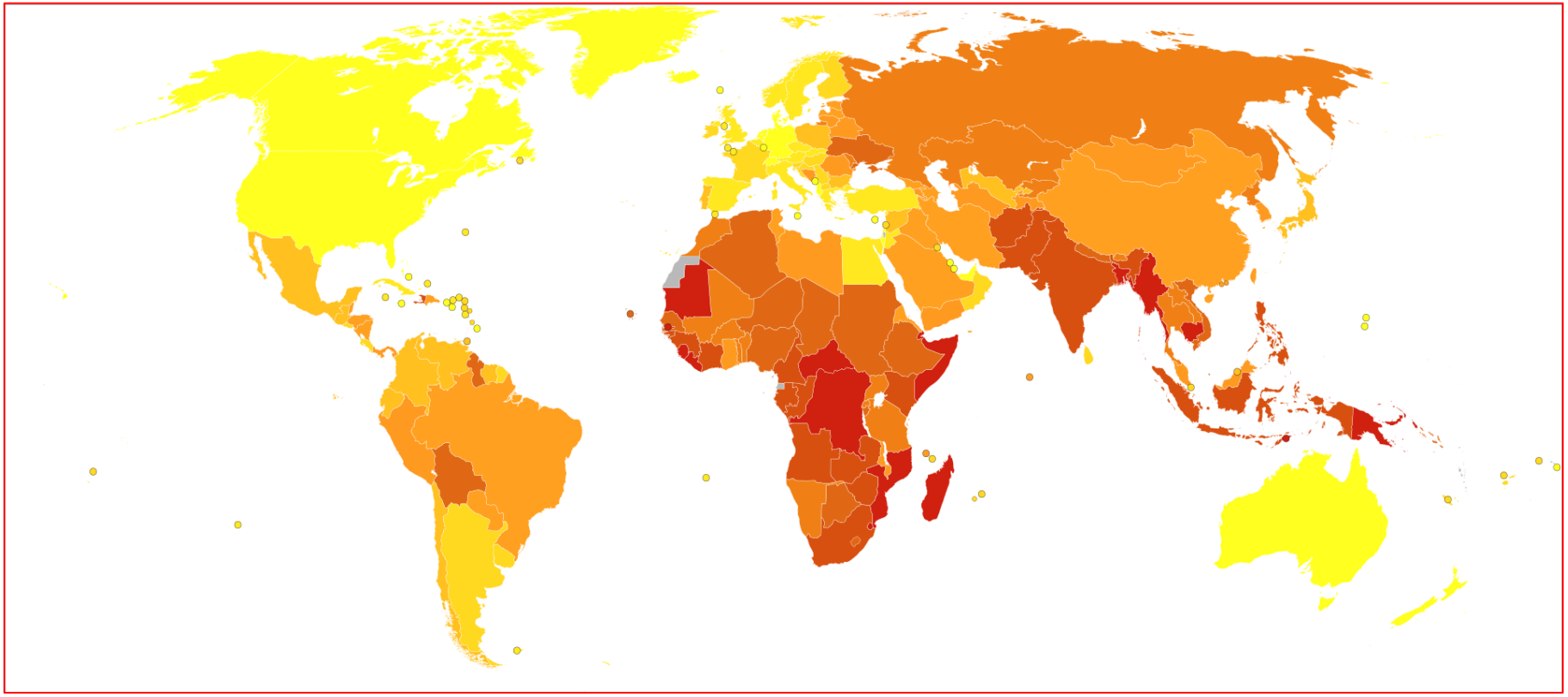


Source: Medical gallery of Mikael Häggström 2014. WikiJournal of Medicine 1 (2). ISSN 2002-4436.



In 2007, the number of cases of TB per 100,000 people was highest in sub-Saharan Africa, and was also relatively high in Asia

Tuberculosis deaths per million persons in 2012



0–3 4–7 8–16 17–26 27–45 46–83 84–137 138–215 216–443 444-1,359

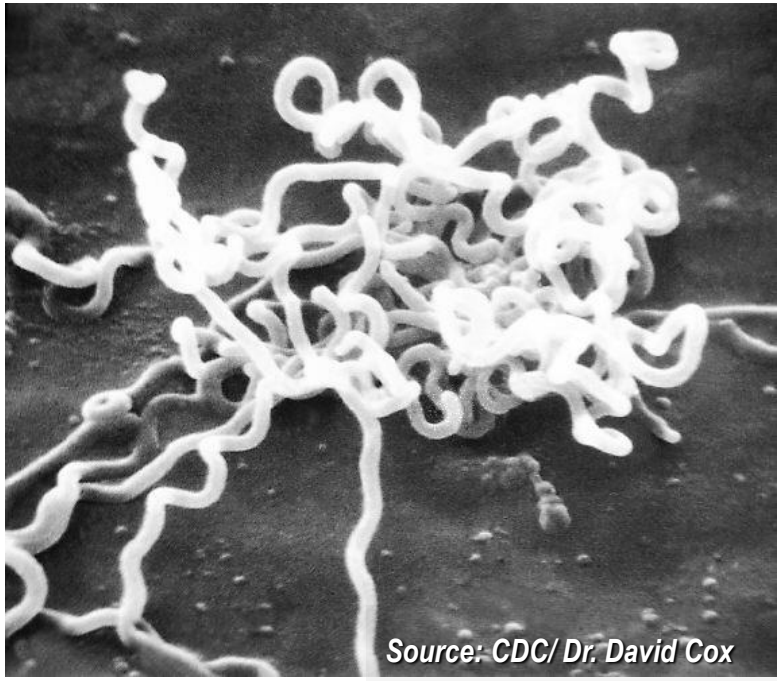
Egytian mummy in the British Museum – tubercular decay has been found in the spine.

SYPHILIS (BEJEL, PINTA, YAWS, etc.)

Causative agent:

spirochate bacterium (with subspecies) ***Treponema pallidum***

Under light microscopy, treponemes are visible only by using dark field illumination.

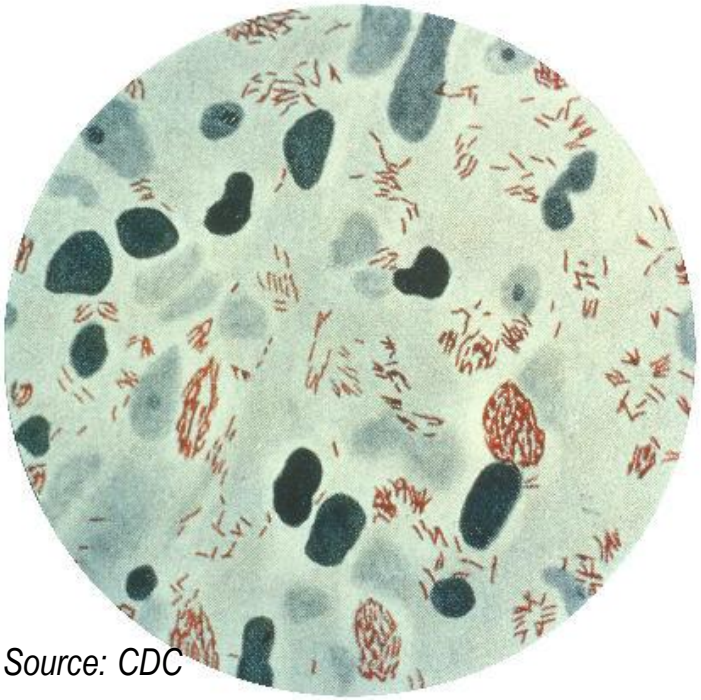


Model of a head of a person with tertiary (gummatous) syphilis that is located in Musée de l,Homme, Paris.

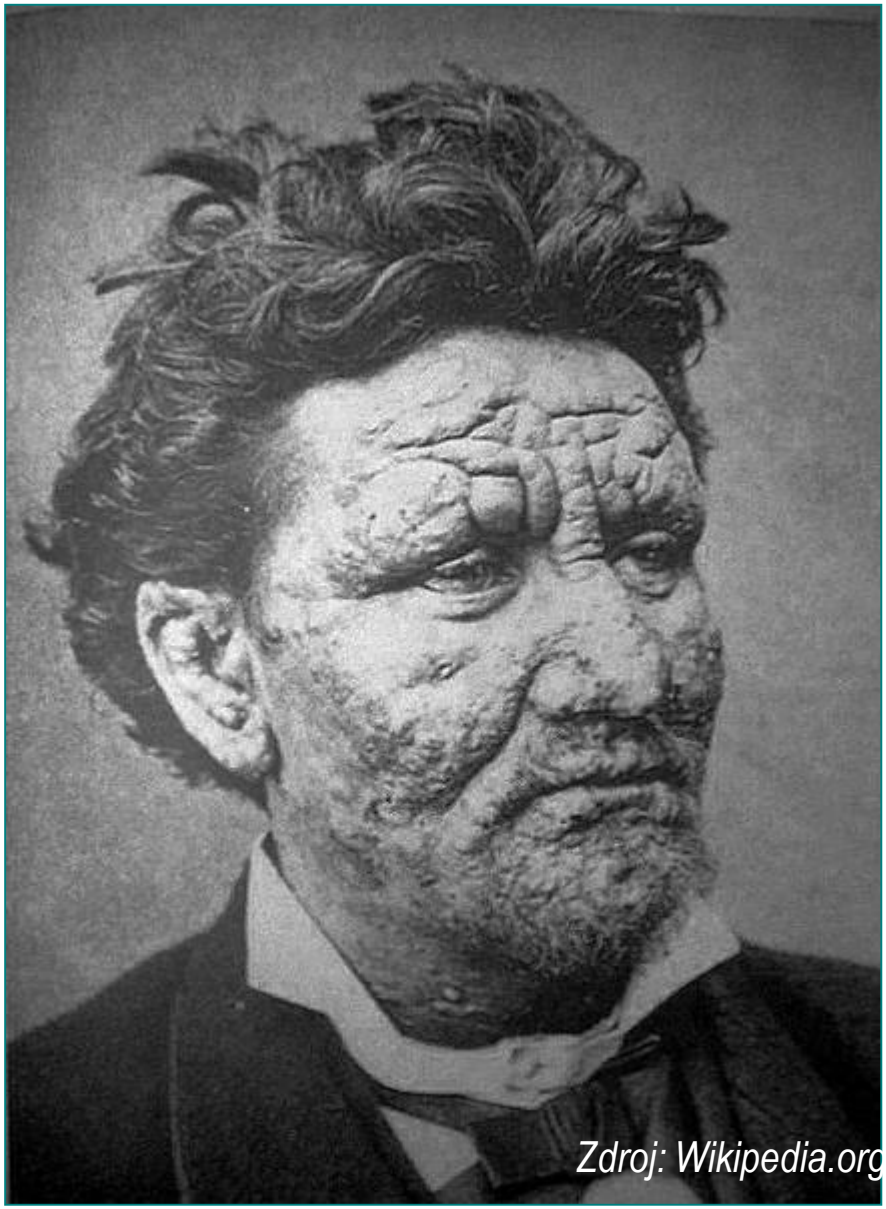
Source: wikipedia.com

LEPROSIS
(Hansen's disease (HD)

Mycobacterium leprae



Source: CDC



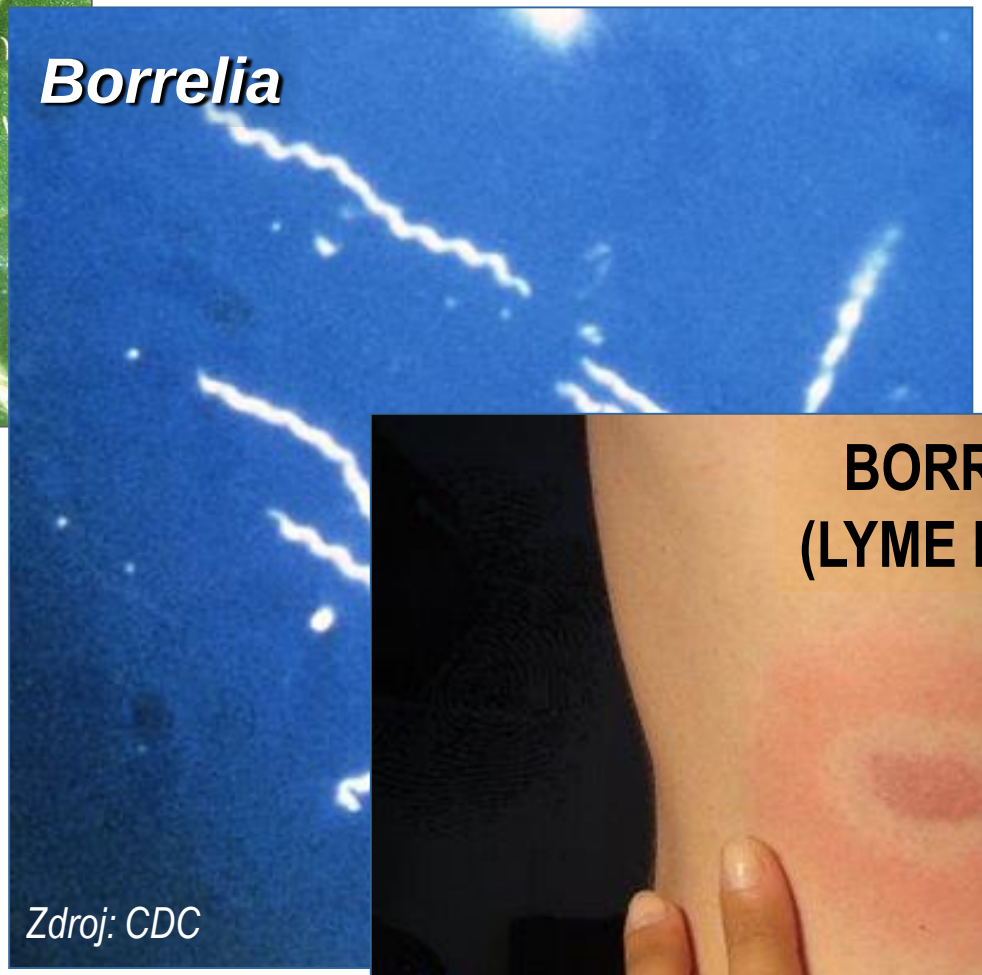
Zdroj: Wikipedia.org

A 24-year-old man with leprosy (1886)

LEPER COLONY

Spinalonga, Crete – on of the last colony in Europe closed in 1957. Source: *https://en.wikipedia.org/wiki/*

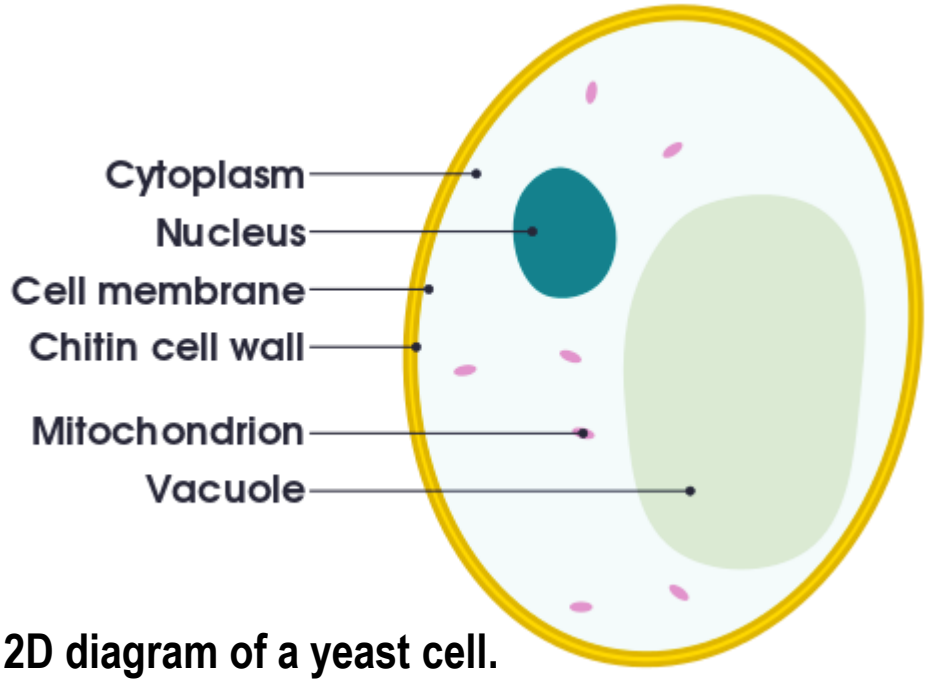
Zdroj: Agricultural Research Service, photo by Scott Bauer.



Zdroj: CDC

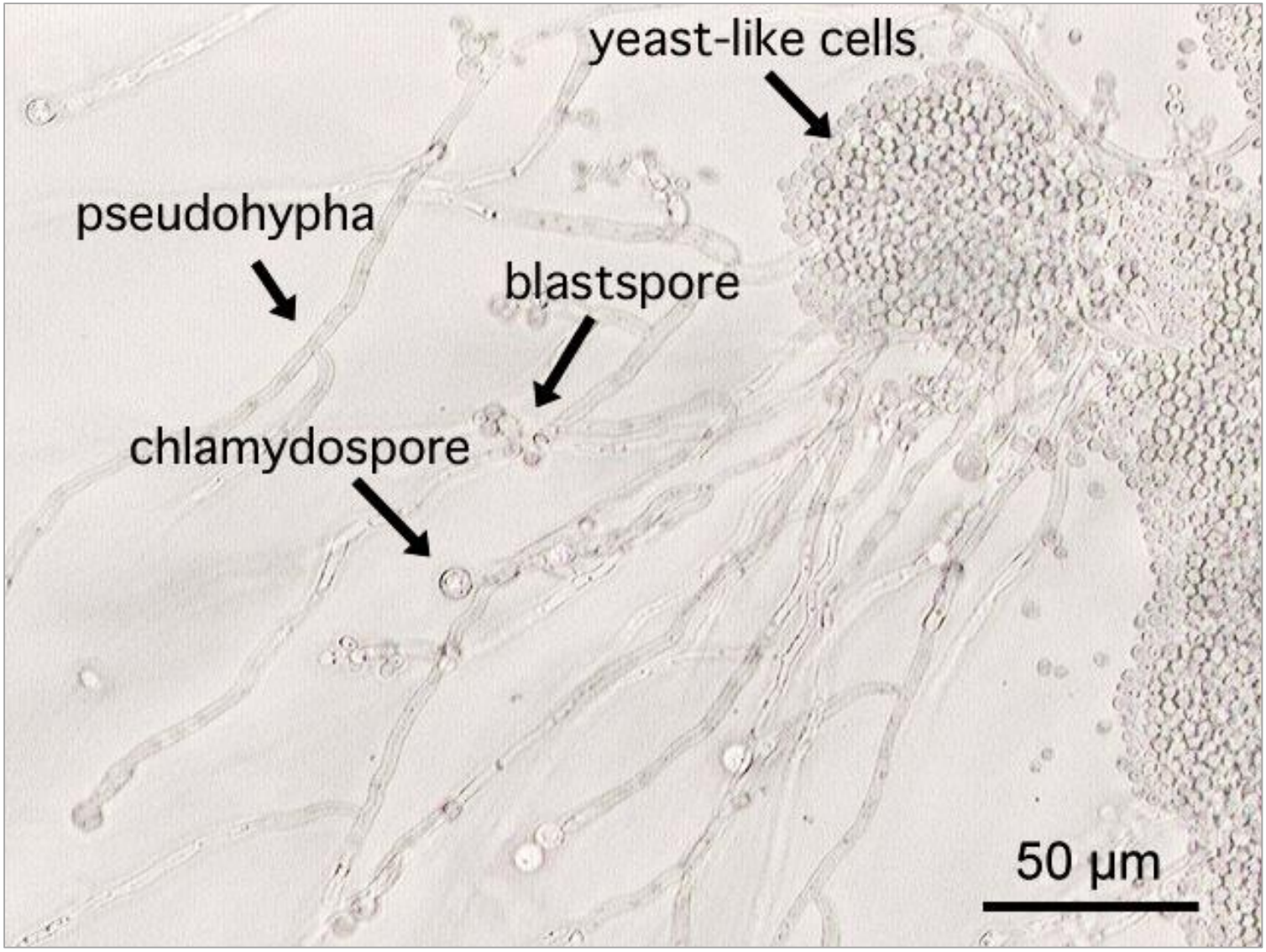
YEASTS, MOLD

- Eukaryota.
- Reproduce mostly asexually, and many do so by the asymmetric division process known as budding.
- Do not form mycelia (only **pseudomycelia** – similar to single-celled colonies)
- **Yeast -** fungi that can adopt a single-celled growth habit
- **Mold** - microscopical fungus that grows in the form of multicellular filaments called hyphae



Cross-sectional 2D diagram of a yeast cell.

Source: Wikipedia.org;domdomegg



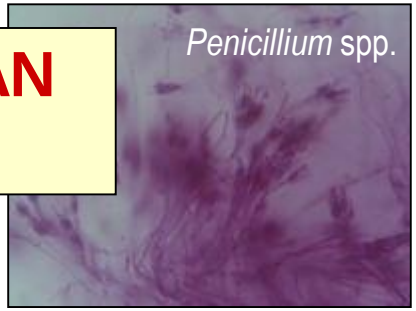
***Candida albicans*: hyphal outgrowth and other morphological characteristics.** Source:wikipedia.org;Y tambe – Y tambe s file

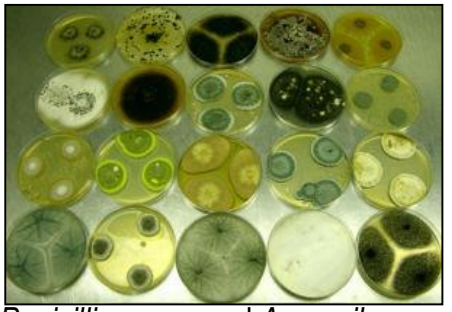
Many yeasts are used in various technologies

A block of compressed fresh yeast.
Source:wikipedia.org;Hellahulla

Some of them can cause severe human diseases.

CAUSATIVE AGENTS OF HUMAN DISEASES - EXAMPLES





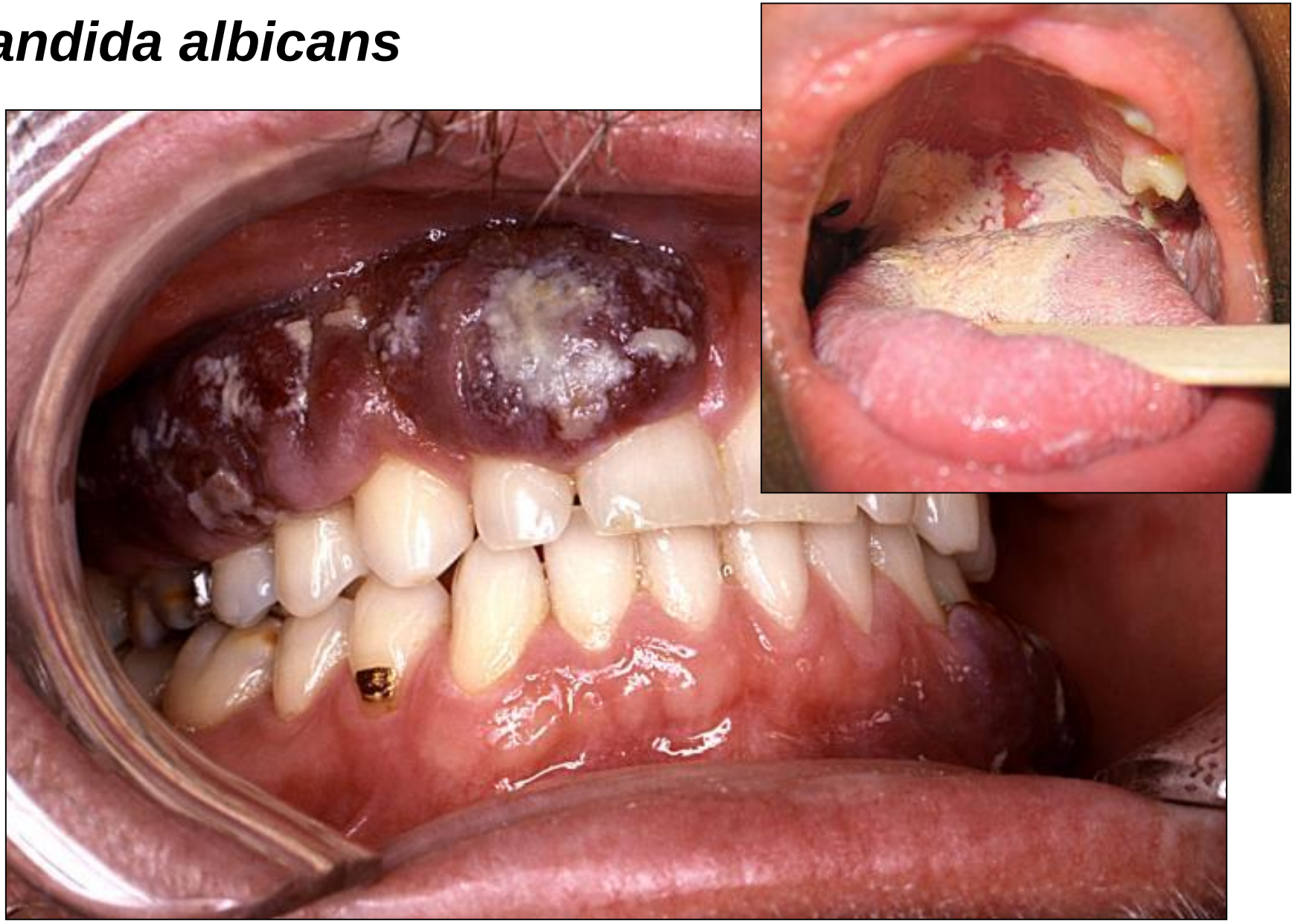
Penicillium spp. and *Aspergilus* spp. in axenic cultures

YEATS, MOLD

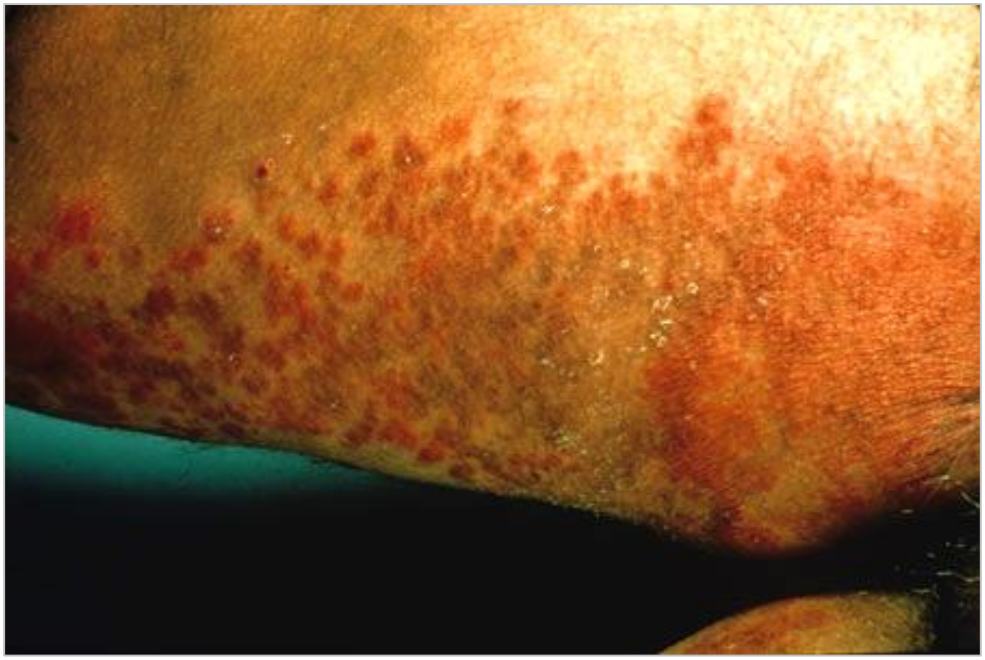
Examples of human pathogens	DISEASE
YEASTS ***Candida***	**candidiasis (thrush)** (*Candida albicans*), **systemic candidiasis**
Cryptococcus	**in immunosuppresed hosts, fatal pulmonary infections, meningitis, sepsis**
Pneumocystis	**in immunosuppresed hosts, intersticial pneumonia**
DIMORPHIC FUNGI	**in immunosuppresed hosts, severe pulmonary infections**
Penicillium	**In the past,** *Talaromyces marneffei* (syn. *Penicillium marneffei*) was considered non-pathogenic, however, it can cause disseminated **penicillosis in AIDS pacients** (rezervoirs bamboo rats)
Fusarium	**attack food, contamination of clinical material**
Dermatophytes	**infections of hair and nails**

Thrush in a child who had taken antibiotics. *Source:wikipedia.com;author James Hilman, MD.*

Candida albicans



Source: CDC, Photo Credit: Sol Silverman, Jr., D.D.S.



Skin candidiasis. *Source:wikipedia.org; U.S. Department of Veterans Affairs*

Nail candidiasis (onychomycosis).
Source: wikipedia.org;Medquy at English Wikipedia

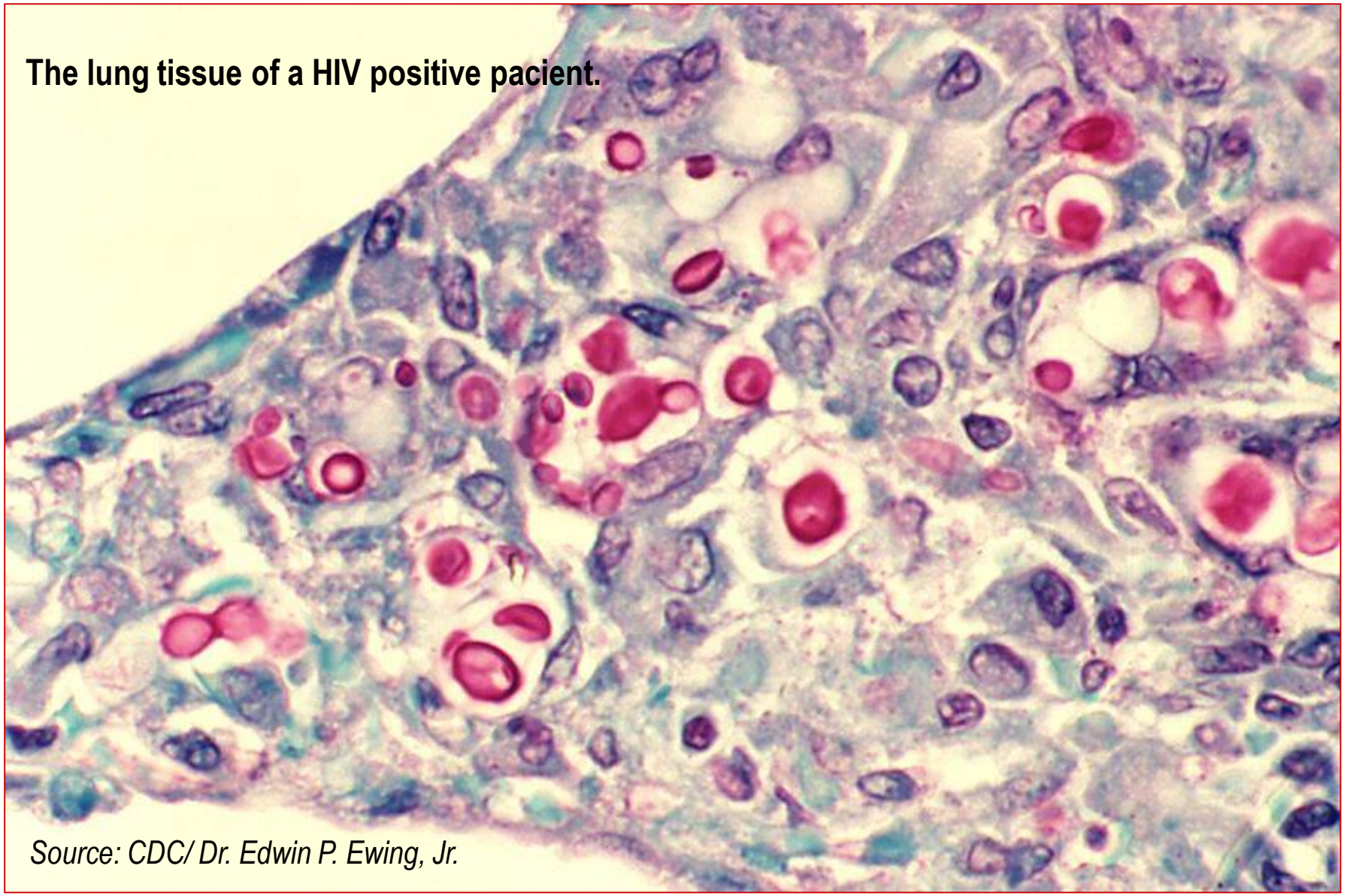
Trichophyton rubrum

Source: CDC/Dr. Libero Ajello

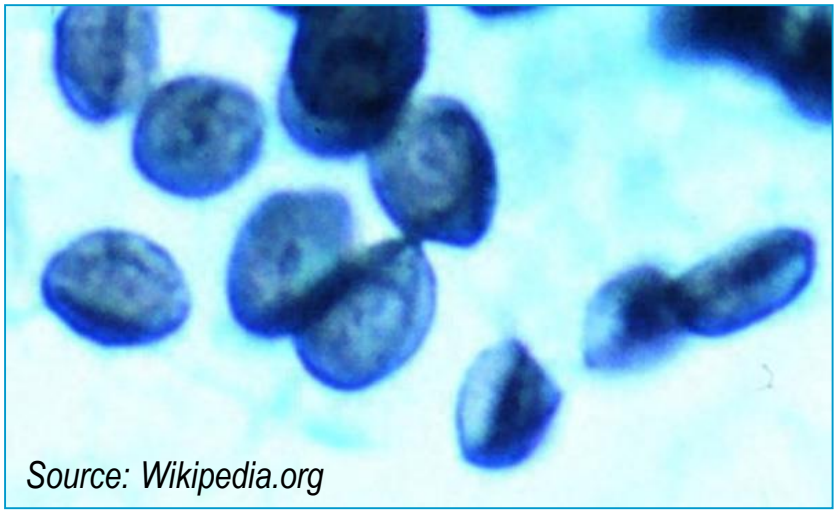
Inflammation in the skin between fingers

Source: Wikipedia

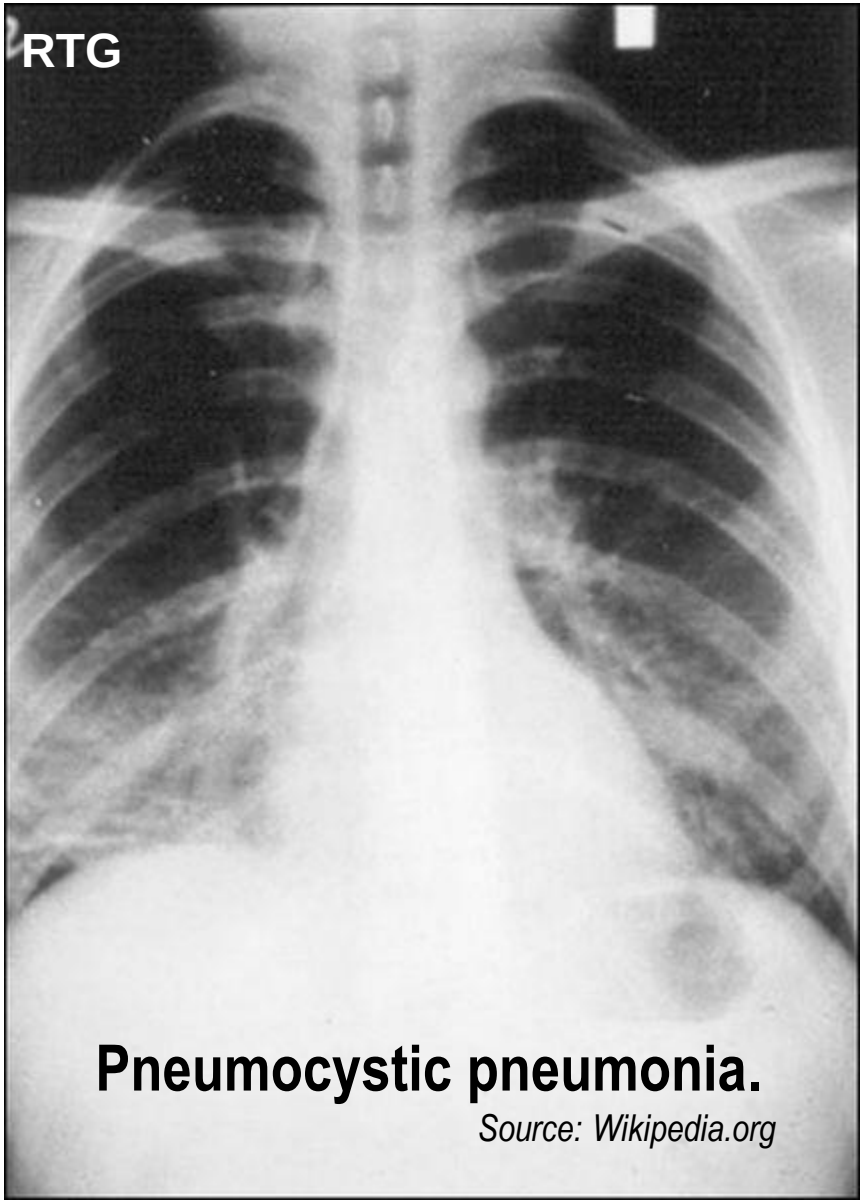
Cryptococcus neoformans



Pneumocystis jirovecii



Cysts in bronchoalveolar fluid (Toluidine)

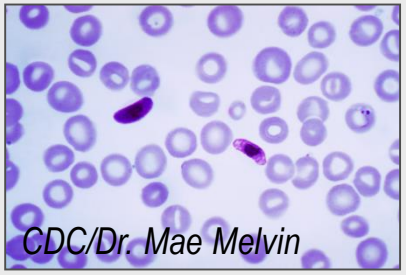


PARASITES

- size from 2 μm to metres
- eukaryots
- own metabolism

PROTOZOA

Giardia spp.



Plasmodium spp.

HELMINTHS

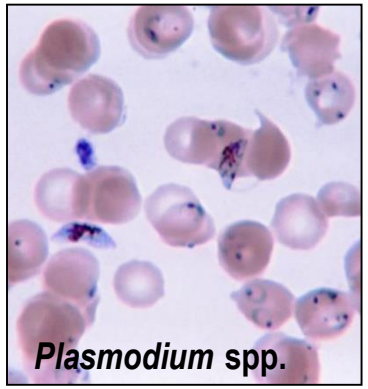
Hookworms

ARTHROPODS

Anopheles gambiae

CAUSATIVE AGENTS OF HUMAN DISEASES - EXAMPLES


Ascaris spp..


Plasmodium spp.

PARASITES

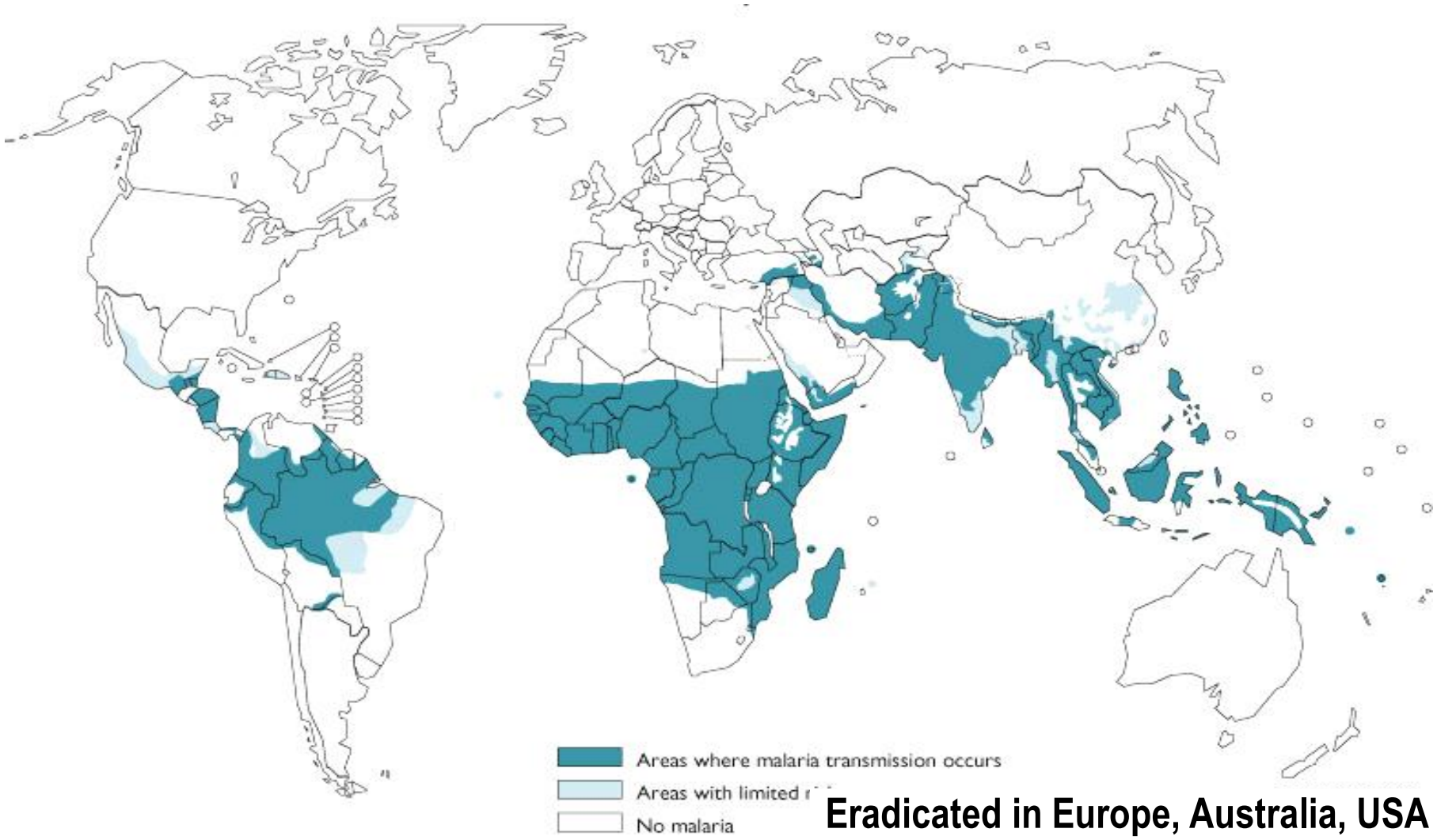
Examples of human pathogens	Disease
plasmodia	**malaria** (*Plasmodium falciparum*, *P. vivax, P. ovale, P.malariae*)
amoebae	**dysentery** (*Entamoeba histolytica*)
leishmania	**visceral and cutaneous leishmaniasis**
toxoplasma	**toxoplasmosis** (*Toxoplasma gondii*)
roundworms	**ascariosis** (*Ascaris lumbricoides*), **larval toxocarosis** (*Toxocara canis, T. cati*)
tapeworms	**cestodoses, cysticercosis, hydatidosis, echinococcosis**
schistosomes	**schistosomosis** (*Schistosoma mansoni*, *S. haematobium*, *S. japonicum*)
hookworms	**ancylostomosis intestinal symptoms and anaemia**
filaria	**filariosis**

MALARIA

- causative agent: ***Plasmodium falciparum***
  P. vivax
  P. malariae
  P. ovale
  P. knowlesi
- vector: mosquitoes of the genus ***Anopheles***
- endemic occurrence: 103 countries of tropics and subtropics

- **the most important parasitic disease**
  - **300 – 500 millions infected**
  - **>100 millions reported cases/year**
  - **1.5 – 2.7 millions of fatal cases/year (mostly children under 5 years)**

MALARIA: OCCURRENCE



Source: WHO, 2003

Eradicated in Europe, Australia, USA

Reduced in North Africa (eradicated in Tunisia)

LEISHMANIA & LEISHMANIOSES

- Occurrence: tropical and subtropical countries
  (except of Australia)
  risk of infection: 350 milion people
  prevalence: 12 millions
  incidence: 1.5-2 millions per year
- Vectors: sanflies (*Phlebotomus*, *Lutzomyia*)
- Host: humans and animals

REZERVOIRS

LEISHMANIA SPECIES:

- **Mostly ZOONOTIC (approx. 100 animal species)**
- **Few ANTHROPONOTIC (e.g. visceral caused by *L.donovani*)**

dogs

Source: http://www.vet.uga.edu, Noah's Arkive, University of Georgia.

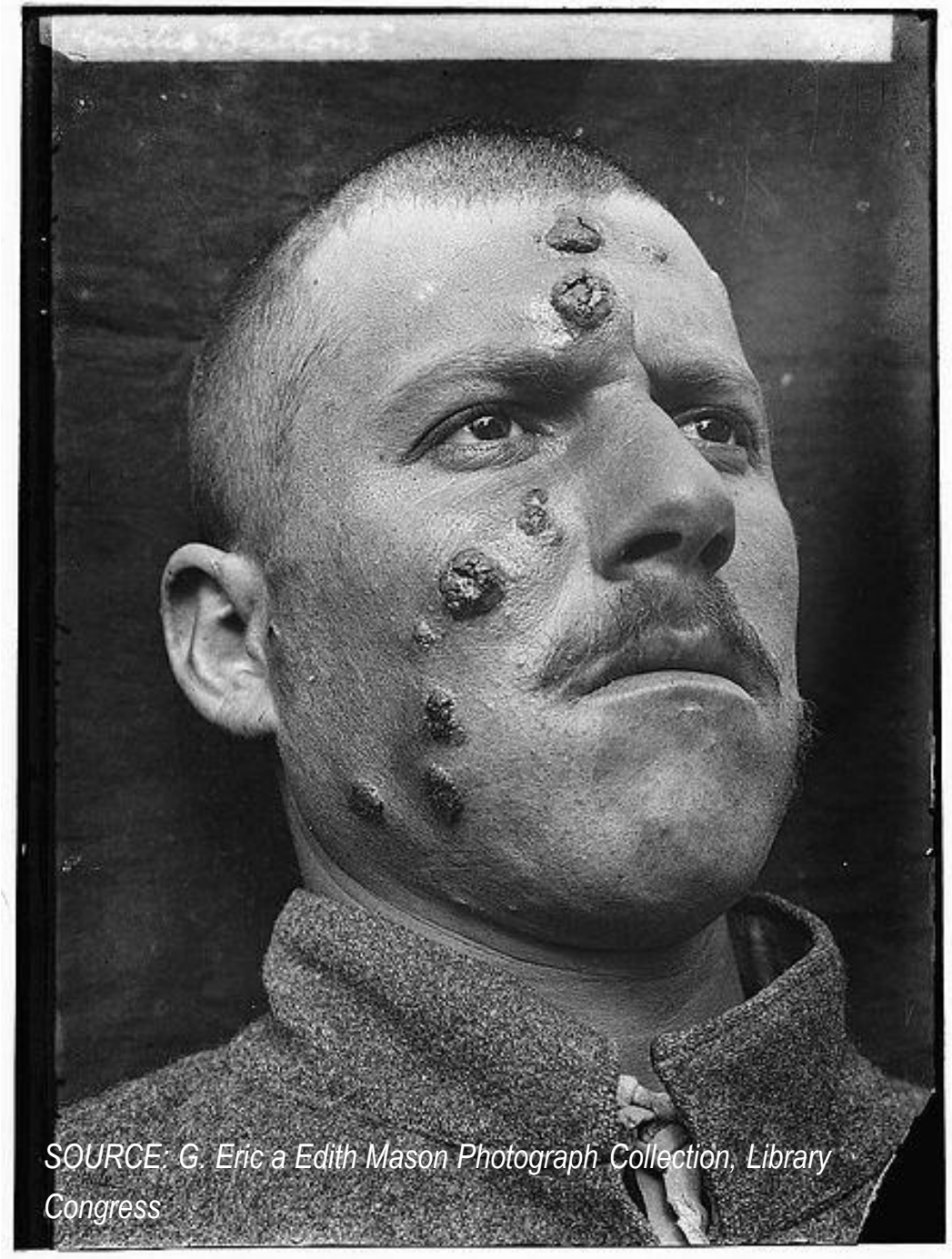
rodents

Source: www.moscowzoo.ru/galeng/asp

Leishmania sp.

CDC/Dr. L.L. Moore, Jr.

CUTANEOUS LEISHMANIOSIS



SOURCE: G. Eric a Edith Mason Photograph Collection, Library Congress

VECTOR

Old World: ***Phlebotomus***

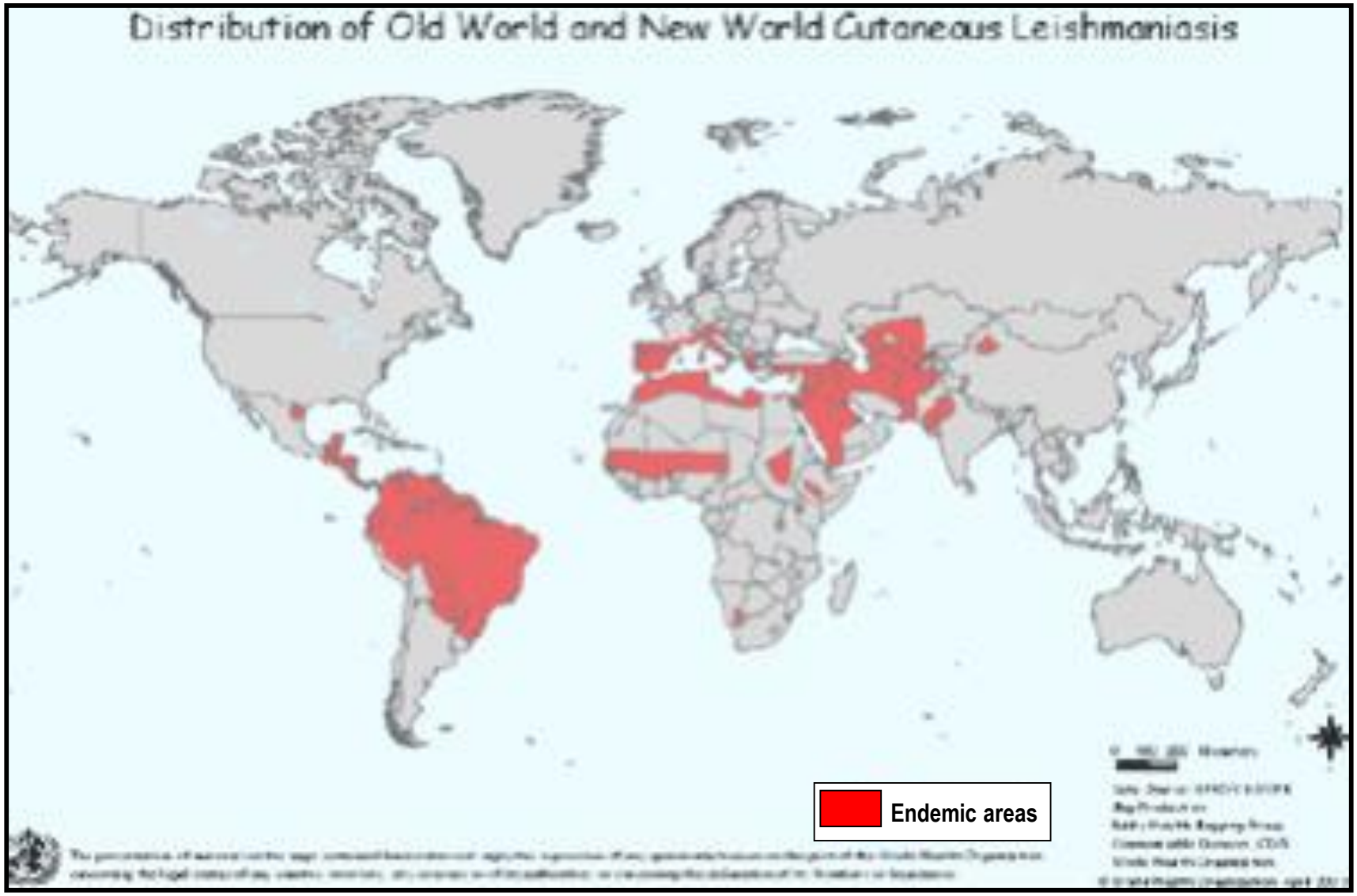
Source: CDC Public Health Image Library

New World: ***Lutzomyia***

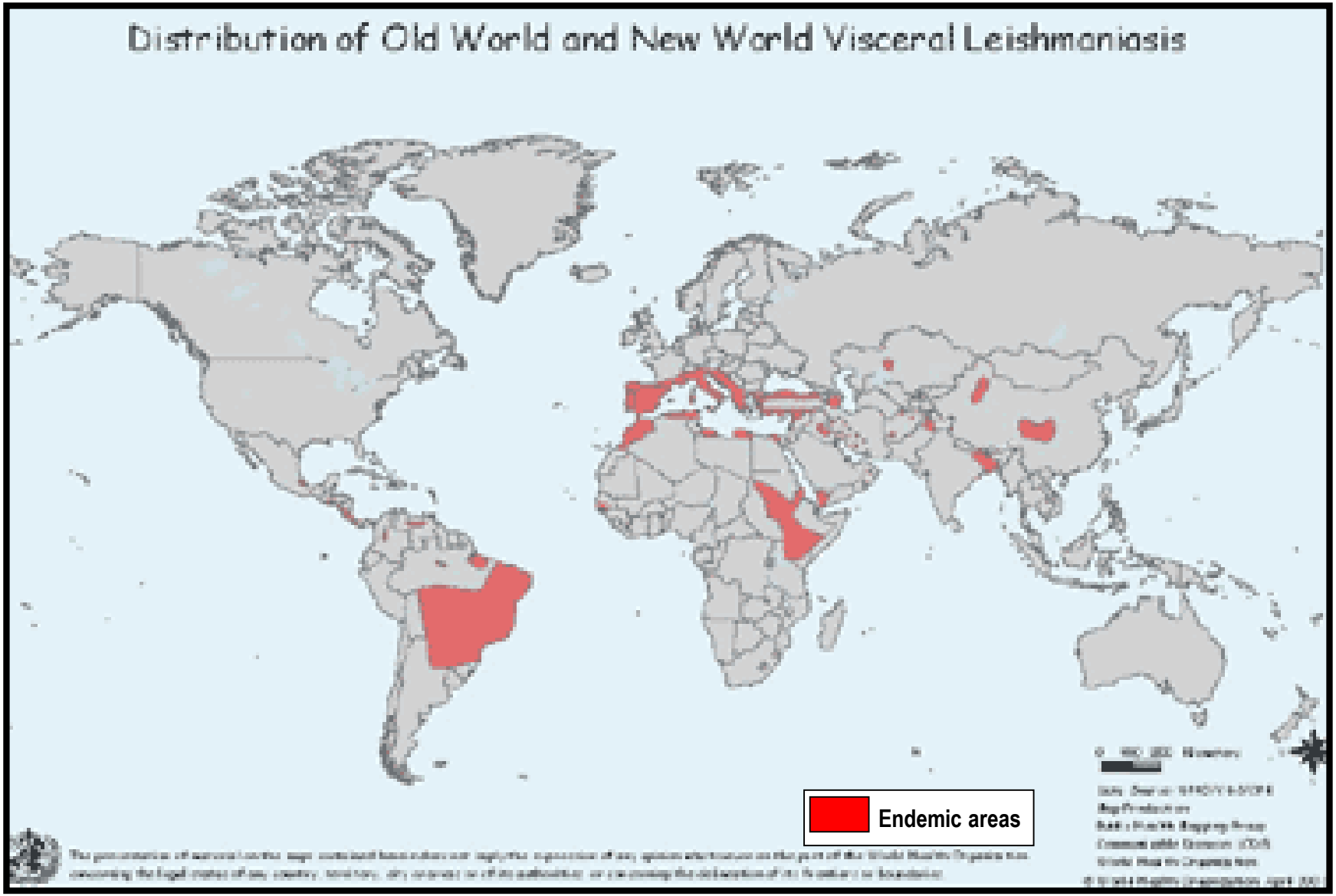
Ray Wilson, Liverpool School of Tropical Medicine

size: 2-3 mm

- **daylight-inactive (most active at dusk)**
- **silent flighting downstairs**



Data source: WHO/CSR/EDC-UNAIDS Map production: Public Health Mapping Group Communicable Diseases (CDS) World Health Organization, October 2003

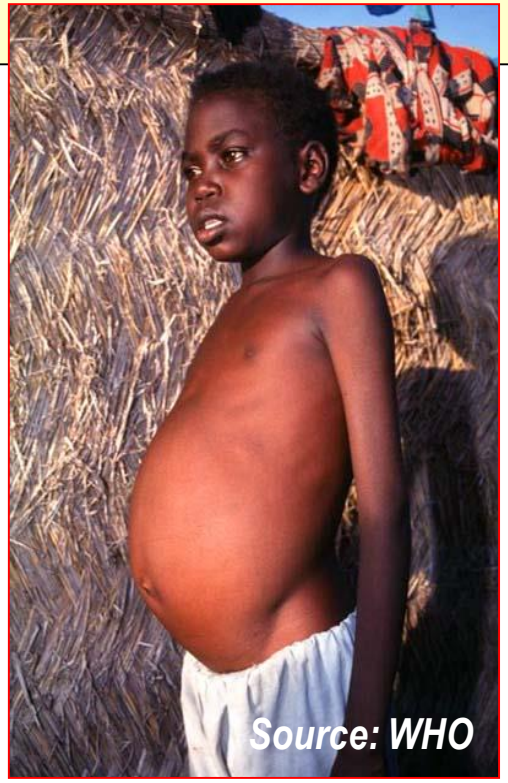


Data source: WHO/CSR/EDC-UNAIDS Map production: Public Health Mapping Group Communicable Diseases (CDS) World Health Organization, October 2003

CLINICAL SYMPTOMS AND SIGNS

VISCERAL LEISHMANIOSIS skin phase asymptomatic

- **escape** of infected macrophages **from skin to blood and lymph silent spread to liver spleen, bone marrow and lymphatic glands**
- proliferation of parazites → increasing load of infected macrophages → reticuloendothelial hyperplasia → splenomegaly



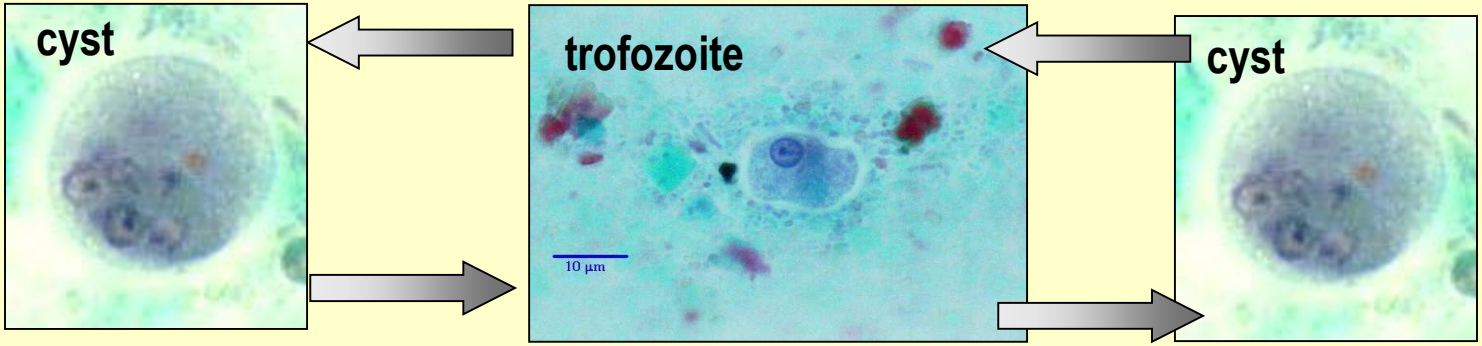
Entamoeba histolytica & AMOEBOSIS

- amoebosis: - **intestinal** (diarrhoea, dysentery, colititis)
  - **extraintestinal** (liver abscess)
- transmission: **per os** (contaminated food, drinks, + anal-oral sex)
- occurrence: **cosmopolitan** (mainly in developing countries)
  hyperendemic: Mexico, Egypt, India, Vietnam
- prevalence: approx. 50 millions of invasive infections with 40-100 thousands of fatal cases per year

- epidemiology: risk factors - indadequate disposal of human feces; poor personal hygiene; use of human feces as fertilizer for vegetables; freshening of vegatables and fruits by contaminated water

Entamoeba histolytica: LIFE CYCLE

source of infections: a carrier with no or minor intestinal disturbances, by the stool of which the parasitic cysts are released



Conversion due to changes
bacterial flora, redox grandient
mucus quality, etc.

FORMA MINUTA
NON PATHOGENIC

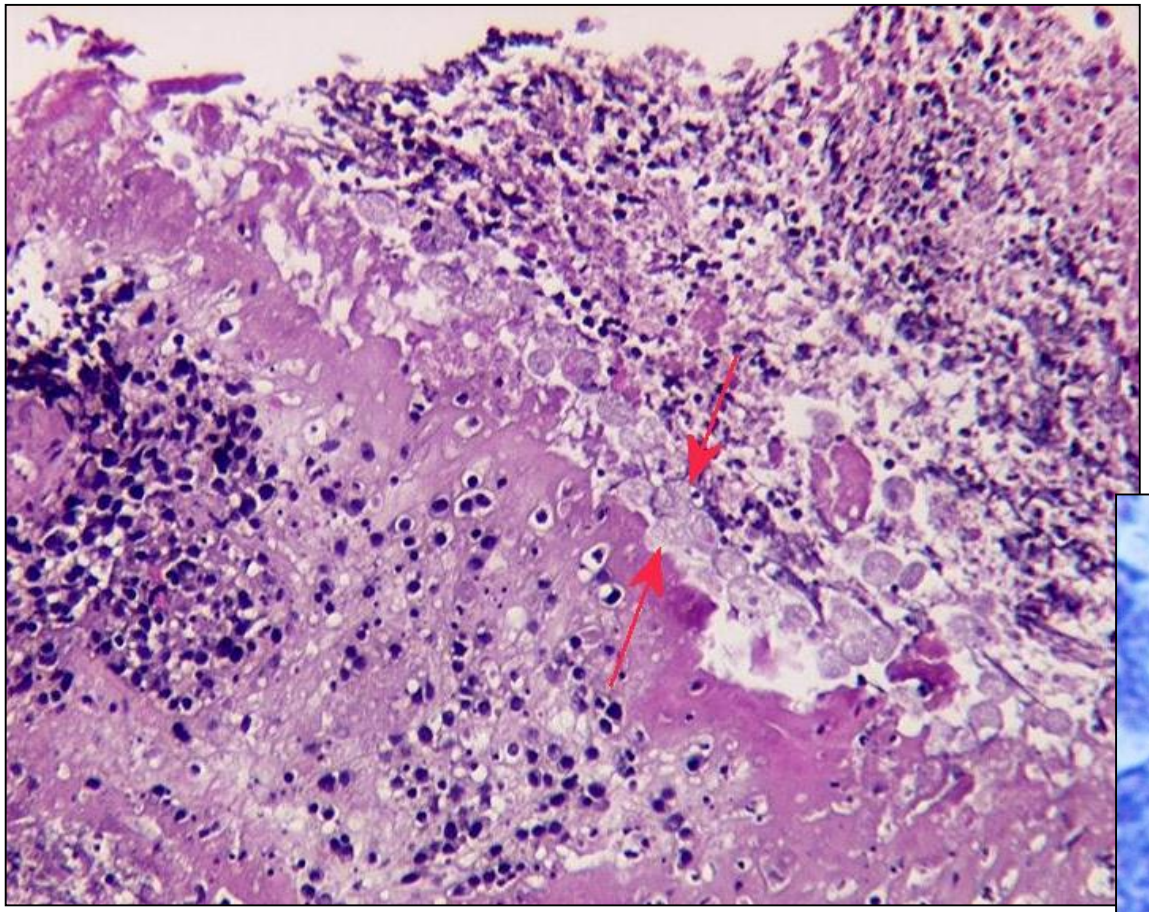
- invasion to the host tissues
- complication → perforation

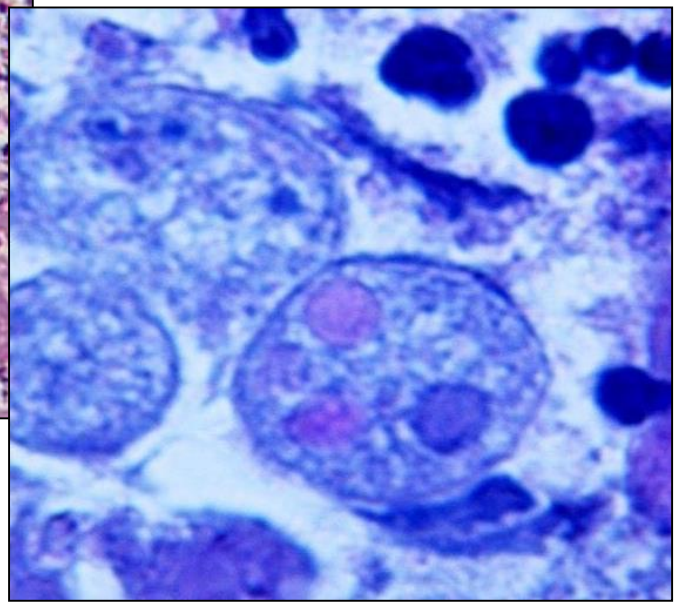
FORMA MAGNA = dysenterica
PATHOGENIC (does not form cysts)

INTESTINE

Source of pictures:: Atlas of Medical Parasitology, Authors D. Zitová and M. Bednář

AMOEBIC DYSENTERY

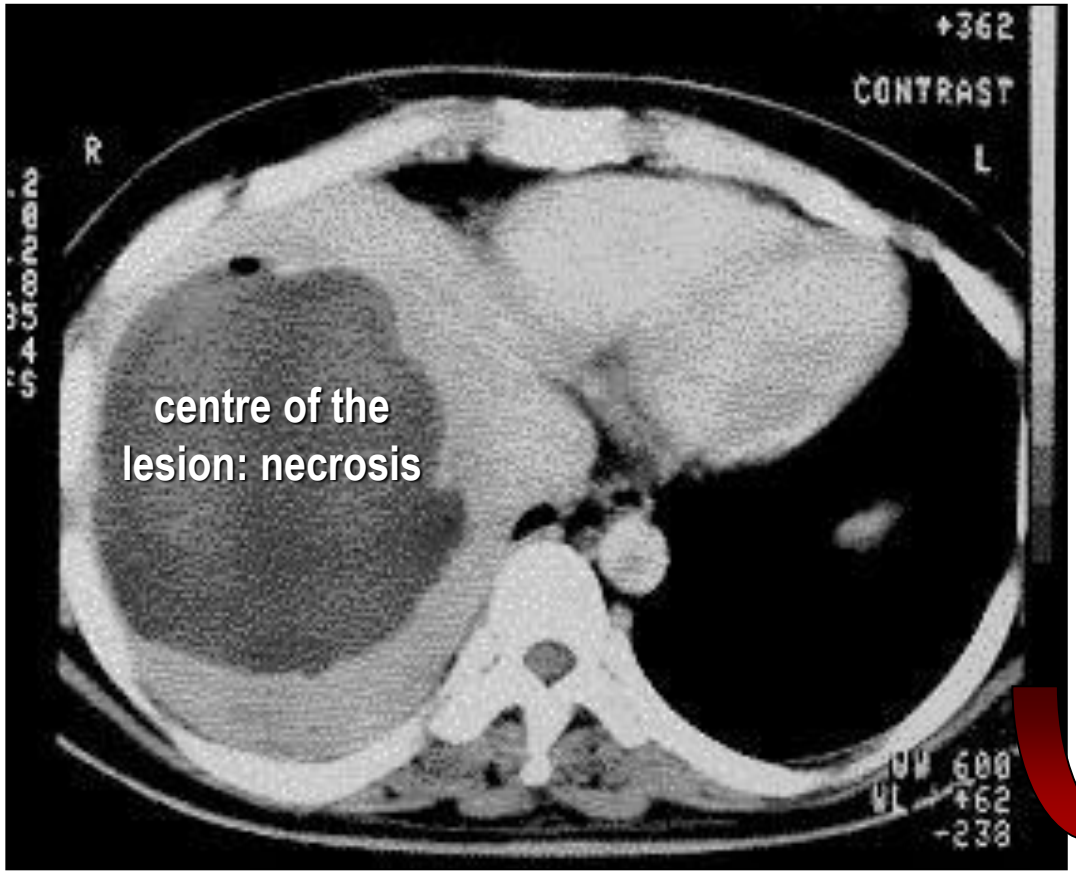




The colonic mucosa invaded by *E. histolytica* trophozoites

Source of pictures:: Atlas of Medical Parasitology, Authors M. Lisci MD and G. Gera M.D.

EXTRAINTESTINAL AMOEBOSIS



More common in adult men (15-55 years old)

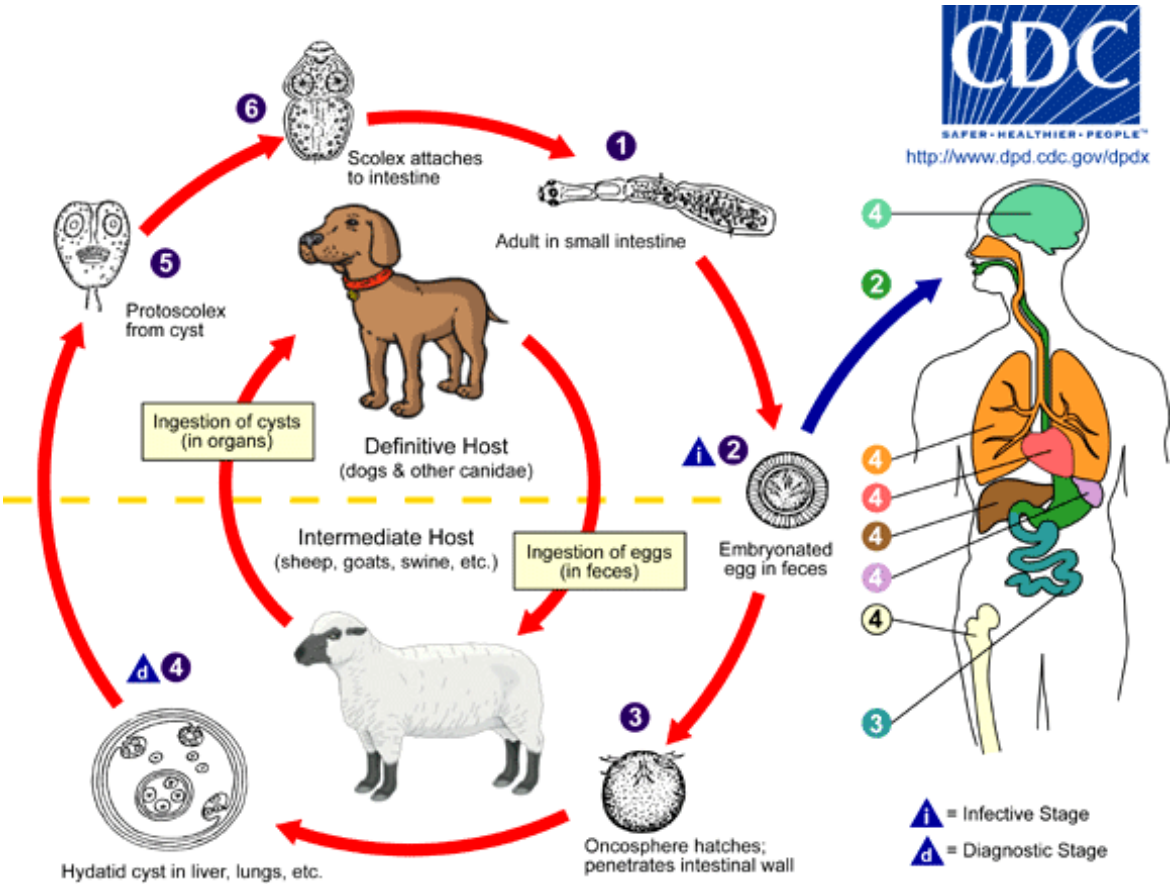
spread to other organs rare

- **always secondary:** follows after intestinal infection (the spread of amoebae by venous system)
- in 80% the lesions develop in upper right liver lobe
- **fever (38-40 °C),** serology show the presence of specific antibodies

HYDATID DISEASE (ECHINOCOCCOSIS)

1. Form: CYSTIC (CE)

AGENT: larval stages of ***Echinococcus granulosus***



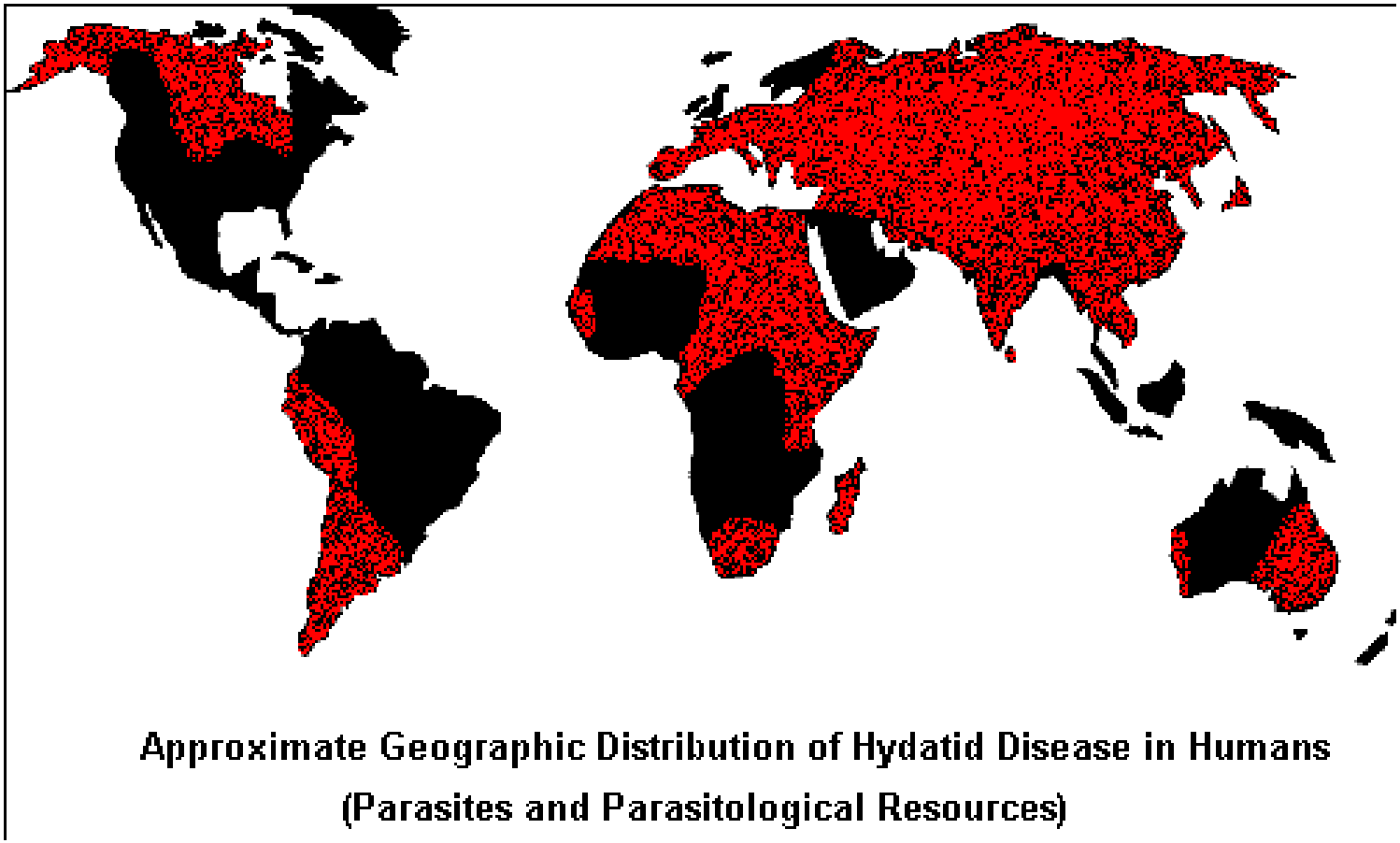
The eggs are infective for intermediate host immediately after their release into the surroundings.

LIFE CYCLE

Distribution: worldwide

The highest infection risks:

- certain areas of China
- North and East Africa
- South America (Uruguay)

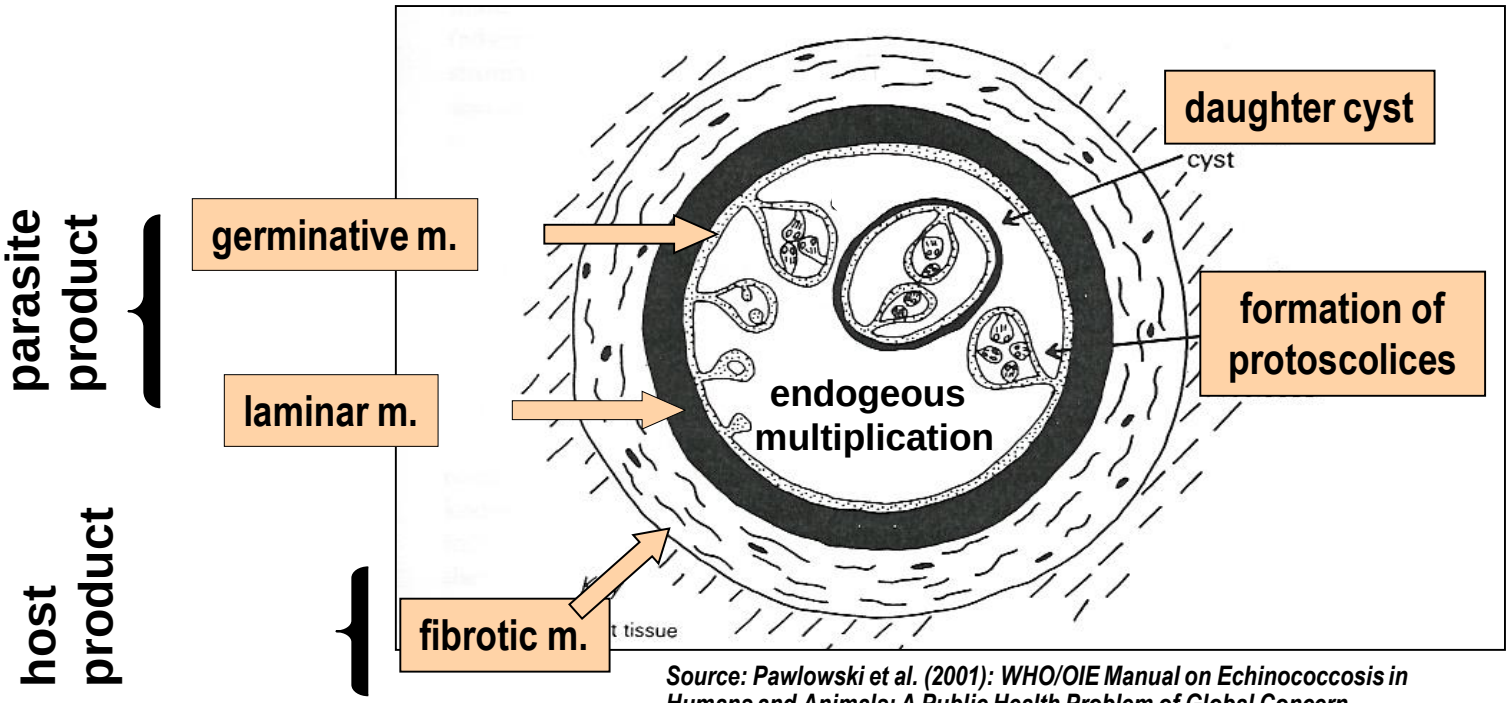


Approximate Geographic Distribution of Hydatid Disease in Humans

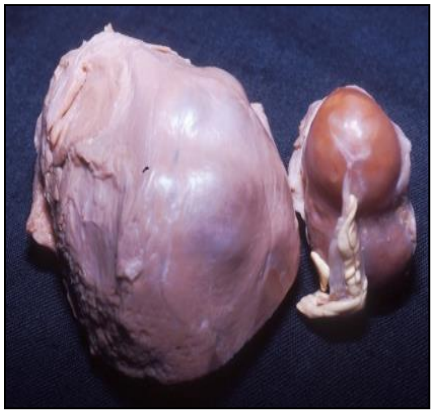
(Parasites and Parasitological Resources)

No risk: Iceland, Greenlad

E. granulosus: LARVAL STAGES



Source: Pawlowski et al. (2001): WHO/OIE Manual on Echinococcosis in Humans and Animals: A Public Health Problem of Global Concern



- **slow growth (1-5 mm/year)**
- **life-span:**

  man……..even 53 year

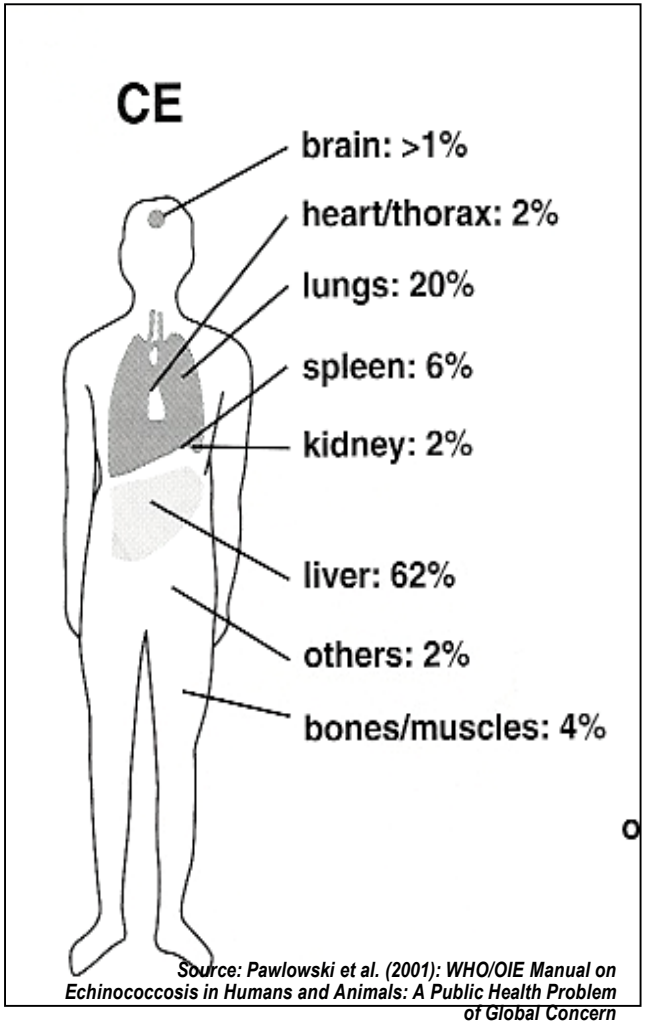
CLINICAL SYMPTOMS AND SIGNS

- **character of symptoms: dependence on cyst localisation**
- **early phase of the infection: asymptomatic**
  manifestation delayed (several years)

- **most common: hepatic and pulmonary forms**

  hepatomegaly,
  bloody sputum in pulmonary form
  cerebral form - neurological symptoms

  cyst rupture - allergic symptoms, anaphylatic shock, death



Source: Pawlowski et al. (2001): WHO/OIE Manual on Echinococcosis in Humans and Animals: A Public Health Problem of Global Concern

CE: primary location of cysts

CE: LIVER INFECTION

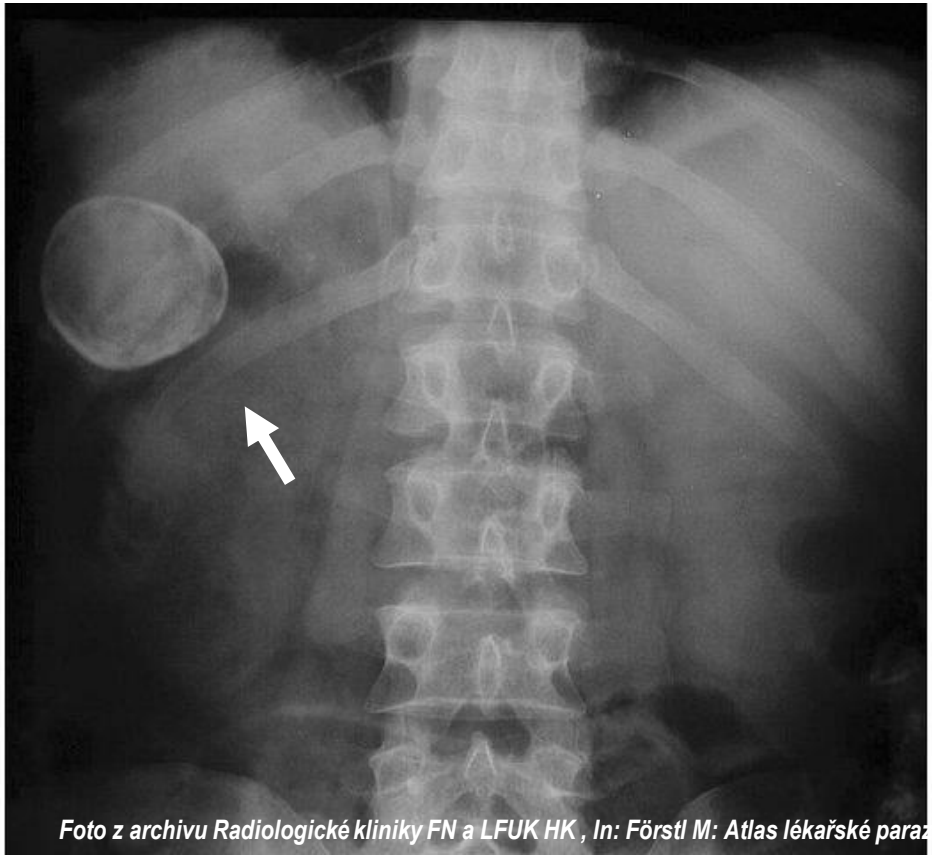
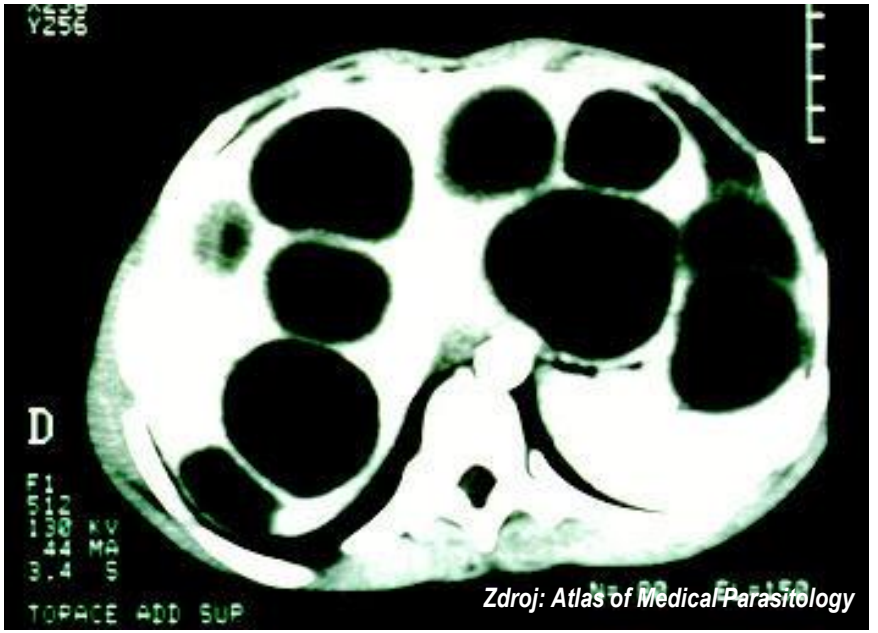


Foto z archivu Radiologické kliniky FN a LFUK HK , In: Förstl M: Atlas lékařské paraz



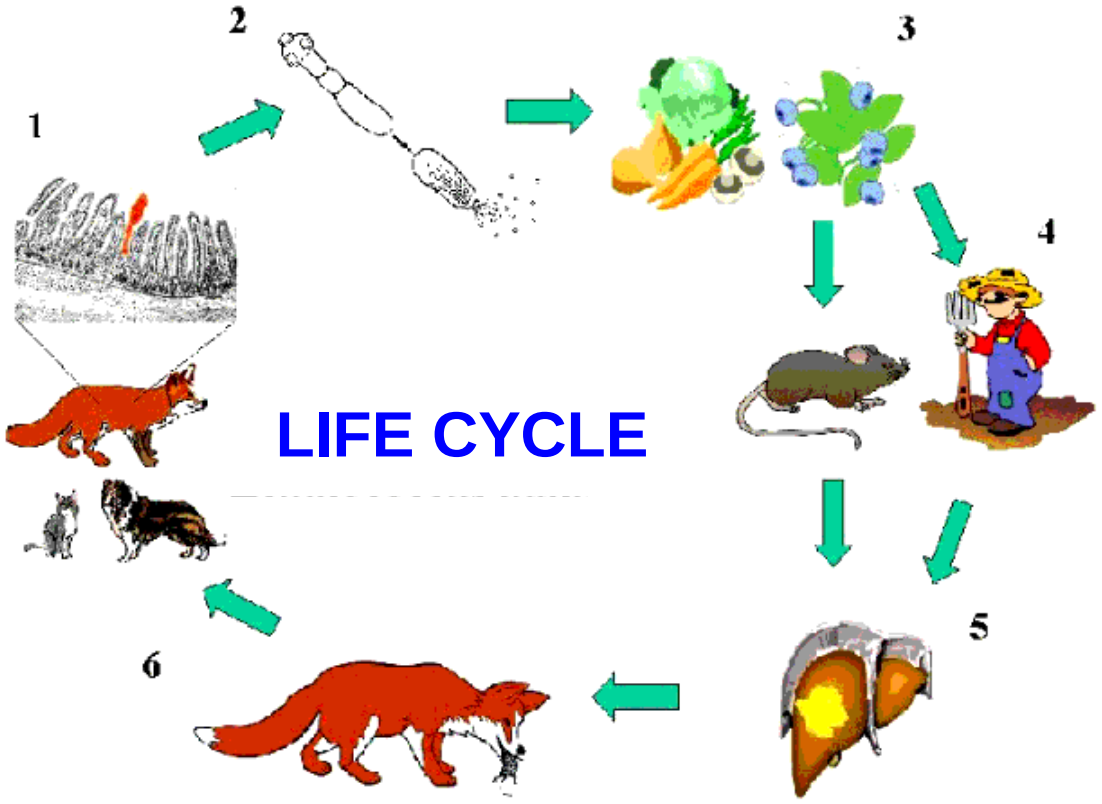
Zdroj: Atlas of Medical Parasitology

in the liver: up to the size of 5 cm in diameter:
usually, no symptoms

HYDATID DISEASE (ECHINOCOCCOSIS)

2. Form: ALVEOLAR (AE)

AGENT: larval stages of ***Echinococcus multilocularis***



Occurrence:
Northern Hemisphere

Author Stefan Reuter, MD., droj: Atlas of Medical Parasitology

E. multilocularis: LARVAL STAGE

- development in the liver (99%)
- extremely slow growth
  (mm per year)
  + in the centre necrosis

↓↓↓

INCUBATION PERIOD:
VERY LONG

(5-30 years)

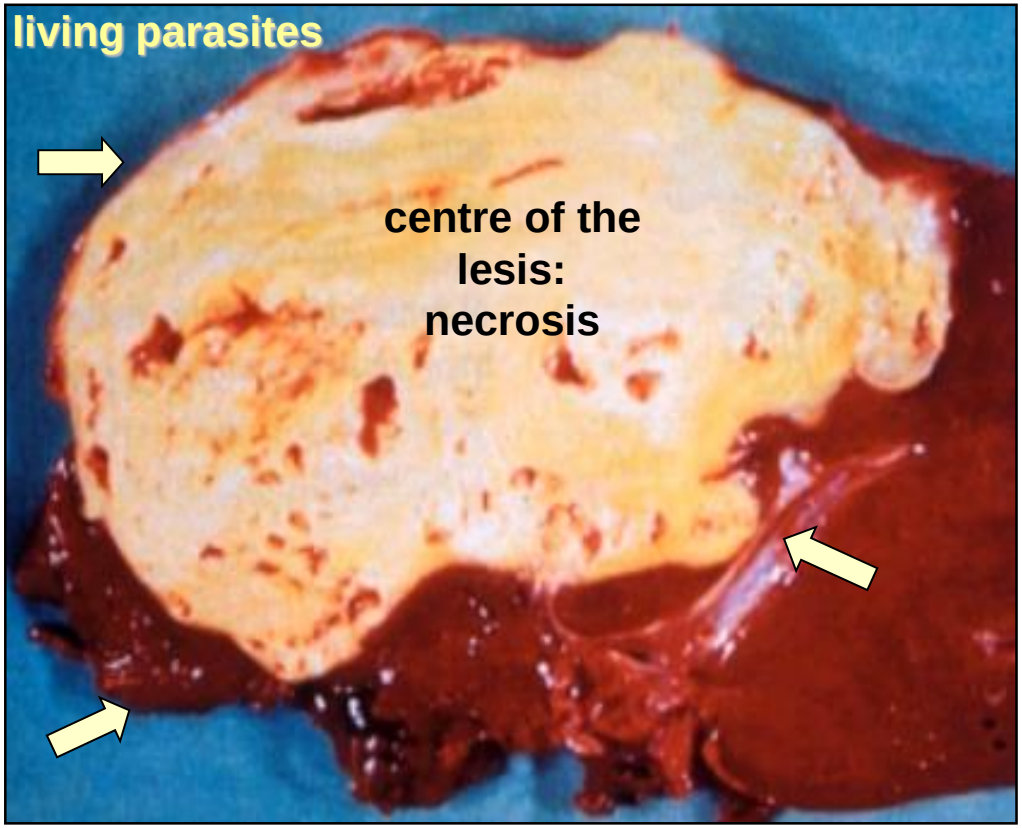
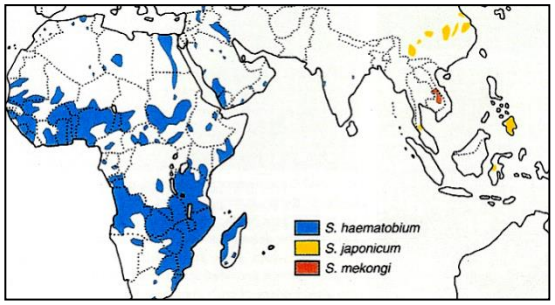


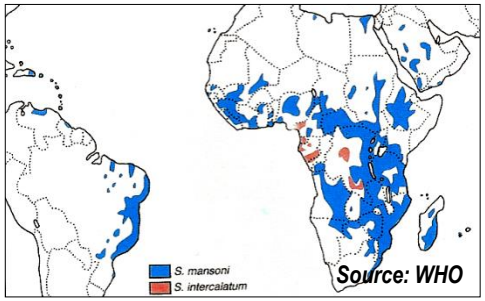
Foto: Prof. P.Kern, Stuttgart

with progresiion of the infection:
invasion of surrounding tissues - malignant tumour
(metastases of the parasite)
fatality up to 100 % when untreated

SCHISTOSOMIASIS (BILHARZIASIS)

THE MOST IMPORTANT HELMINTHIC DISEASE.

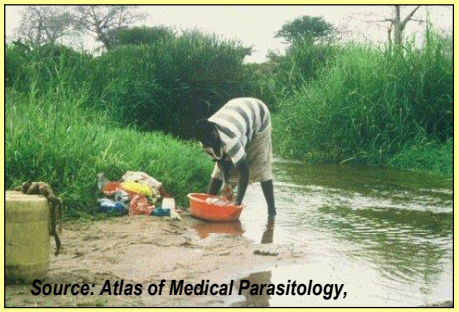




- **infected: 193 milllions of people**
- **at risk of infections: 652 mil. osob**
- **susceptibility to the infection: no differences in host sex and its age**

- **85% of infections – Africa**

→ from which 20% (i.e., 33 millions) of pregnant women from Subsaharan area



Forms of the disease:

urogenital: *Schistosoma haematobium*

intestinal: *S. mansoni*, *S. japonicum* group

Schistosoma: LIFE CYCLE

FINAL HOST - man

Source: Atlas of Medical Parasitology, Author: Professor A.E. Butterworth FRS

Foto: Libuše Kolářová, In: Förstl M: Atlas lékařské parazitologie

Foto: Libuše Kolářová, In: Förstl M: Atlas lékařské parazitologie

cercaria

Source: Atlas of Medical Parasitology, Author Prof. A.E. Butterworth

infective stadium

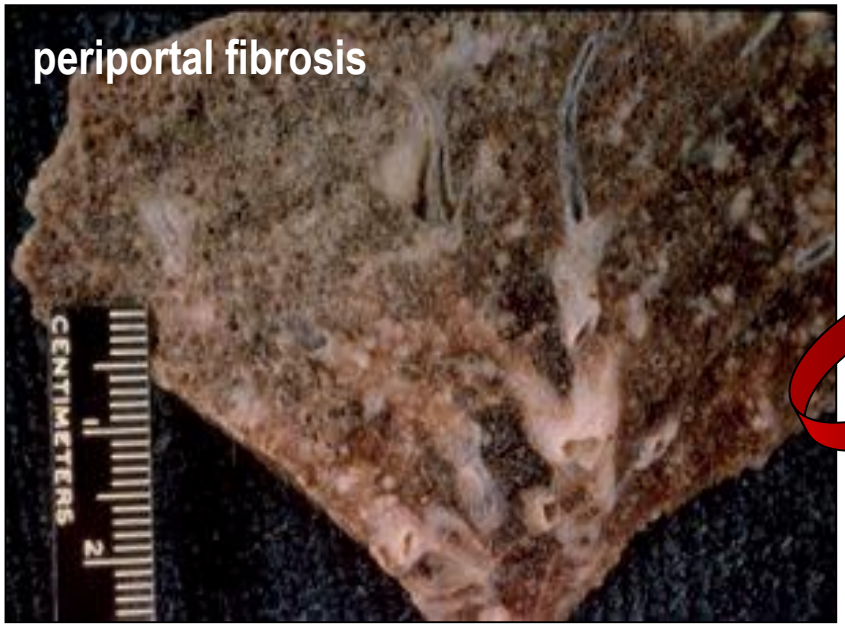
Source: Atlas of Medical Parasitology, Autor Prof. A.E. Butterworth

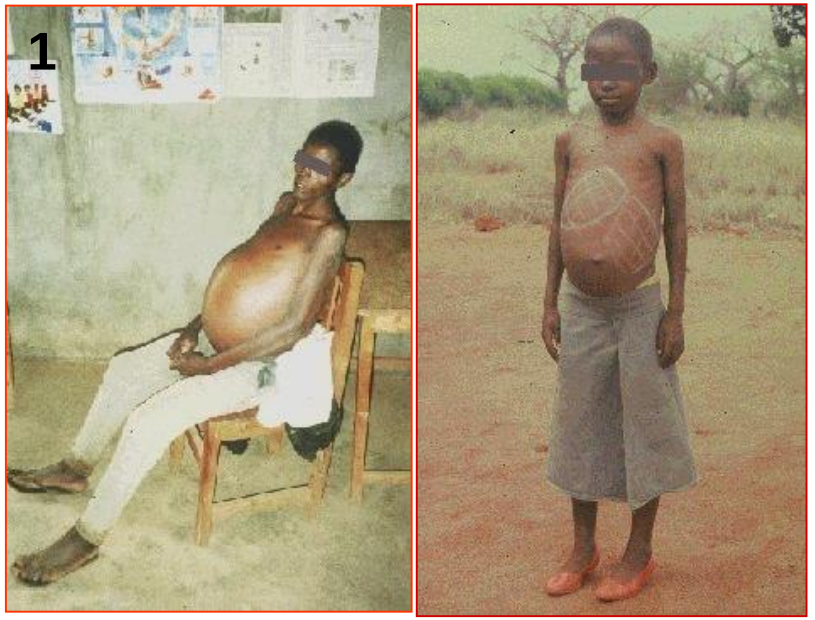
INTERMEDIATE HOSTS

Source: Atlas of Medical Parasitology, Photo: Byer manual of

only fresh-waters

SCHISTOSOMIASIS: CLINICAL SYMPTOMS AND SIGNS





hepatosplenomegaly

portal hypertension

involvement of other organs - lungs, heart (cor pulmonale), etc.

Source: Atlas of Medical Parasitology, Author: Professor A.E. Butterworth FRS, Scientific Director

FILARIASES

Wuchereria bancrofti
Brugia malayi, B. timori

- disease: **lymphatic filariasis, elephantiasis**

- vectors: **mosquitoes** of the gen. ***Aedes***, ***Anopheles***, ***Culex***, ***Mansonia***

Zdroj: Wikimedia Commons

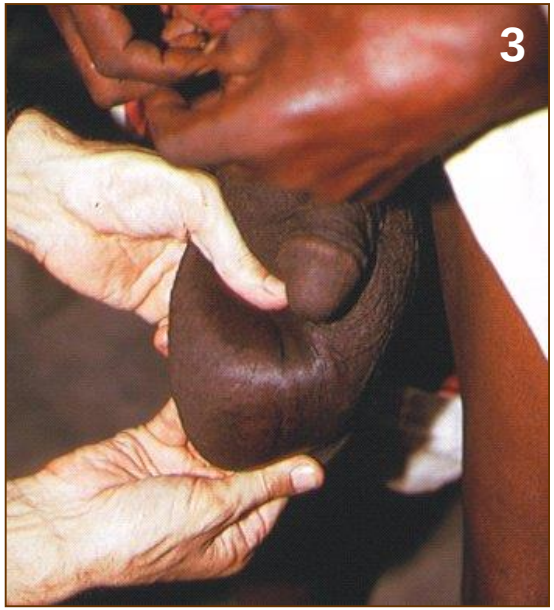
SYMPTOMS AND SIGNS

The main patogenic agent: adults in lymph vessels in the groin, scrotum, axillae etc.

↓

excretion of antigens and toxic metabolites
thickening of the walls of the lymph vessels
(lymphangitis, lymphadenitis
elephantiasis)

+ allergic reaction, secondary bacterial infections



Source: Atlas of Medical parasitology, Authors: 1,3 Professor Wallace Peters, 2 SmithKlime Beecham and WHO

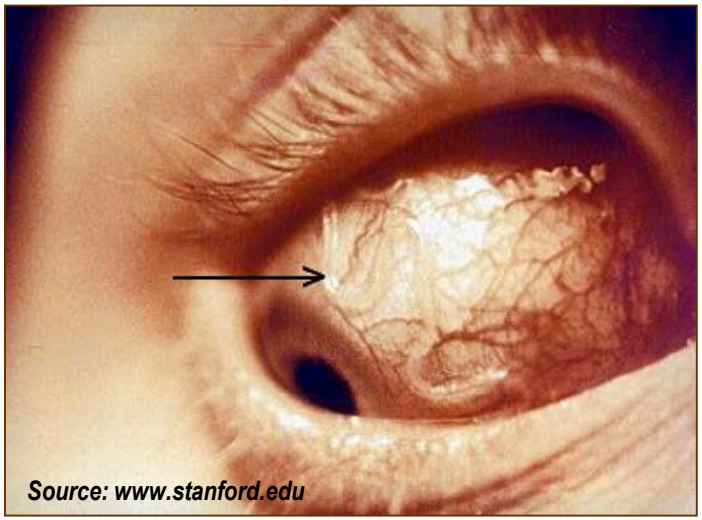
Loa loa

- vector: horse or deer fly (g. *Chrysops*)

- patobiology: adults in subcutaneous tissue (freely migrating)

  - acute inflammation – mechanical injuries, allergic reactions, toxic metabolites
  - edema in focus with infiltrated eosinophils (Calabar swelling)
  - ocasional migration in the eye or inner organs – specific symptoms

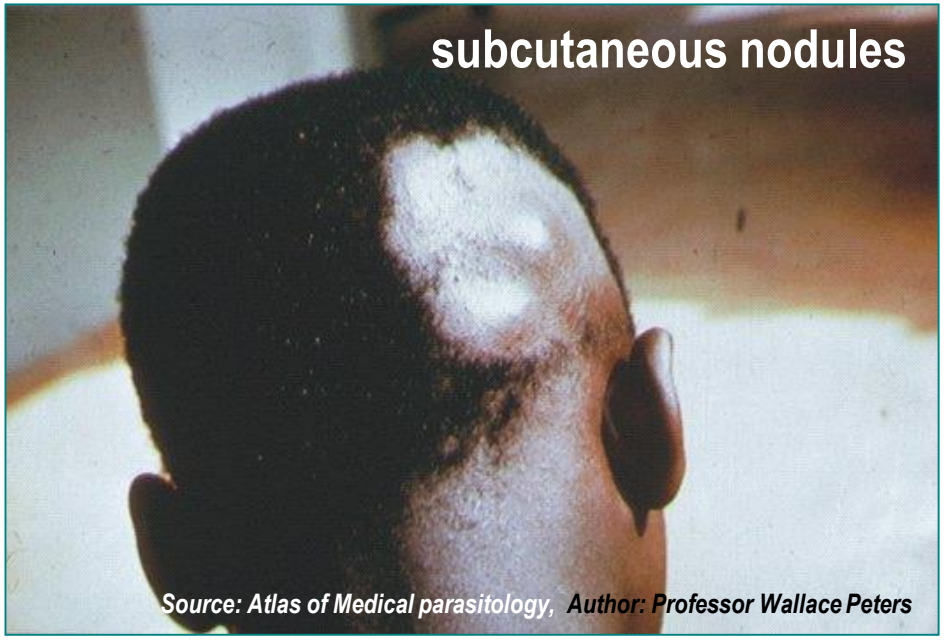

SoUrce: Wikimedia Commons


Source: www.stanford.edu

Onchocerca volvulus

- disease: 1. onchocerciasis or 2. river blindness
- vector: blackflies (g. *Simulium*)
- pathobiology: 1. adults in subcutaneous nodules (onchocercom, non migrating nodules)
  2. microfilariae in the eye

Source: Bayer Manual of Pest Control



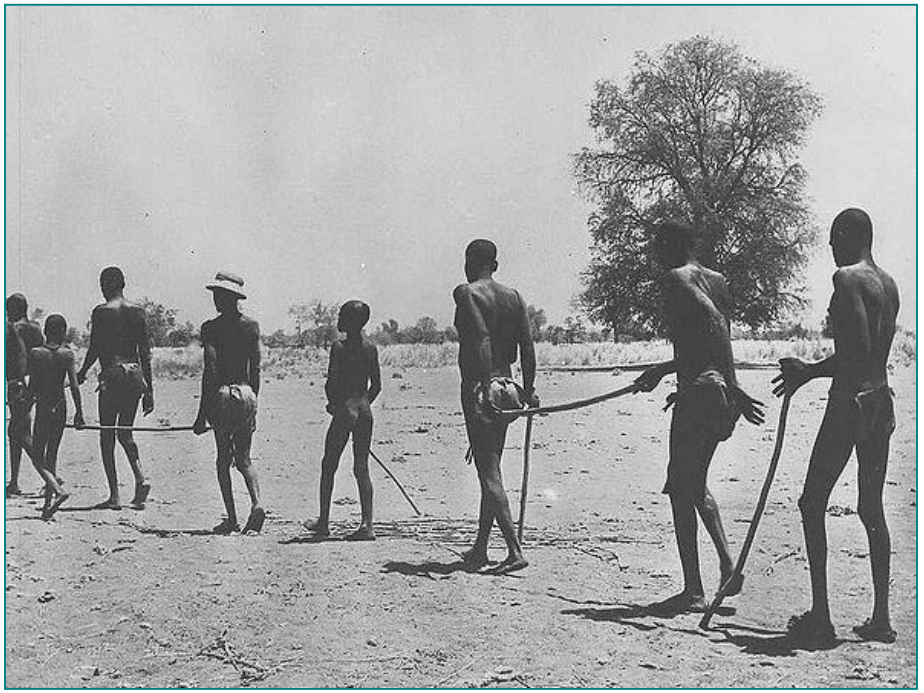
Source: Atlas of Medical parasitology, Author: Professor Wallace Peters

Soiuce: Atlas of Medical parasitology, Author: Gustavo A. Gini

ONCHOPHTALMIA

(*river blindness*)

due to the inlammatory reaction around the microfilariae in the eye



Zdroj: ***Otis Historical Archives Nat'l Museum of Health & Medicine***

Thank you for attention