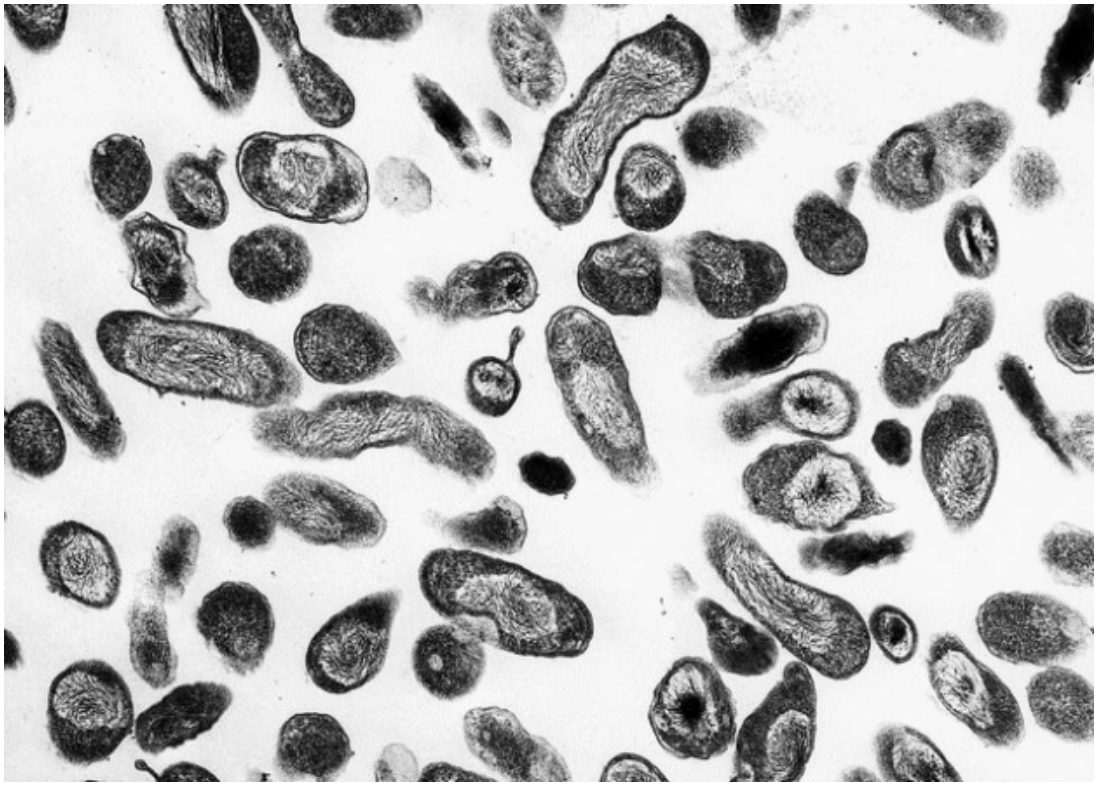
Gram-Negative Bacterial Infections

See online here

Infectious diseases transmitted by gram-negative pathogens are – in some cases – zoonotic diseases with great pathogenic potential, which is why they are investigated as biological weapons in some countries. The remaining listed bacteria are no less dangerous so that every clinical practitioner benefits from having a good overview of clinical presentations, diagnostics, and treatment of these diseases.



Bartonella

Characteristics of Bartonella

The genus Bartonella comprises 4 species that are well recognized as pathogens in human beings. Bartonella are emerging pathogens, and in recent years many other Bartonella species have also been associated with human diseases. Bartonella is a fastidious, zoonotic pathogen transmitted by animal bites, scratches, and arthropods and can show iatrogenic transmission by needle prick injuries or blood transfusion. These facultative intracellular bacteria grow slowly in aerobic environments. **Endothelial cells** or **erythrocytes** serve as host cells. Blood culture-negative endocarditis is a commonly undiagnosed presentation of infection associated with several Bartonella species

Bartonella is a short **pleomorphic coccoid gram-negative rod-shaped bacterium**. Some species have **pili**, with which they can actively move. For cultivation, hemin is needed. Due to its slow growth, the most common identification methods are not applicable to Bartonella.

Infection with *Bartonella henselae*

Infection with ***Bartonella henselae*** especially occurs in children and teenagers in fall and winter. The reservoirs for the pathogen are pet cats; in 10–70% of cats, the bacteria can be detected (especially in warm areas; however, it has a 0% occurrence in Norway). *B. henselae* is transmitted either directly **via skin lesions caused by cats or via cat fleas**.

At the site of the lesion, a small, crusted papule forms, which does not itch and can be present for several months. Also, one-sided **lymphadenitis** can be observed, mostly in the region of the armpits or at the neck, which sometimes develops to necrolysis. After 2–3 weeks, this lymph node swelling regresses.

Because of the reticular abscess formation, which can be identified histologically, the cat-scratch disease is also referred to as **benign lymphoreticulosis**. If it co-occurs with non-purulent conjunctivitis, the condition is called **Parinaud oculoglandular syndrome**. In immunosuppressed patients, manifestations may include encephalitis, endocarditis, osteomyelitis, or sepsis.

Because of the angiogenetic potential of the pathogen via a protease-sensitive factor, *B. henselae* can also trigger **bacillary angiomatosis** and **peliosis hepatis**. These are **vasculoproliferative disorders**. They cause **lobular capillary proliferations** that are lined with endothelium and can bleed severely.

In peliosis hepatis, these capillary proliferations can be found in the liver; in bacillary angiomatosis, they can be found on the skin. These capillary proliferations are reddish-brown papules, which can ulcerate and also lead to bone lesions. These diseases are very frequently observed in HIV-positive patients. A CT image of peliosis hepatis looks like the image below:

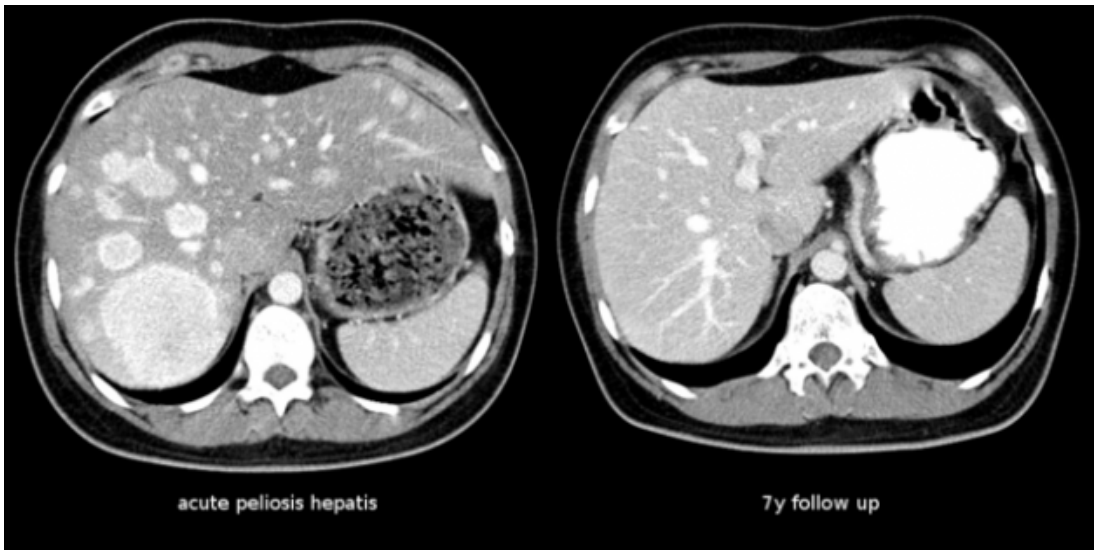


Image: Follow up of a patient with peliosis hepatis over 7 years with full remission. By Braegel, License: CC BY-SA 4.0

In differential diagnosis, **toxoplasmosis** and the **Kawasaki syndrome** have to be

considered. Moreover, other causes of lymphadenitis like **tuberculosis**, **CMV**, and **infectious mononucleosis** should be ruled out.

Detection of *Bartonella henselae*

With an **immunofluorescence test**, specific **IgG antibodies** can be detected. In problematic cases, direct detection using **PCR** based on biopsy material is another option. Cultivation lasts up to 120 days and is, therefore, not a practical procedure.

Histology of the lymph nodes shows **granulomatous inflammation** with central necrosis. This inflammation is surrounded by **epithelioid and giant cells**. An increase in inflammation parameters can be detected in the blood. Furthermore, patients might also develop **hemolysis** and **thrombocytopenia**.

Treatment of Cat-scratch Disease

In most cases, the disease heals without any therapy. In case of complications, **azithromycin** can be used.

Infections with *Bartonella quintana*

Infections with ***B. quintana*** occurred mainly during the world wars in Eastern Europe, where the term ‘trench fever’ originated. The transmitters of **Wolhynia fever** (another name for trench fever) are cloth and head lice, whose feces remain infectious for many years.

After an incubation period of 10–30 days, sudden symptoms like headaches, aseptic meningitis, and fever set in. As the fever has a recurrence time of 5 days, the disease is also referred to as **5-day fever**. Afterward, bone pain may persist for months, mostly in the shin and spine regions. Headaches also stay for some time.

Nowadays, this infection mostly affects homeless people and patients with AIDS. In immunosuppressed individuals, *B. quintana* can be the trigger of bacillary angiomatosis, peliosis hepatis, and especially of endocarditis.

Detection is similar to that of *B. henselae*, e.g. via PCR based on heart valve biopsy.

Treating Infections with *Bartonella quintana*

Treatment consists of antibiotics that reach intracellular concentrations. These drugs include **doxycycline, erythromycin,** and **azithromycin**. In AIDS patients, long-term antibiosis is advisable.

Infections with *Bartonella bacilliformis*

Sandflies serve as vectors for this type of Bartonella. After transmission, the bacteria mainly live in erythrocytes. Secondarily, they can also be present in the spleen and other organs. The hemolytic form of this type of bartonellosis is **Oroya fever**.

Lymph node swelling and **hepatosplenomegaly** occur – accompanied by very high fever and severe hemolysis. This is followed by a phase of severe immunosuppression, which used to have lethal consequences in the past as, without antibiotic treatment, it led to secondary infections.

Without antibiotic treatment, Peruvian warts form after 2–4 months. Usually, they heal spontaneously after several months.

Note: After infection with Bartonella, individuals no longer qualify for blood donations.

The following table provides an overview of the most important species of the genus Bartonella:

Species	*B. henselae*	*B. quintana*	*B. bacilliformis*	*B. elizabethae*
Reservoir	Cat	Human	Human	Rat
Occurrence	Worldwide	Worldwide	South America	Unknown
Vector	Cat flea, ticks	Head and clothes lice	Sandflies	Unknown
Clinical pictures	Cat-scratch disease, bacterial angiomatosis, peliosis hepatis, endocarditis, encephalitis, sepsis	Trench fever, bacterial angiomatosis, endocarditis, chronic lymphadenopathy	Carrion disease, sepsis	Endocarditis

Brucella

The most important brucelloses in humans are Malta fever, mostly caused by *B. melitensis*, and Bang disease, which is caused by *B. abortus*.

Characteristics of Brucella

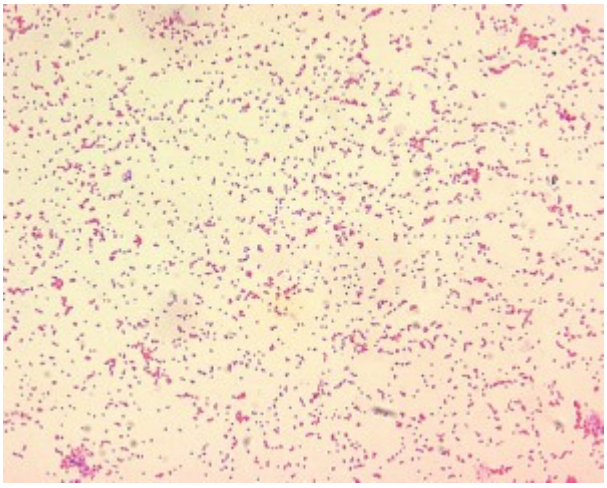


Image: Brucella. By CDC/Courtesy of Larry Stauffer, Oregon State Public Health Laboratory, License: Public domain

These bacteria are **gram-negative rod-shaped bacteria that vary in length from coccoid to short**. They are immobile and obligatorily host-bound. Only under favorable conditions can these pathogens maintain their infectious capacity outside of the host for several months.

These aerobic bacteria use livestock like cattle, sheep, and swine as reservoirs.

Therefore, it is those in contact with livestock, like veterinarians, farmers, shepherds, or zookeepers, who are at risk of contracting an infection. In countries in which brucellosis is endemic, there is also an increased risk for those who consume insufficiently heated milk products.

The following are important representatives of the genus Brucella:

Species	Pathogen reservoir	Disease
B. melitensis	Goats, sheep, camels	Malta fever, also known as undulant fever
B. abortus	Cattle	Bang disease
B. suis	Swine	Swine brucellosis

Infections with *Brucella abortus and melitensis*

Brucellosis is especially common in Mediterranean countries. Transmission occurs **via direct contact with animals or their excretions** (the pathogen lives primarily in the animals' urinary tract).

Depending on the portal of entry (e.g., the respiratory or digestive tract), local inflammations with non-specific symptoms can be observed. Due to **hematogenic spread,** basically every organ can be affected; typical **non-caseating granulomas** form.

The bacteria mainly proliferate in the cells of the **reticuloendothelial system** and in reproductive organs. In up to 90% of the infections, the disease has a subclinical process. After an incubation period of 5–60 days, symptoms like fatigue, joint pain, hepatosplenomegaly, and high fever accompanied by shivering and night sweats can be observed.

Since the fever is regularly interrupted by fever-free intervals, it is also referred to as **undulant fever** with respect to its wave-like course. Other clinical presentations include endocarditis with an inflammation of the aortic valve, chronic processes with neurological symptoms, and spondylodiscitis. The skeletal system is commonly affected in children. Arthritis, spondylitis, and osteomyelitis are commonly reported in such cases. During pregnancy, the infection often leads to miscarriage.

The image shows a typical non-caseating granuloma:

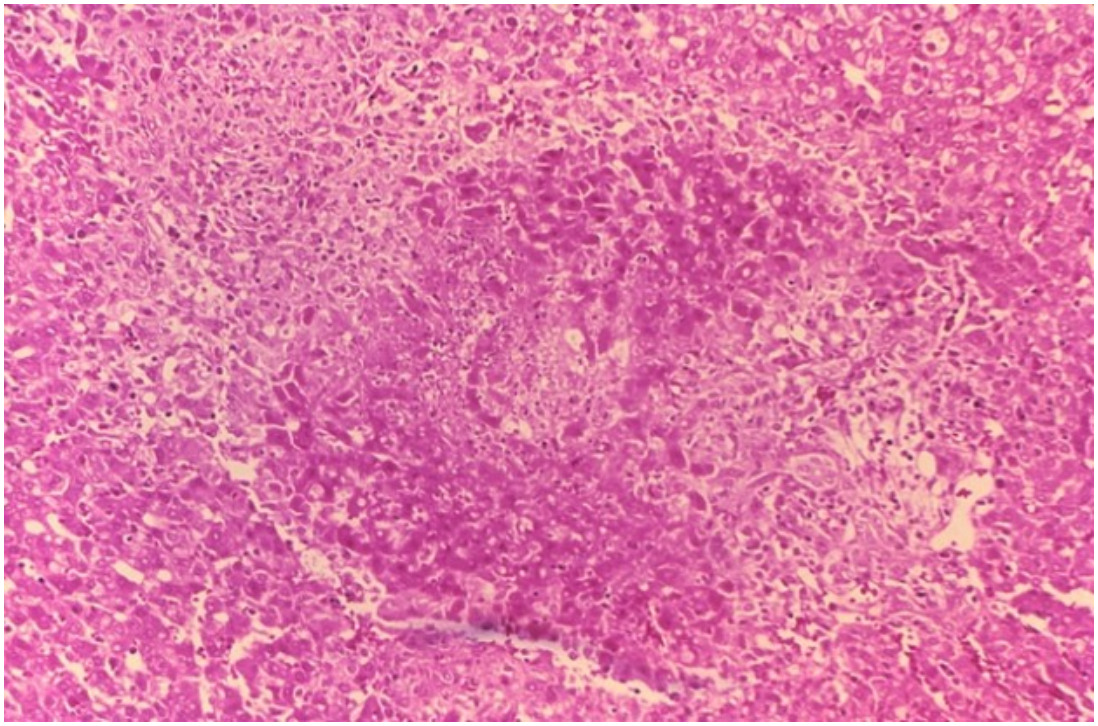


Image: Brucella granuloma. By CDC/Dr. Marshall Fox, License: Public domain

Detection of Brucella

For cultivation, blood cultures, abscess material, bone marrow, and other tissues can be used. Every suspicion has to be communicated to the laboratory since there is the danger of contagion and cultivation must only occur in an S3-laboratory.

A further method is the detection of antibodies in the serum. For this, **slow agglutinations** and the **Rose-Bengal test** can be used. It is an antigen agglutination

test with a Rose Bengal dye test antigen from ***B. abortus***.

As differential diagnoses, **tuberculosis** and **yersiniosis** should be considered.

Treatment of Brucellosis

Combination therapy is recommended. The gold-standard drug is **doxycycline** for 6 weeks and **streptomycin** for 2–3 weeks.

Usually, the disease and any resulting deaths have to be reported to competent authorities.

Coxiella

Characteristics of *Coxiella burnetii*

The only species of this genus is ***C. burnetii***. Coxiella is a close relation of **Rickettsia, Legionella**, and **Francisella.**

This strictly intracellular bacterium is gram-negative and rod-shaped, however, it cannot be imaged with Gram stain, but with **Gimenez stain**.

Due to its ability to sporulate, *C. burnetii* can remain infectious in the dust, hay, and wool for a time span of up to 10 months and more. The pathogen can be present in 2 antigenic forms: **phase I**, which is very infectious, and **phase II** with lesser virulence.

Recently, *C. burnetii* has been classified as a potential bioterrorism agent by CDC and it caused a large outbreak in the Netherlands.

Infection with *Coxiella burnetii*

Q fever (i.e., Query fever) is a zoonosis with worldwide spread with the exceptions of New Zealand and Antarctica. The pathogen reservoirs are artiodactyls like sheep and cattle, in addition to cats, dogs, and wild animals. Transmission mostly occurs **via inhalation of contaminated dust**. Only in exceptional cases, human-to-human transmission occurs.

At-risk populations are primarily individuals with occupational exposure, like butchers, fur processors, and veterinarians. Even a minor dose of 10 bacteria can lead to contagion.

After an incubation time of 2–4 weeks, symptoms like high-grade fever, shivering, muscle aches, and severe headaches occur in 50% of cases. Primary infection can be asymptomatic in a large number of patients Moreover, **interstitial pneumonia** and **hepatitis** are potential complications. X-ray images of Q fever pneumonia (lower image) compared to the normal state (upper image) can be seen in the image below:

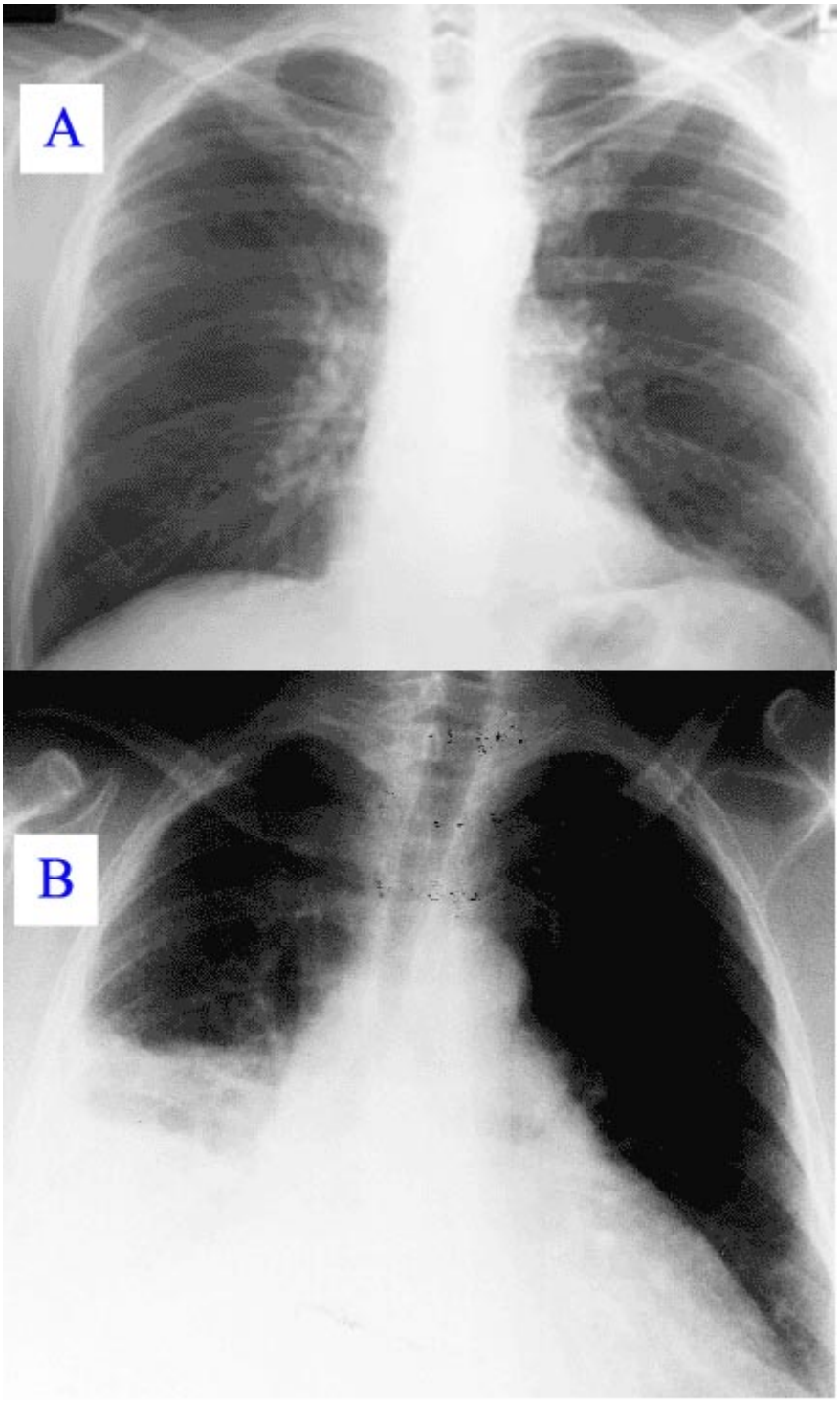


Image: X-ray of fever Pneumonie. By Hehkuviini, License: Public domain

In roughly 1% of the diseased, chronic infection with **Q fever endocarditis** occurs. Patients with **cardiac valvular defects, cardiac valve prostheses**, or the immunosuppressed are predisposed to Q fever endocarditis. After infection, there is long-lasting immunity; however, during pregnancy or with a weakened immune system, the bacteria can be reactivated as they can survive in **macrophages.**

Observational studies have shown the association of *C. burnetii* infection with long-term syndromes like atherosclerosis, chronic fatigue syndrome, and lymphoma.

Treatment of Q Fever

For the treatment of Q fever, antibiotics that act intracellularly,

like **tetracyclines** and **macrolide antibiotics**, are used. In chronic cases, long-term antibiotic treatment for up to 4 years may be necessary. Hydroxychloroquine along with doxycycline is indicated in endocarditis). A whole-cell inactivated vaccine is available and has been used in occupational workers in Australia, and during the epidemic in the Netherlands.

Detection of *Coxiella burnetii*

When patients present with fever of uncertain genesis and atypical pneumonia, Q fever should be considered as a possibility.

In the acute stage of the inflammation, tests mostly reveal antibodies against the phase-II antigens. The detection of phase-I antibodies suggests a chronic course. However, cross-reactions with ***Chlamydia pneumoniae*** and Bartonella spp. have to be considered.

Using **immunofluorescence** and **electron microscopy**, pathogens can also be directly detected in biopsy material. Laboratory tests must be performed in S3 laboratories. Detection of *C. burnetii* DNA by PCR is also used to diagnose infection. Direct and indirect pathogen detection has to be reported to authorities.

Haemophilus

The species Haemophilus consists of gram-negative, facultative anaerobic and capnophilic immobile rod-shaped bacteria. They have a characteristic need for growth factors **hemin** and **NAD** or NADP. These factors are released from erythrocytes through heat, which is why Hemophilus is typically cultivated in **chocolate agar**. *H. influenzae* is a commensal of the human nasopharynx that can cause various diseases of the upper respiratory tract such as pneumonia, otitis media, and bronchitis.

Infections with *Hemophilus influenza*

Non-encapsulated variants of these bacteria cause infections of the respiratory tract; the encapsulated cause systemic infections like **sepsis, purulent meningitis**, and **epiglottitis**. This **polysaccharide capsule** inhibits **phagocytosis**. Since during the growth process the substance of the capsule is released into the surroundings, it can be used for diagnostics.

The most dangerous capsule type is the B type (Hib) as it can cause sepsis and meningitis. Moreover, some variants of **Hib** have **IgAse**, which cleaves IgA antibodies and thus inhibits the local immune system, e.g., in the respiratory tract. The portion of penicillinase-producing variants also grows. As Hib conjugate vaccines are widely used, most infections are now caused by the Hia strain.

Infections with **non-encapsulated strains** usually have endogenous origins since roughly 80% of the population are asymptomatic carriers. *H. influenzae* can primarily be found in the pharyngeal epithelium.

Capsulated strains, on the other hand, are transmitted by droplets. The symptoms of such an infection include inflammation of the paranasal sinus, bronchitis, and meningitis. Even with appropriate antibiosis, mortality from Haemophilus meningitis is more than 5%. If the disease subsides, neurological defects like hearing damage or mental disorders remain in most cases.

Further complications are sudden-onset epiglottitis with the risk of suffocation, pleuritis, and sepsis. The only effective prophylaxis is vaccination against HiB beginning in the 2nd month of life.

Infections with *Haemophilus ducreyi*

Image: Image of ulcus molle. By CDC/Joe Miller, License: Public domain

This pathogen has a widespread in tropical African, South Asian, and South America. After contamination through sexual intercourse, rotund (chancroid) ulcers develop in the area of the labia, glans, and penile shaft. These ulcers are extremely painful.

More, there is a swelling in the inguinal lymph nodes, called **a bubo.**

As a differential diagnosis, **syphilis** has to be considered.

STIs with *H. ducreyi* are on the decline, but it is now emerging as a pathogen responsible for chronic limb ulceration that is similar to yaws.

Therapy for Haemophilus infections

Typically, chancroid ulcers can be easily treated with a single intramuscular injection of **ceftriaxone**. However, the treatment of *H. influenzae* infection should include the administration of **amoxicillin** and **clavulanic acid** or **moxifloxacin**.

Detection of Hemophilus

Possible materials for cultivation are **sputum,** blood, and **cerebrospinal fluid**. The optimal cultivation is chocolate agar. Hemophilus can grow in the hemolytic zone of ***Staphylococcus aureus*** (satellite phenomenon) since *S. aureus* produces NAD. The colonies are smooth, slightly translucent, and have a characteristically salty smell – some say it smells like sperm.

Other Pathogenic Species of Haemophilus

H. aegyptus, which is primarily present in North Africa, causes **purulent conjunctivitis**. Another human-pathogenic bacterium is ***H. parainfluenza***, which rarely causes **endocarditis**.

Leptospira

Characteristics of Leptospira

Leptospira (Greek: ‘leptos’ for thin and ‘spira’ for curl) are very thin and long bacteria that are helicoidally wound in the middle.

Their ends are thick so that in a scanning electron microscope image, they resemble a cane. By rotating around its own axis, leptospira can move actively.

They are **obligatorily aerobic**, do not form spores, and are **catalase-positive.**

Infections with *Leptospira interrogans*

Leptospirosis is a potentially fatal zoonosis endemic to many tropical regions and causes large epidemics after heavy rainfall and flooding.

L. interrogans is the most important pathogen of leptospirosis. Natural hosts are mainly rats and mice. Swine and cattle are also hosts. The pathogens are transmitted through contact with the urine, blood, or tissue of infected animals.

***L. interrogans* serovar Icterohaemorrhagiae** is the cause of the most common leptospirosis called **Weil disease.** Other serovars with similar clinical presentations are ***L. interrogans serovar* Australis** (sugar cane fever) and **L. interrogans serovar Pomona** (swineherder’s disease).

About 90% of the infections have a mild process with flu-like symptoms. Severe processes are accompanied by liver and kidney failure. Higher mortality is seen in patients older than 60 years of age.

Detection of Leptospira

The generation time of leptospira is roughly 10 hours. In comparison, the generation time of ***E. coli*** is 20 minutes. Thus, cultivation takes relatively long. In bouillons, leptospira typically grow in a flat disc 1–3 cm below the surface of the culture medium.

In contrast to most other bacteria, microscopy of leptospira is only possible via **dark-field or phase-contrast microscopy.** However, the most important test is serology with the detection of **IgM** and **IgG antibodies**.

Treatment of Leptospirosis

The medication of choice is **penicillin**. However, there is, as with other **spirochaete bacteria,** the risk of a **Jarisch-Herxheimer reaction**. In the second stage of the disease, the immune reaction dominates, which is why only symptomatic treatment should be performed at this point. Leptospira are susceptible to β-lactams, macrolides, tetracyclines, fluoroquinolones, and streptomycin.

Rickettsia

Characteristics of Rickettsia

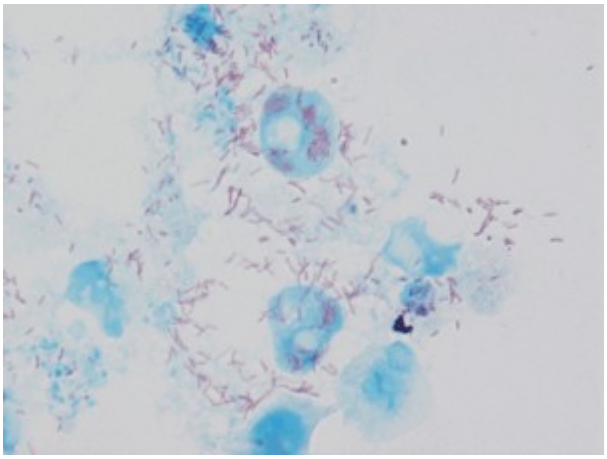


Image: *Rickettsia conorii*. By Clarisse Rovery, Philippe Brouqui, Didier Raoult, License: Public domain

Rickettsias are obligatory cell parasites, allowing them to escape the immune system of the host. In order to reach the host cells, the **rOmpB protein** of the rickettsia binds to the **KU70 protein** of the eukaryotic cell.

Proliferation also takes place in the cytoplasm of the host cell. Pathogen release occurs through **exocytosis** or **lysis.**

Rickettsiae are **pleomorphic, non-sporogenic,** and of special interest for researchers since the genome of rickettsia is very similar to that of mitochondria. Thus, they corroborate the endosymbiotic theory.

Infections with Rickettsia

Generally, human-pathogenic rickettsias are divided into 3 groups. They are pathogens of **tick-bite fever**, **spotted fever**, or **Tsutsugamushi fever**.

These are the pathogens of tick-bite fever:

Pathogen	Disease	Occurrence
R. rickettsia	Rocky Mountain fever	Western Hemisphere
R. africae	African tick-bite fever	Africa
R. sibirica	Siberian tick-bite fever	Siberia
R. conorii	Boutonneuse fever	Mediterranean countries
R. japonica	Japanese spotted fever	Japan

The pathogen of spotted fever is ***R. prowazekii***, and ***Orienta tsutsugamushi*** is the actuator of **Tsutsugamushi fever**. Vectors are ticks, fleas, mites, and lice.

Rocky Mountain Fever

After a few days, fever, headaches, nausea, and diarrhea occur. Approx. 1 week after the 1st symptoms, a typical skin rash consisting of elevated, violet, non-itching maculae appears. These maculae are actually **petechiae**.

Complications can affect the lung and kidneys.

Spotted Fever

The incubation period for spotted fever amounts to roughly 10–14 days. The first symptoms are shivering, fever, and clouded awareness. Later, **petechial bleedings** occur, which give the disease its name.

Tsutsugamushi Disease

This disease is prevalent in Southwest Asia and presents with a severely manifested **exanthema**. If the disease takes a severe course, it can lead to encephalitis, as do other rickettsioses.

Detection of Rickettsia

Since rickettsias are intracellular parasites, cultivation is only possible using living cells and **chicken embryo cultures**. Antibody detection is also possible serologically since the serum of a patient containing rickettsia antibodies cross-reacts with **Proteus-OX19**. This is called the **Weil-Felix reaction.**

Spotted fever is a reportable disease.

Treatment of Rickettsioses

Roughly 5% of all rickettsioses result in death. Immediate treatment with intracellularly efficient antibiotics like doxycycline is crucial, even if the disease is only clinically suspected.

Ehrlichia

Ehrlichia belong to the Rickettsiales and have similar characteristics. They are also intracellular parasites and are transmitted to humans via ticks. In the host, they persist in **monocytes** and **granulocytes**. The infection mostly takes a bland course; in rare cases, symptoms resembling those of **Rocky Mountain spotted fever** can occur.

Chlamydia

Characteristics of Chlamydia

Chlamydiae are very small gram-negative bacteria that are obligatorily intracellular. Vegetative forms are called **reticulate bodies** while infectious forms are called **elementary bodies**.

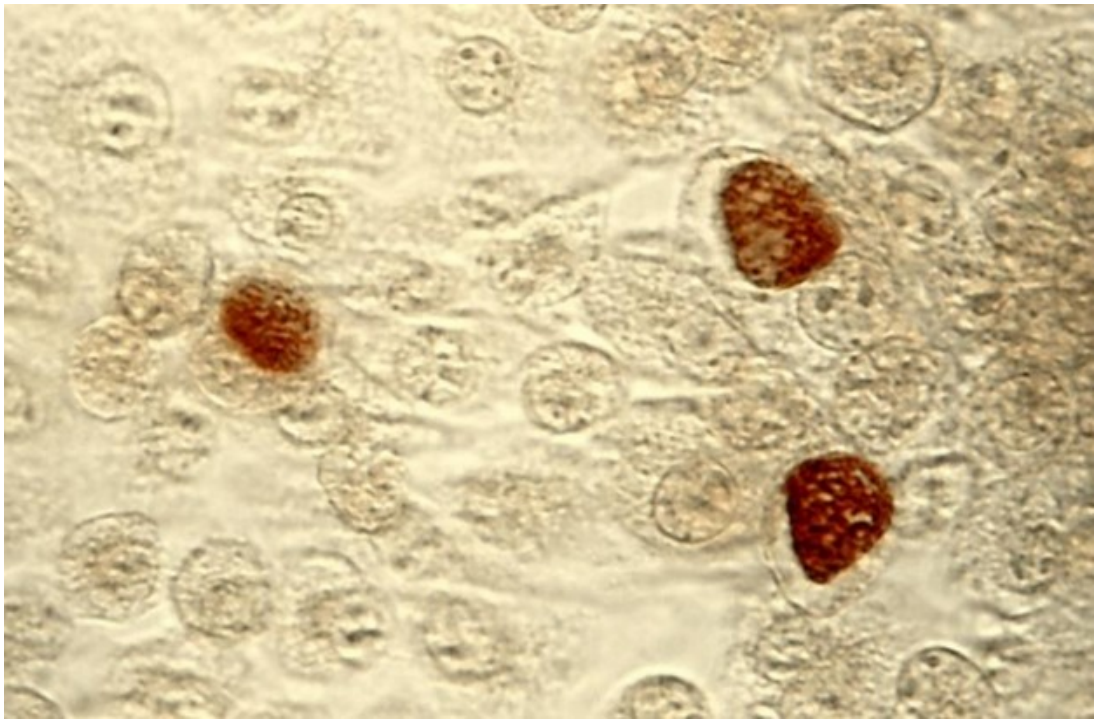


Image: Chlamydia trachomatis. By CDC/ Dr. E. Arum, Dr. N. Jacobs, License: Public domain

Elementary bodies are relatively resistant to environmental influences and can survive outside the host organism for some time. The reticulate bodies destroy the host cell after proliferation via lysis and are thereby released.

Current findings state that there is a third form: the **aberrant bodies**. They are considered an outlasting form for unfavorable conditions since their metabolism is extremely reduced. Presumably, they are the actuators of **reactive arthritis**.

Detection of Chlamydia

Due to its parasitic metabolism, a culture of chlamydia is only possible with living cells. **HeLa cells** (human cells from a cervical cancer patient) are used but **McCoy cells** are also employed.

Serologically, Chlamydia can be detected via **immunofluorescence** with marked antibodies due to the **lipopolysaccharides** on their cell wall (see image below).

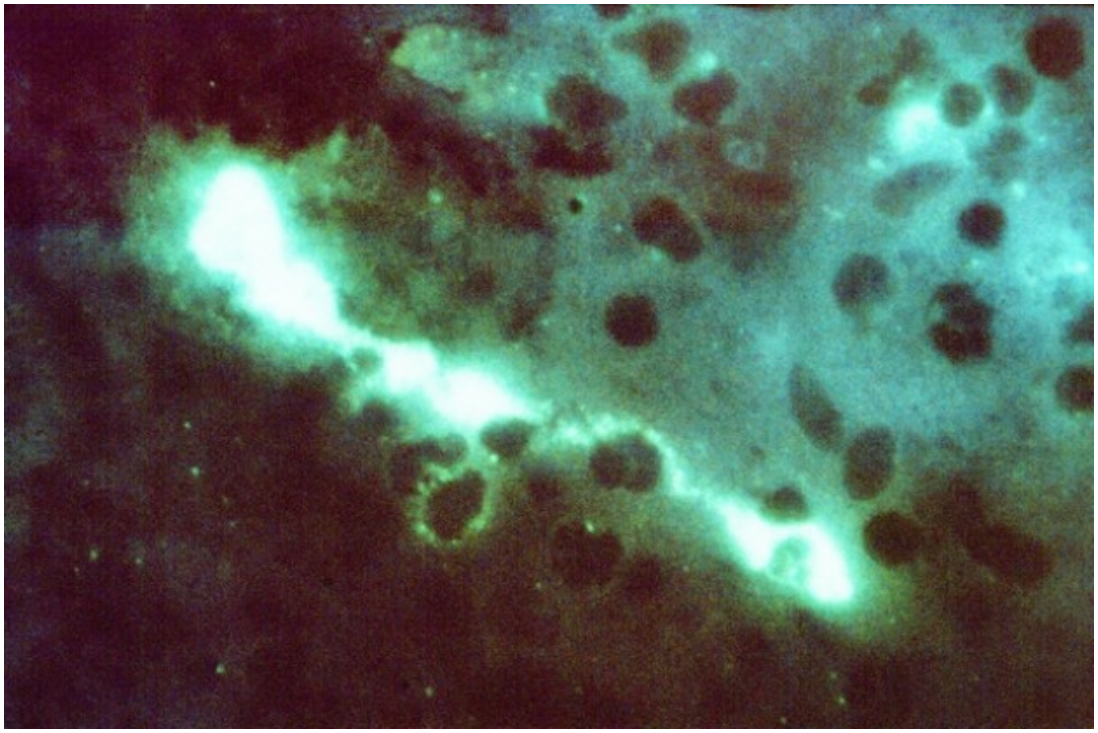


Image: Immunofluorescence. By CDC/Dr. Vester Lewis, License: Public domain

Clinically, the detection of Chlamydia antibodies using **ELISA** is very common.

Much more specific than the above-mentioned tests are molecular biological methods like PCR. WHO reports a specificity of 99.2–99.8% for ***Chlamydia trachomatis***.

Differentiation between Chlamydia and Chlamydophila species can be achieved with **Lugol's solution**. This iodine potassium-iodide solution detects the glycogen that is only produced by Chlamydia.

Infections with Chlamydophila

Chlamydophila pneumoniae

This species is almost exclusively present in humans. Transmission is typically **aerogenic**. In immunocompetent individuals, the infection is symptom-free or triggers **pharyngitis**. After 4–6 weeks, **post-infectious arthritis** and **tendinopathies** can occur.

In immunosuppressed persons, *C. pneumoniae* is a frequent pathogen in lung inflammations. On X-ray images of the lung, a small-spotted, non-typical infiltration can be seen. Treatment includes the administration of **clarithromycin** or doxycycline. The level of endemic infection is considered to reach up to 70%.

Since *C. pneumonia* can last in the body for a long time in the form of reticulate bodies, these bacteria are associated with arthritis and arteriosclerosis. Studies prove that **antibody titers** in patients with coronary diseases are higher than in the rest of the population.

Chlamydia psittaci

The clinical picture caused by this bacterium is referred to as **ornithosis** or parrot disease. As the name suggests, birds like parrots, pigeons, or seagulls are the reservoir of *C. psittaci*. Transmission occurs through the inhalation of the infectious dust of animal

feces.

The primary proliferation of Chlamydophila takes place in the **ciliated epithelium** of the respiratory tract. Subsequently, secondary proliferation and **bacteremia** occur in the **reticuloendothelial system**, for instance, the spleen and the liver. Therefore, possible findings include hepatomegaly and splenomegaly. In the lung, the infection leads to atypical pneumonia with **interstitial edema** and **necrosis of the alveolar walls**.

Usually, the diagnosis is made in exposed people based on the clinical picture. Endangered occupational groups are, for example, people who work in poultry farming.

Cultivation of ***C. psittaci*** must only be performed in laboratories with a protection level of 3. It is a reportable disease. As with *C. pneumoniae*, treatment consists of **tetracyclines**.

Infections with *Chlamydia trachomatis*

There are several serotypes of *C. trachomatis*, which are divided into 3 groups according to the diseases they cause:

Serotype	Disease	Transmission
Serovar A–C	Trachoma: severe conjunctivitis, often leads to blindness	Poor hygiene
Serovar D–K	Genital chlamydiosis, conjunctivitis, paratrachoma (swimming pool conjunctivitis), pneumonia in newborns, late sequel: reactive arthritis	Sexual intercourse; perinatally; contaminated water (e.g., in whirlpools)
Serovar L1–L3	Lymphogranuloma venereum	Sexual intercourse

Trachoma

Trachoma caused by the serotypes A**–**C is primarily prevalent in tropical countries. Transmission occurs through shared contact with towels, the direct contact of mucosae, and via flies.

After an incubation time of about 5 days, bilateral conjunctivitis develops. After some time, a **yellow-whitish lymph follicle** forms in the conjunctiva of the upper eyelid. The swelling of the upper eyelid leads to **ptosis**. Due to scarring, an **entropium** form that causes friction on the cornea at every blinking of the eye, which in turn leads to infection and scarring of the cornea. If this condition is left untreated, it often results in blindness.

WHO has summarized 4 measures for the elimination of trachoma with the acronym '**SAFE**', which stands for surgery, antibiotics, facial cleanliness, and environmental improvement.

Urogenital Infections with Chlamydia

Genital chlamydia is the most common bacterial STI in developed countries with a majority of infections affecting young adults.

The Robert Koch Institute (Germany) assumes a level of endemic infection of approx. 4.5% of the population. In women, the infection ascends from the urethra to the fallopian tubes. Such **salpingitis** can make the fallopian tubes agglutinate due to scarring, which can lead to sterility or extrauterine pregnancies.

Proliferation in the small pelvis is called **pelvic inflammatory disease**, which is accompanied by chronic pain. In the **Fitz-Hugh-Curtis syndrome**, the chlamydiae cause perihepatitis, which is accompanied by liver capsule pain and increased levels of transaminases.

Typical infections in men are **prostatitis** and **epididymitis**–which can also lead to sterility.

Paratrachoma (inclusion body conjunctivitis) is also caused by the serotypes D–K; this conjunctivitis can lead to purulence. Transmission often occurs in insufficiently chlorinated swimming pool water.

Lymphogranuloma Venereum

Image: Follow up of a patient with peliosis hepatis over 7 years with full remission. By Braegel, License: CC BY 2.0

This disease can frequently be found in tropical areas and is characterized by small, painless ulcers at the portal of entry, which regress after roughly 2 weeks. After that, **lymphadenitis** develops.

This painful lymph node swelling often develops in the groin and lasts for several weeks.

Without treatment, obstructions of the lymph drainage pathways can occur over the years, leading to the formation of lymphedema.

Treatment consists of macrolides and tetracyclines and must include both sexual partners.

Reactive Arthritis

Reactive arthritis is an immune-mediated inflammation reaction after a primary chlamydia infection of the mucosa. The combination of **urethritis, conjunctivitis, aseptic arthritis,** and **skin lesions** was formerly known as Reiter's syndrome but is currently known as **reactive arthritis (oculo-urethro-synovial syndrome).**

Notes