

Genus *Trueperella*

Trueperella pyogenes

(Genus name: named after the German microbiologist Hans Georg Trüper

Species epithet: pus producing)

(*Arcanobacterium pyogenes*/*Actinomyces pyogenes*/*Corynebacterium pyogenes*)

Trueperella Bacteria from the species *Trueperella pyogenes* are a part of the biota of skin and mucous membranes of the upper respiratory, gastrointestinal, or urogenital tracts of animals, but also, opportunistic pathogens. *T. pyogenes* causes a variety of purulent infections, species is involved in polymicrobial diseases, such as metritis, mastitis, pneumonia, and abscesses, which, in livestock breeding, generate significant economic losses.

The species *Trueperella pyogenes*, previously classified as *Arcanobacterium pyogenes*, *Actinomyces pyogenes*, and formerly as *Corynebacterium pyogenes*, belongs to the family *Actinomycetaceae*, in the order *Actinomycetales* of the class *Actinobacteria*, the so-called actinomycetes.

Species	Host	Pathological condition
<i>Trueperella pyogenes</i> (<i>Arcanobacterium pyogenes</i>) (<i>Actinomyces pyogenes</i>) <i>Corynebacterium pyogenes</i>	Cattle, Sheep and Pigs mainly	Chronic or acute suppurative mastitis , suppurative pneumonia, septic arthritis, vegetative endocarditis (Cattle), endometritis, umbilical, wound infections and Seminal vesiculitis (Bulls and Boars).
<i>Trueperella abortis uis</i>	Pig	Summer mastitis – a mixed infection Endometritis, Abortion

Morphology

Trueperella pyogenes is a Gram-positive,

Small coccoid or pleomorphic rods, appear singly, in short chains or pairs. The pairs are often V-shaped. May also form filaments.

Size: 0.5 x 2 µm,

Non-spore-forming,

Non-motile, Non-capsulated,

Facultatively anaerobic, which is characterized by a fermentative metabolism and strong **proteolytic activity**.

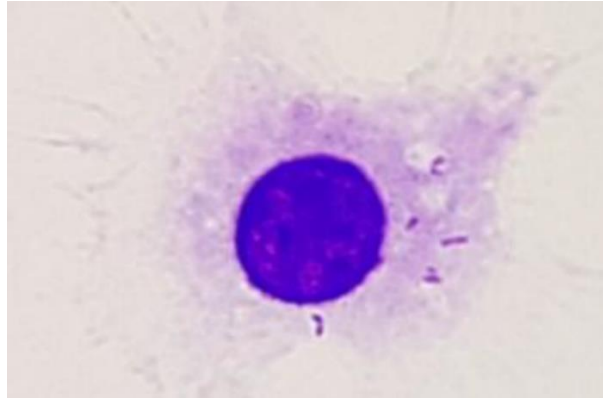


Fig. The macrophage cell line infected with *Trueperella pyogenes*. Staining using the Giemsa–MayGrünwald method; scale bar = 20 μ m (photo by Anna Hupał-Sikorska, BSc) Rzewuska *et al.*, 2019

Cultural characteristics:

Growth requirements are not excessive, but media enriched with blood or serum need to be used for the culture. The preliminary recognition of *T. pyogenes* isolates is based on the cell morphology; the features of colonies, which are surrounded by a **zone of beta-haemolysis on blood agar**; and a **negative catalase assay**.

Trueperella pyogenes will grow aerobically but 10% CO₂ will enhance their growth.



Fig. Colonies of *Trueperella pyogenes*, strain CCUG 13230^T, cultivated aerobically during 48 h on horse blood agar at 37°C in the presence of 5% CO₂. Note the β -hemolysis, which is clearly visible around single colonies. The length of the scale bar corresponds to 1 cm. Date: 2010-05-20 (Image: www.vetbact.org)

Biochemical tests

Trueperella pyogenes is **catalase negative**, ferments several sugars and produce acid.

Reduction of nitrate is negative.

Biochemical properties can be tested for species determination. Sometimes, additional bacteriological methods other than the conventional ones are necessary for the differentiation and appropriate identification of isolates.

Resistance

Are killed at a moist heat temperature of 60°C for 20 minutes and are susceptible to various disinfectants.

Antigens and virulence factors

Trueperella pyogenes produces a haemolytic exotoxin, which is dermonecrotic and lethal and it also produces a **protease** and an extracellular neuraminidase.

Pyolysin is a major known virulence factor of *T. pyogenes* that belongs to the family of cholesterol-dependent cytolysins. Its cytolytic activity is associated with transmembrane pore formation. Other putative virulence factors, extracellular matrix-binding proteins, fimbriae, and biofilm formation ability, contribute to the adhesion and colonization of the host tissues.

Pathogenesis

Trueperella pyogenes

In livestock, *T. pyogenes* infections occur mainly in cattle, swine, sheep, and goats, rarely in horses or birds, and are often associated with heavy economic losses.

In cattle, *T. pyogenes* mainly causes infections of the reproductive tract and the mammary gland, as well as pneumonia, liver abscessation. The most prevalent diseases in dairy cows are **metritis and endometritis**, may develop in a clinical form in animals after parturition.

Frequently, uterine disorders are from co-infections with *T. pyogenes* and other bacteria, such as *E. coli*, *Streptococcus* spp., *Staphylococcus* spp., *Fusobacterium* spp., *Prevotella* spp., and *Clostridium* spp. Such **polymicrobial uterine infections**, especially those with anaerobes, result in an increased purulent secretion and higher severity of lesions. The problems regarding parturition, the subsequent negative energy balance, or hyperketonemia are considered to be important risk factors for these diseases.

Another important and **common *T. pyogenes* infection in cattle is mastitis**, which may affect lactating and dry cows, as well as heifers. *T. pyogenes* is well known as one of the crucial agents of polymicrobial infection, called **summer mastitis**, which occurs mainly in pastured cows during the summer, and is associated with pathogen transmission by an insect, *Hydrotaea irritans*.

T. pyogenes alone can cause clinical mastitis called **pyogenes mastitis**, even with a high severity of symptoms. The mammary gland inflammation caused by this bacterium is characterized by severe pyogenic lesions in the mammary tissue, and malodorous and purulent milk, especially in case of co-infection with anaerobes, decreasing the milk yield and the low recovery rate. The anaerobes most often involved in mastitis together with *T. pyogenes* are *P. indolicus*, *F. necrophorum*, and *Prevotella melaninogenica* (formerly *Bacteroides melaninogenicus*).

T. pyogenes also contributes to many other disorders in cattle, among them, **liver abscesses** and **interdigital phlegmon** have a more significant economic impact.

Moreover, *T. pyogenes* may cause a variety of other purulent infections **in cattle** such as **pneumonia, encephalitis, pyelonephritis and kidney abscesses, lymphadenitis, endocarditis, and abscesses of various localization**. This pathogen was also isolated from cases of **septicaemia and abortion**.

T. pyogenes together with many other bacteria comprises a vaginal biota of healthy cows, and may also colonize and persist in the uterus of dairy cows with normal puerperium. However, as an opportunistic pathogen, this bacterium can invade the distant parts of the reproductive tract, especially after parturition, when the protective epithelium of the endometrium is disrupted, and it can also increase the influx of inflammatory cells in these tissues.

The presence of *T. pyogenes* in the endometrium is correlated with the damage of the tissue because of the cytolytic activity of the **pyolysin** against the endometrial stromal cells, which are particularly sensitive to this cholesterol-dependent toxin. The ability of *T. pyogenes* to produce inflammatory lesions in the endometrium was confirmed by the findings of Lima *et al.* and additionally, premature luteolysis was observed in some animals.

In swine, *T. pyogenes* is a common agent of **pneumonia, pleuritis, endocarditis, osteoarthritis, polyarthritis, mastitis, reproductive tract infections, and septicaemia**. Abscesses—superficial, muscular, or located in different organs—occur frequently, and may lead to the development of systemic purulent infection and inflammation of lungs, liver, kidneys, muscles, bones, joints, or other tissues.

In small ruminants, *T. pyogenes* is mostly a cause of abscesses formation in different tissues and localized in various parts of the body, including bone marrow and **foot (footrot) abscesses**.

Infections related to *T. pyogenes* were noted sporadically in horses, and included single cases of metritis, orchitis, mastitis, septicaemia, umbilical infection in foals, abscesses, and wound infection.

Diagnosis

1. Isolation and identification of bacteria:

T. pyogenes isolates is based on the cell morphology; the features of colonies, which are surrounded by a **zone of beta-haemolysis on blood agar**; and a **negative catalase assay**.

Gram-positive,

Small coccoid or pleomorphic rods, appear singly, in short chains or pairs. The pairs are often V-shaped. May also form filaments.

Size: 0.5 x 2 µm,

Non-spore-forming,

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- #### 2. New techniques, such as loop-mediated isothermal amplification (LAMP) assay, matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) mass spectrometry, Fourier transform infrared (FT-IR) spectroscopy, or 16S rRNA gene sequencing may be useful for the diagnostics of *T. pyogenes* infections. Those methods enable the recognition of the closely related taxa of the order *Actinomycetales*, and sometimes the reclassification of some of them.

References

Lima, F.S.; Greco, L.F.; Bisinotto, R.S.; Ribeiro, E.S.; Martinez, N.M.; Thatcher, W.W.; Santos, J.E.; Reinhard, M.K.; Galvão, K.N. Effects of intrauterine infusion of *Trueperella pyogenes* on endometrial mRNA expression of proinflammatory cytokines and luteolytic cascade genes and their association with luteal life span in dairy cows. *Theriogenology* **2015**, *84*, 1263–1272.

Madsen, M.; Aalbaek, B.; Hansen, J.W. Comparative bacteriological studies on summer mastitis in grazing cattle and *pyogenes* mastitis in stabled cattle in Denmark. *Vet. Microbiol.* **1992**, *32*, 81–88.

Rzewuska, Magdalena, Ewelina Kwiecień, Dorota Chrobak-Chmiel, Magdalena Kizerwetter-Świda, Ilona Stefańska, and Małgorzata Gieryńska. 2019. "Pathogenicity and Virulence of *Trueperella pyogenes*: A Review" *International Journal of Molecular Sciences* 20, no. 11: 2737. <https://doi.org/10.3390/ijms20112737> .

Schaal, K.P., Yassin, A.F., Stackebrandt, E. (2006). The Family Actinomycetaceae: The Genera *Actinomyces*, *Actinobaculum*, *Arcanobacterium*, *Varibaculum*, and *Mobiluncus*. In: Dworkin, M., Falkow, S., Rosenberg, E., Schleifer, KH., Stackebrandt, E. (eds) *The Prokaryotes*. Springer, New York, NY. https://doi.org/10.1007/0-387-30743-5_21.
