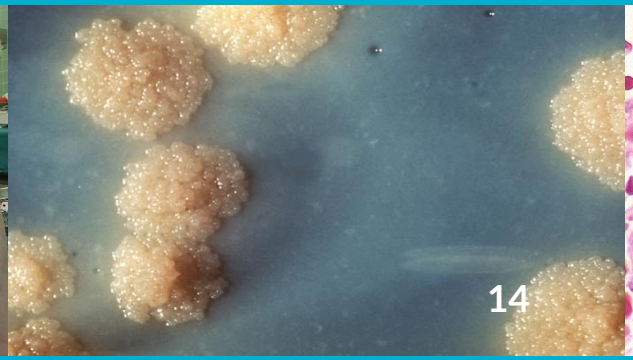
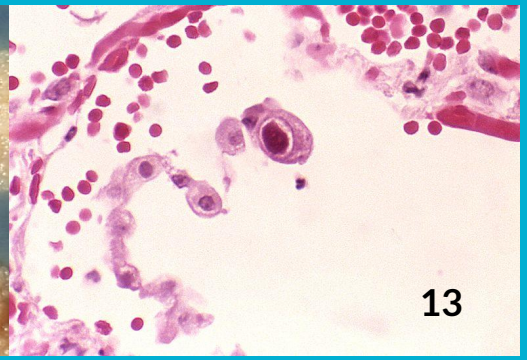
OPPORTUNISM

Causes and examples of opportunistic microorganisms (facultative pathogens)





Updated June 12, 2024

OPPORTUNISM

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DEFINITION

OPPORTUNISM: definition

In biology, opportunism is typical of living species that demonstrate flexibility in variable and transient environments (prairies, deserts, clear-cut forests, green areas that have experienced fires, etc.). This flexibility is primarily due to their ability to utilise diverse nutritional sources. They can also delay reproduction or remain dormant until the situation changes.

OPPORTUNISM: definition

Among all examples, perhaps the prairie best illustrates the colonisation by opportunistic species. Prairies can be devastated by intensive grazing or extreme natural events that significantly limit resource availability.

Herd of bisons grazing in South Dakota

OPPORTUNISM: definition

The situation becomes advantageous for opportunistic species, which are generally small in size and initially have a high growth rate. Thus, they can produce many seeds or offspring and easily colonise environments that have become hostile for other species.

Ecologists call this strategy r-selection, and it is not related to any genotypic variation.

OPPORTUNISM: definition

Among the animal species, some birds, amphibians, and mammals are opportunistic.

Eriodictyon parryi or poodle-dog bush

Acomys russatus - Golden spiny mouse

Among the plant species, the poodle-dog bush, typical of California, is very particular.

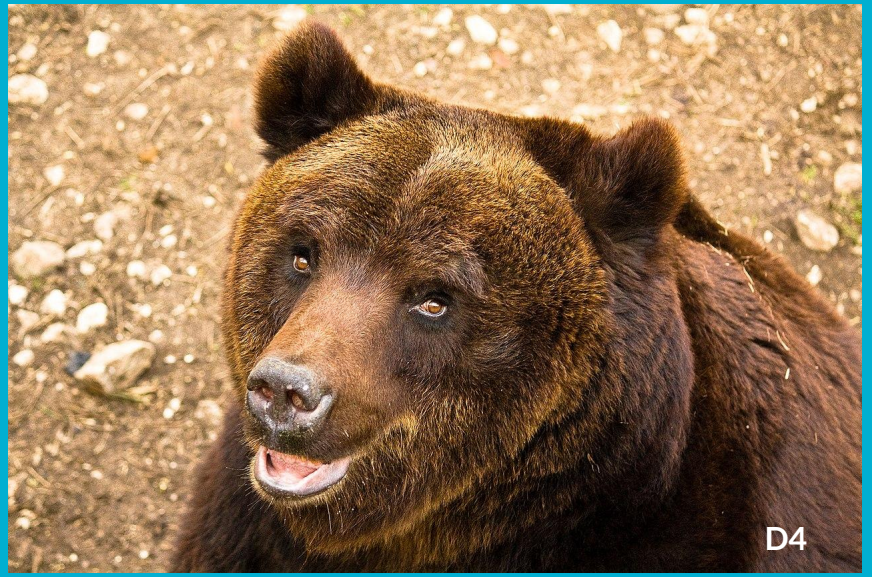
OPPORTUNISM: definition

As environmental conditions typical of the area are restored, opportunistic species are gradually replaced by endemic species.

In biology, the term opportunism can have several connotations beyond the example just proposed.
Why not mention the dietary opportunism of the bear?

OPPORTUNISM: definition

The brown bear is certainly not a small mammal, but its diet adapts to the season and it hibernates when environmental conditions become difficult.



Ursus arctos arctos - Marsican brown bear

OPPORTUNISM: definition

Opportunists also include various microorganisms, the so-called facultative pathogens. Generally, they are not highly virulent, so it is very difficult for them to cause infections. These include bacteria, fungi, viruses, and protozoa that normally live as commensals or saprophytes on living organisms or freely, and who may encounter an opportunity not always available.

OPPORTUNISM: definition

This opportunity may be due to a decrease in the efficiency of the human immune system, a disruption in the protective skin barrier following trauma, or a significant change in the microbiota.

Let's look at the causes in detail because, for example, an immunodeficiency can be determined by numerous factors.

CAUSES

OPPORTUNISM: causes

Malnutrition. It can occur during pregnancy, the early years of life, or an uncontrolled weight loss diet and is due to a poor intake of calories, proteins, or micronutrients.
Moderate malnutrition always weakens the immune system and is a risk factor for various diseases, including infections.

OPPORTUNISM: causes

Fatigue. It can be chronic or transient, physical or mental, and can affect people of all ages. It is a symptom, not a sign, when perceived by the individual.

OPPORTUNISM: causes

Recurrent infections. They weaken the individual and require repeated antibiotic therapies that always have negative consequences on the individual's microbiota.

Genetic predisposition. In every disease, a larger or smaller part of the responsibility is due to our genes.

OPPORTUNISM: causes

Immunosuppressive drugs

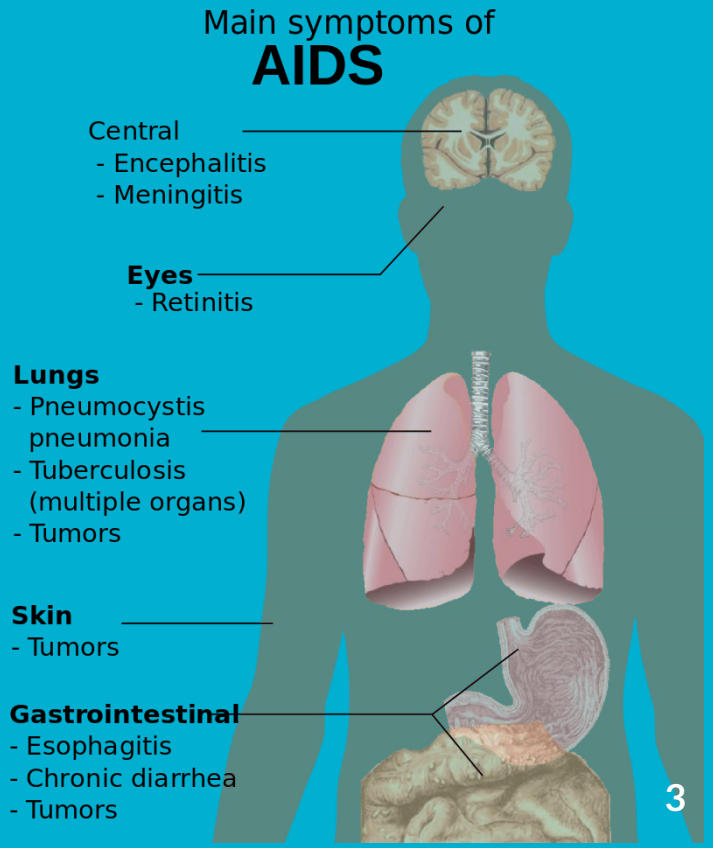
These are administered when undergoing organ or tissue transplants to prevent rejection or when autoimmune diseases must be treated.

Reconstruction of the first heart transplant
1967 - Cape Town - South Africa - Prof. C. Barnard

OPPORTUNISM: causes

Advanced HIV infection.

It has long been known that the HIV virus causes an acquired immunodeficiency that manifests with the individual's tendency to contract opportunistic infections.



OPPORTUNISM: causes

Cancer chemotherapy. The purpose of chemotherapy is to eliminate neoplastic cells or at least block their mitosis. But the drugs are not selective enough to act exclusively on the tumour. Hence the side effects and the compromise of the immune system.

Woman undergoing chemotherapy for breast cancer

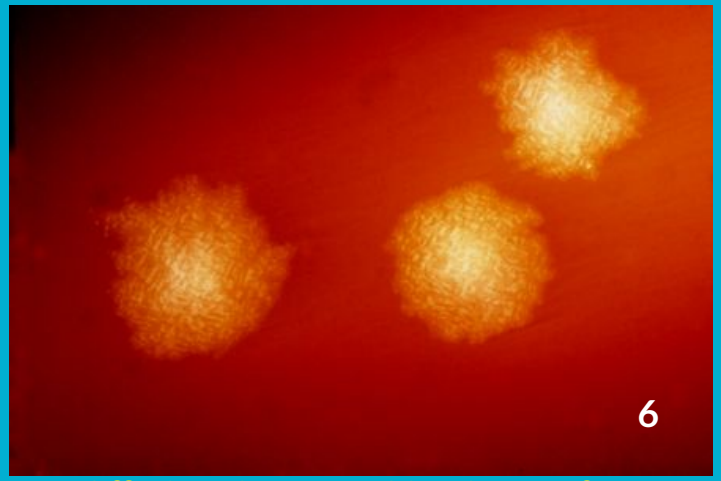
OPPORTUNISM: causes

Damage to the skin. Any injury to the skin can be an entryway for bacteria, fungi, or protozoa that normally live as commensals or saprophytes outside our body. Internally, conditions change and opportunistic pathogens take advantage.

Epidermis and dermis of human skin under the microscope

OPPORTUNISM: causes

Antibiotic treatments. Our intestinal microbiota is damaged because, in this case too, antibiotics, like chemotherapeutic agents, cannot be selective and eliminate only the pathogens. The imbalances can create infections, for example from Clostridium difficile.



C. difficile colonies on blood agar after 48 hours of growth

OPPORTUNISM: causes

To what has been listed we must also add some medical procedures, not sufficiently accurate. Indeed, opportunistic infections represent a serious problem in hospitals.

And then we must not forget pregnancy, which always represents a delicate moment in a woman's life.

We conclude the list with ageing. Older people have a weaker immune system.

Examples of Opportunistic Microorganisms

OPPORTUNISM: examples

Candida albicans.

It is a fungus belonging to the family of Saccharomycetes, capable of dimorphism; it normally lives as a saprophyte, or rather commensal, in many districts of our body.

Candida albicans under the microscope

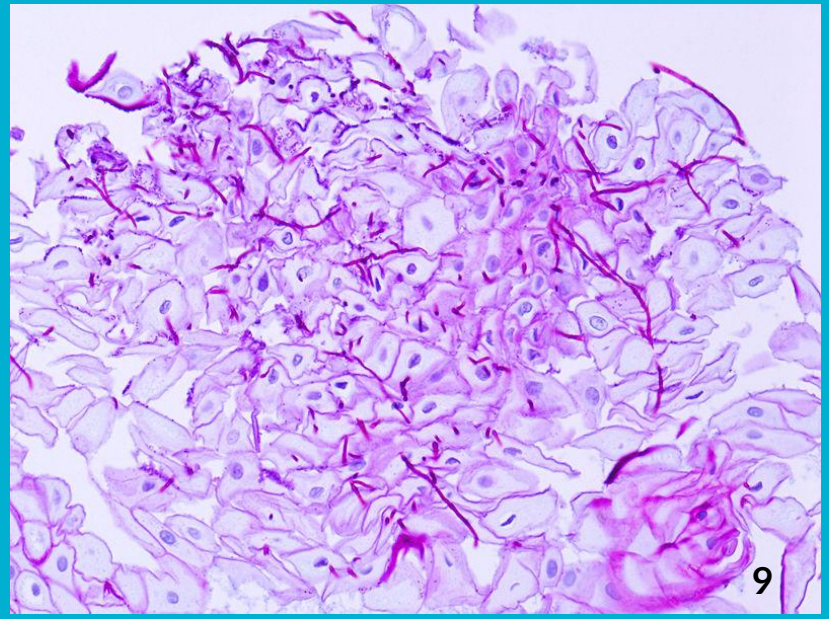
OPPORTUNISM: examples

Candida albicans. For example, it is normally found in the intestinal tract of 40% of healthy subjects, or in the oral cavity, and also on the vaginal mucosa. It becomes pathogenic following one of the previously mentioned causes.

Candida albicans under the microscope, isolated from sputum

OPPORTUNISM: examples

Candida albicans.
It is therefore responsible for mucosal and skin candidiasis and represents a serious problem in hospital opportunistic infections.

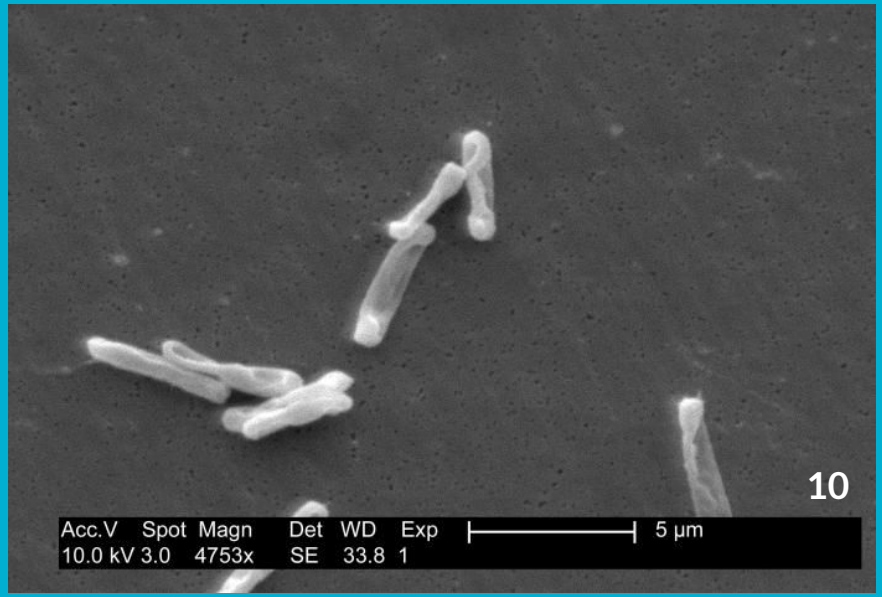


Esophageal candidiasis. The slide highlights the esophageal mucosa in which some Candida fungal hyphae are visible

OPPORTUNISM: examples

Clostridium difficile

An anaerobic, gram-positive, spore-forming, ubiquitous bacterium, a normal component of the human microbiota.

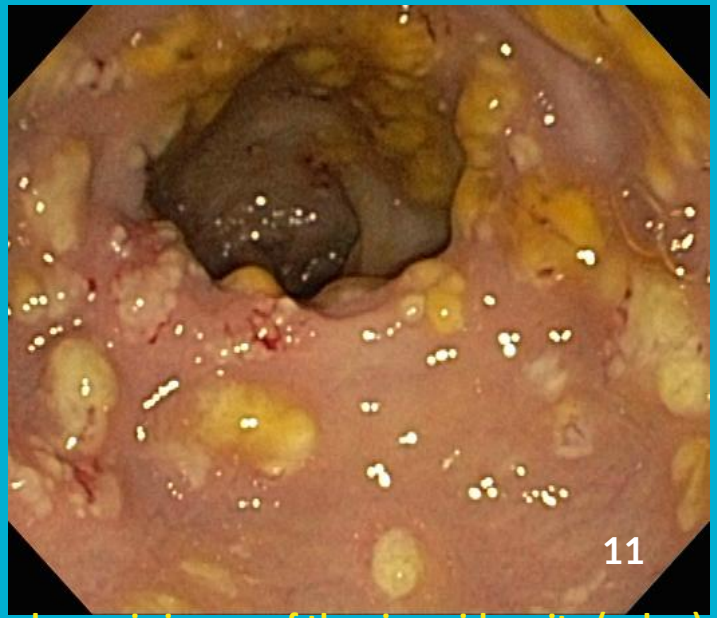


Clostridium difficile under a scanning microscope

OPPORTUNISM: examples

Clostridium difficile

In some cases, following antibiotic treatment that creates abnormal conditions in the normal balance between the components of the human microbiota, C. difficile can take over and cause pseudomembranous colitis.



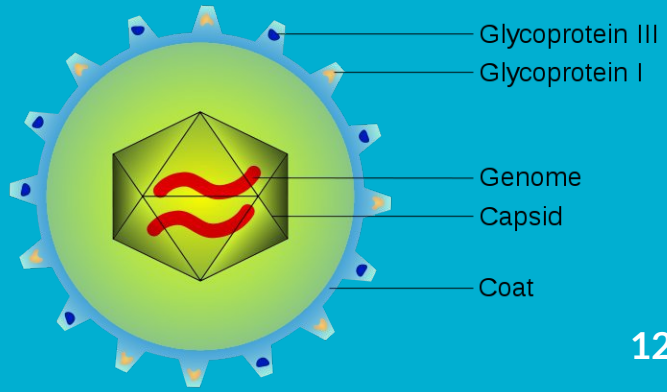
Endoscopic image of the sigmoid cavity (colon) with pseudomembranes, a clear sign in C. difficile colitis

OPPORTUNISM: examples

Cytomegalovirus

The virus belongs to the family of Herpesviridae. It is enveloped, and its capsid has an icosahedral structure.

Diameter: 120 - 200 nm.

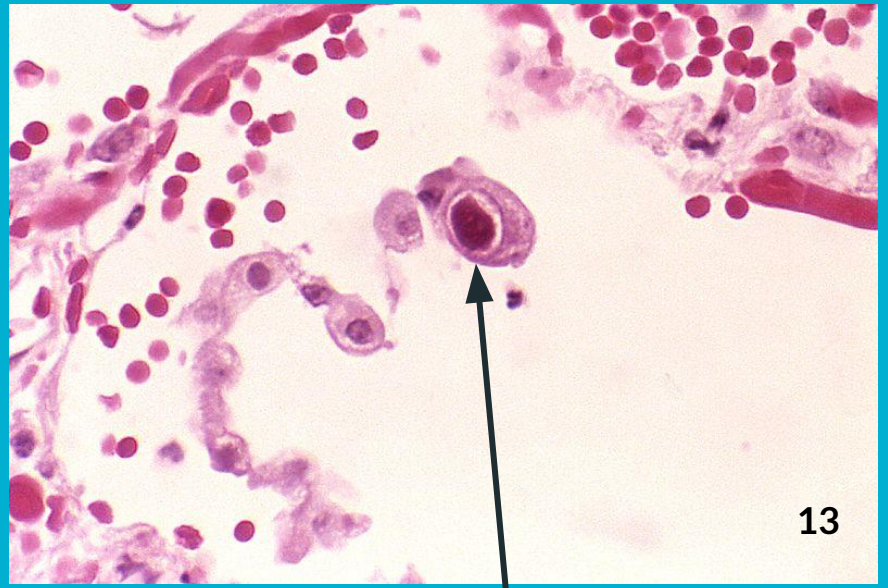


Reconstruction of Cytomegalovirus structure

OPPORTUNISM: examples

Cytomegalovirus

The virus can cause a typical pneumonia related to episodes of immune system failure, for example, in organ transplants.



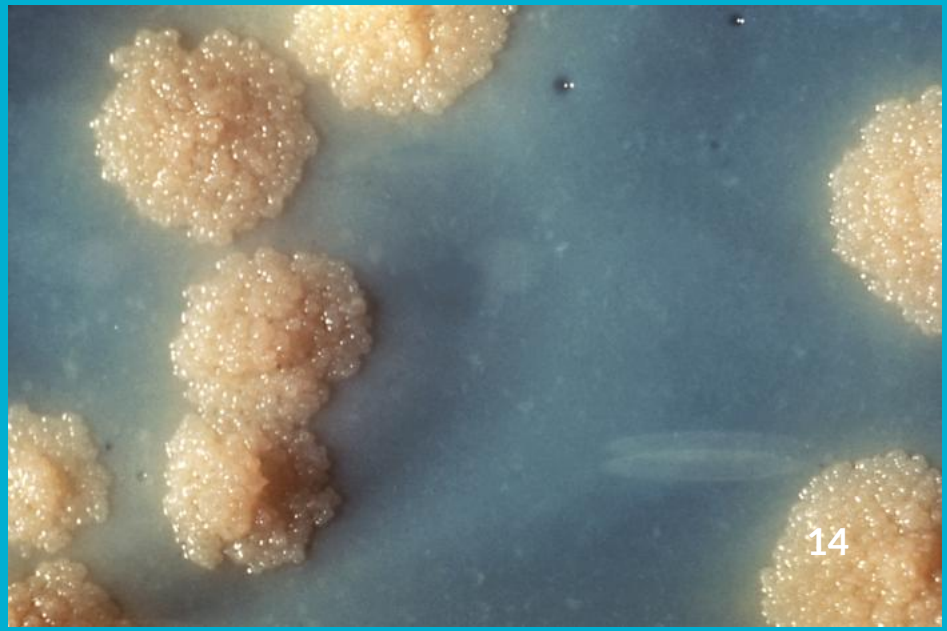
Cytomegalovirus pneumonia slide.
The cell in the center (pneumocyte) shows the nucleus significantly enlarged and with inclusions, characteristic of CMV infections

OPPORTUNISM: examples

Mycobacterium tubercolosis

An obligate aerobic, non-sporogenic bacillus, characterised by slow growth.

In the photo you can see the typical appearance of its colonies on culture medium.

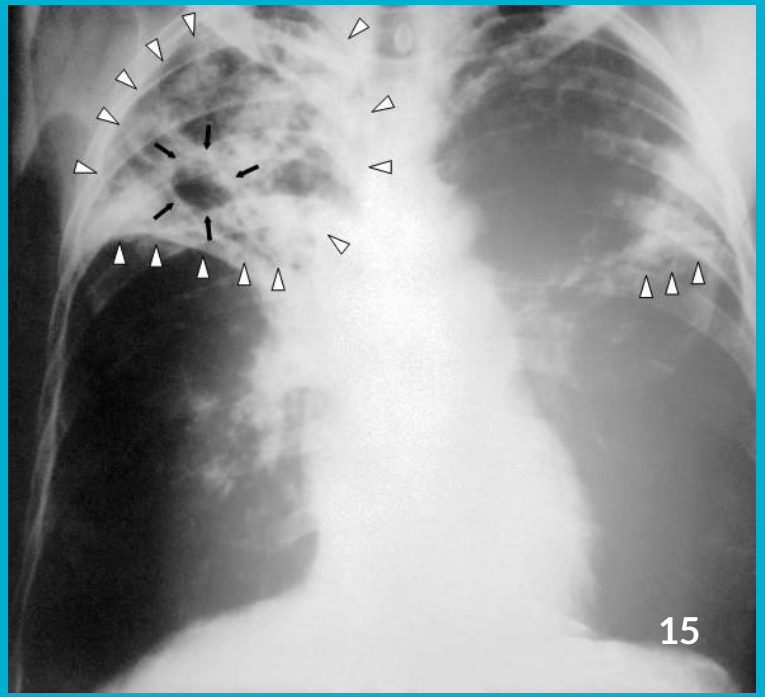


M. tuberculosis colonies

OPPORTUNISM: examples

Mycobacterium tubercolosis

This bacillus is responsible for tuberculosis in humans. An infectious disease that most frequently affects people with compromised immune systems.

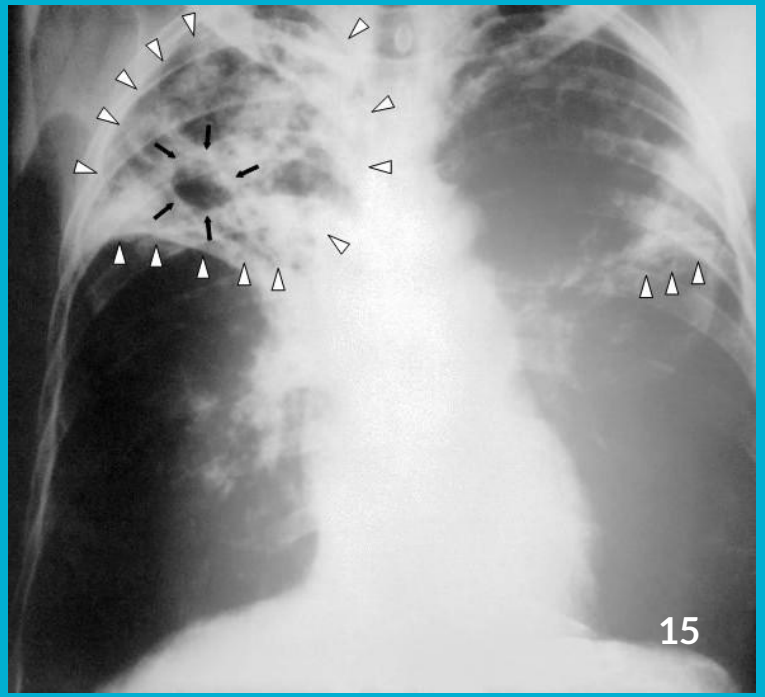


Anteroposterior chest x-ray in a patient with advanced bilateral tuberculosis.

OPPORTUNISM: examples

Mycobacterium tubercolosis

In the x-ray alongside you can see the infiltrates (the area delimited by white triangles) and the cavity formations identified by the black arrows in the right lung apex.

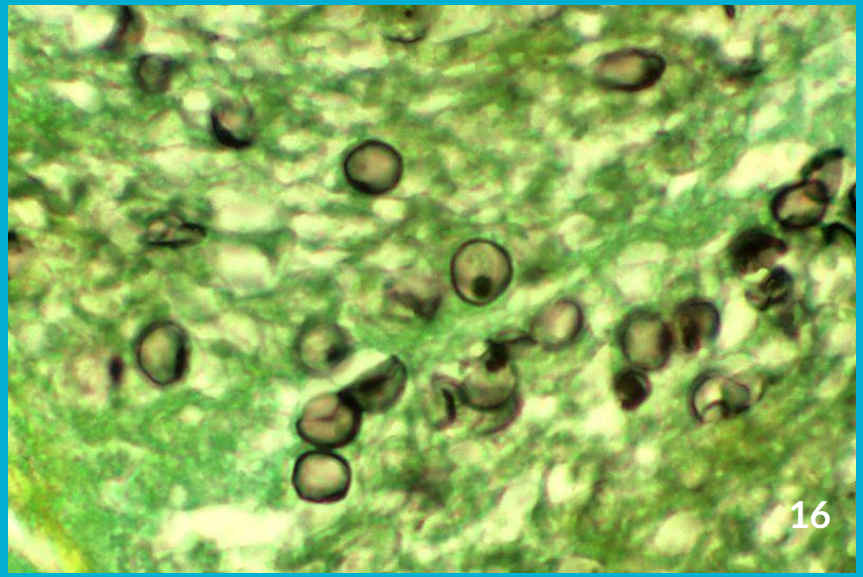


Anteroposterior chest x-ray in a patient with advanced bilateral tuberculosis.

OPPORTUNISM: examples

Pneumocystis jirovecii (carinii)

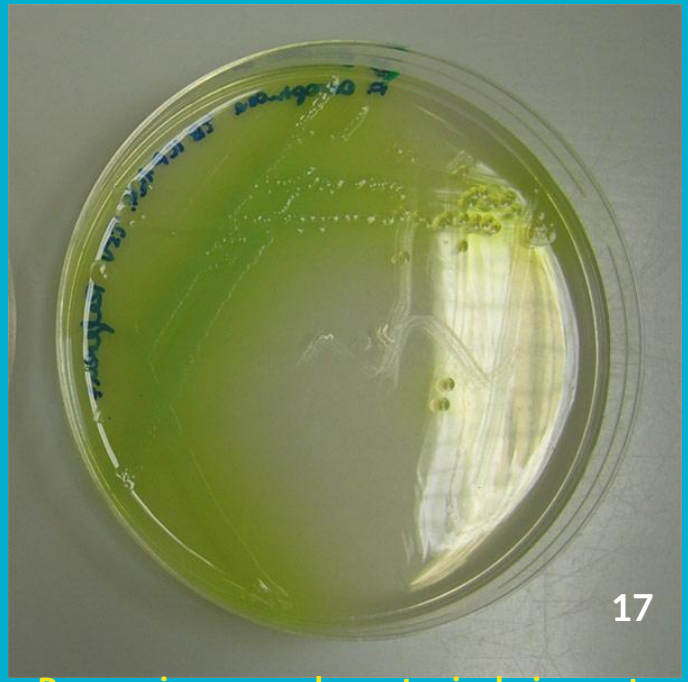
Until some time ago it was classified as a protozoon, now it is considered a fungus. It is responsible for a form of pneumonia typical of subjects with immunodeficiency.



Tissue cysts from Pneumocystis jirovecii infection

OPPORTUNISM: examples

Pseudomonas aeruginosa A gram-negative, ubiquitous bacillus. Considered an opportunistic pathogen, it can create significant problems in the hospital setting in patients with immune deficits. It infects wounds, burns, the urinary tract, and can also cause septicemia.

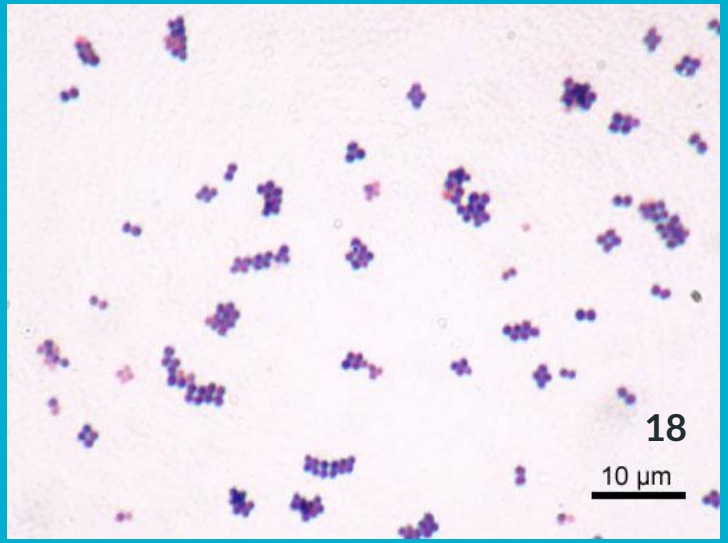


P. aeruginosa produces typical pigments, pyocyanin, pyoverdin or pyorubine.

OPPORTUNISM: examples

Staphylococcus aureus

A gram-positive, non-sporogenic bacterium, normally present on the skin and in the pharynx of humans. Under certain conditions, it can cause suppurations of the skin, skeletal system, respiratory and urinary systems, and the Central Nervous System.



S. aureus under the microscope (magnification x1000)

OPPORTUNISM: examples

There could be many more examples. From Toxoplasma gondii to Streptococcus pyogenes or Streptococcus pneumoniae or the genus Salmonella.

One thing is certain. Infections from opportunistic germs represent a significant problem at the nosocomial level, and prevention, therefore, becomes crucial.

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