LECTURERS:

Prof. Ing. A. Lebeda, DrSc.
Doc. RNDr. M. Sedlářová, Ph.D.
Doc. RNDr. B. Mieslerová, Ph.D.
RNDr. B. Sedláková, Ph.D.
Survey of lectures:
1. Introduction
2. Organisms which cause the infectious diseases of plants
3. Specificity of host-pathogen relationships
4. The infection process
5. Plant defense reactions
6. Genetics in the host-pathogen interaction
7. Plant protection
8. - 9. Practical phytopathology in lab
10.-11 Lectures of students focused on plant pathogens on crops in your country
Requirements:

At least 60% attendance

The exam includes

1. Writing exam – knowledge from lectures
2. Own presentation about diseases of selected group of plants in your country


PHYTOPATHOLOGY - journals

Plant Protection Science

Rostlinolékařství

Elsevier

Physiological and Molecular Plant Pathology

Springer

European Journal of Plant Pathology

Journal of General Plant Pathology

Ulmer

Journal of Plant Diseases and Protection

Priel Publishers

Phytoparasitica

AR

Annual Review of Phytopathology
PHYTOPATHOLOGY - journals

Blackwell Publishing
- Journal of Phytopathology
- Plant Pathology
- Forest Pathology
- Molecular Plant Pathology

APS
- Phytopathology
- Molecular Plant-Microbe Interactions
- Plant Disease
- Plant Health Progress

IPS
- Journal of Plant Pathology

Akadémiai Kiadó
- Acta Phytopathologica et Entomologica Hungarica

A mnoho dalších např. Fungal Genetics and Biology…
1. LECTURE – INTRODUCTION

Syllabus:

1. Definition of Phytopathology, its integration into the system of biological sciences, practical significance

2. History of phytopathology

3. Definition of disease and classification of diseases, causes of diseases
PHYTOPATHOLOGY

- Phytopathology is the study of plant diseases
- Theoretical Phytopathology focuses on the nature and causes of disease
- Practical Phytopathology focuses on methods of protection against them
- The narrowest conception of Phytopathology deals with the diseases of biotic origin caused by viroids, viruses, bacteria, fungi and parasitic plants
- In a broader sense they are studied Plant Pathology and diseases caused by nematodes and protozoa, resp. disorders caused by abiotic factors
PHYTOPATHOLOGY
in relation to other sciences
PHYTOPATHOLOGY

GENERAL

Division in terms of plants

• Pathological Morphology
• Pathological Anatomy and cytology of plants
• Genetics of host-pathogen interaction
• Pathological Physiology and Biochemistry of Plants
• Molecular Phytopathology
• Epidemiology of phytopathogenic organisms
• Ecological phytopathology

Division in terms of plant diseases

• Phytopathological Virology
• Phytopathological Bacteriology
• Phytopathological Mycology
• (Phytopathological Entomology)
SPECIAL

Describes individual plant disease:

• Diseases of crops

* Diseases of wild plants

Agricultural phytopathology
Forestry phytopathology

 Phytophthora infestans

*Bremia lactucae on Lactuca serriola
Importance of Phytopathology

1. Use of yield potential of plants

- Plant diseases can both reduce the photosynthetic efficiency of plants assimilating, partly degrade, disrupt and destroy the already finished plant products.
Yield loss of 6 basic market crops (rice, wheat, barley, corn, potato, soybean) caused by animal pests, weeds and pathogens
2. Medical harmlessness (nezávadnost) of plant products and environmental protection

- Some phytopathogenic and saprophytic fungi produce mycotoxins are able to endanger human and animal health, e.g. *(Claviceps purpurea* (cause of ergotisms), *Fusarium poae* – trichotecens, *Aspergillus flavus* – aflatoxins)
Ergot (Claviceps purpurea) – production of Ergot alcaloids and Lysergic acid

Fusarium spp. Production of Fusaric acid, Trichotecens (toxic for herbivores)
Pesticide residues

• Is the use of chemicals safe?

• Is it doing everything necessary to control harmful chemical agents, and harmless regulation replaced or less risky?

Quantity of consumed substances and cost of chemical protection
3. Importance for other disciplines

- Phytopathology draws from many disciplines, on the other hand, knowledge of Phytopathology are also good for other disciplines.

- For example discovery that filtrates of fungus *Giberella fujikuroi* stimulate plant growth, as well as the fungus itself. It led to the discovery of a whole group of substances produced even in healthy plants, growth regulators.

*Giberella fujikuroi* and symptom of excessive growth in rice
History of Phytopathology

Human population - growth with the development of agricultural productivity - famine due to crop failure

Rust epidemics in the old world (Wheat and barley)

2000 BC disease “samara” : leaves of barley in wet conditions get red
1700 BC Genesis 41:23, „east wind“
700 BC – AD 200 celebrated April 25 as „Robigalia“ (Robigo – God of molds)

Theophrastus (371-286 př.n.l.)
De historia plantarum
De causis plantarum

Plinius old (23-79 n.l.)
the impact of weather
Ergot - *Claviceps purpurea*

- attacks grasses, particularly rye cereal
- ergot is used in connection with the induction of childbirth, resp. treatment of postpartum hemorrhage
- ergot alkaloids – four groups:
History

Mass poisoning after eating of flour from the infected grain
Ergotism = St. Anthony's fire (AD 890)

China - 1100 BC
USA - 1690 - witches
Russia - 1722 - 20 thousand of soldiers
Russia - 1926 - 10 thousand of people
France - 1951 - 200 people
Irish famine

Epidemy of Late blight (*Phytophthora infestans*) in 1845 – caused emigration to USA
1861 – Anton de Bary – described *Phytophthora infestans* (Mont.) de Bary

- showed responsibility of *Phytophthora infestans* for the emergence of late blight on potatoes
1. Phase of migration of *Phytophthora infestans*
2. Phase of migration of *Phytophthora infestans*
The beginnings of phytopathology

Thoullier – 1670 – observed that ergotism is linked with the consumption of ergot
A. van Leeuwenhoek – 1680 – structural improvements of microscope

C. Linné – 1735 – Systema naturae
C. Darwin – 1859 – The Origin of species by means of natural selection
History

M. Tillet – 1755 – experiments with smut (*Ustilago*), influence CuSO₄ - interpretation of "poison"
M.J. Berkeley – 1878 – proved that the outbreak of late blight is caused by a fungus – originally *Botrytis infestans* – „the potato murrain“

A. De Bary (1853-1884) – works on smuts and rusts
- development of fungi from penetrating into the host after fructification
- founder of experimental mycology
  introduced the concepts of parasitism infection, resistance...
History

Fungi

C. Tulasne – 1861
Selecta fungorum Carpologia
History

Protozoa

M. Woronin – 1878 – found that clubroot is caused by *Plasmodiophora brassicae* - originally considered as a fungus, now ranked among the Protozoa to group Plasmodiophoromycota.
History

Bacteria

Erwin F. Smith – 1890

- Studied tumors of plants, confirmed that this is caused by bacteria
  *Agrobacterium tumefaciens*
History
Viruses

Adolf Mayer – 1886 – experiments with TMV (*Tobacco mosaic virus*),

W.M. Stanley – 1935 – the first crystalization of virus, 1946 Nobel price for TMV
Frankel-Konrat – 1956, 1960 DNA viruses; from 1980 – ELISA, RFLP, RT-PCR,
History

Phytoplasmas

Doi et al. (Japon) - 1967

- in phloem of plants were found **MLO (Mycoplasma Like Organisms)** (in this time were expected that problems with yellowing is caused by viruses)
- from 90th called as **Phytoplazmas**
- till now were described more than 200 plant diseases caused by Phytoplasmas
History

Viroids

T.O. Diener – 1971
Experiments with Potato spindle tuber mosaic viroid

Prions

S. Prusiner – 1972
1997 Nobelova cena Prion Theory
Definition of Disease

- **DISEASE** is deviation from normal functioning of physiological processes that act long enough to cause disruption or cessation (damage) of life activities.

- Term **Disease** should be used only for malformations caused by pathogens (infectious agents).
Classification of Diseases

- The number of diseases described on one plant species is about one hundred.
- In total there are known several tens of thousands of plant diseases

1. According to the etiology
   a/ Heredopaty = genetic anomalies (gene for synthesis of some compound is missing) - slight influence of external conditions
   b/ Abionosis = disorders
   c/ Bionosis - caused by viroids, viruses, bacteria, fungi
     - specific tiredness of soil (replant disease)
Factors causing disease, physiological disorders and damage

Biotic

- Microorganisms
  - Fungi, bacteria, protozoa (flagellates), mycoplasmas (mlos), viruses, viroids
- Animals
  - Birds, mammals, insects, mites, slugs, snails, nematodes
- Plants
  - Parasitic angiosperms, competitors (weeds)

Abiotic

- Physical factors
  - Temperature
  - Light
  - Water
  - Wind
  - Lightning
  - Extremes
- Pollutants
  - Ozone, nitric oxide, sulphur dioxide, fluorine, organic compounds, heavy metals, salt
- Chemical factors
  - pH extremes, mineral imbalances, nutrient deficiencies, oxygen/carbon dioxide
Non-infectious causes or physiological disorders

- temperature, water, lighting and weather extremes
- lack of oxygen, toxic metals (Hg, As) soil pH
- air pollution
- nutrient deficiency
- inappropriate agrotechnic
- inadequate management = iatrogenic disease (effect of pesticides - curative or prophylactic
Bionosis

Non cellular organisms
Viroids and Viruses
Prokaryots
Bacteria  Phytoplasmas
Eukaryots
Protozoa (Protista)
Oomycota (Chromista)
Fungi
Animalia
Parasitic plants
Classification of Diseases

1. According to the etiology

2. According to disruption of physiological functions

   a/ Permeability of attacked cells (membranes, structural changes of cell wall)

   b/ Metabolisms of water in attacked cells
      - movement of water in the plant
      - transpiration

   c/ Minerals
      - absorption and transport
      - physiological deficiency

   d/ Photosynthesis (content of pigments, transport and storage of sugars)

   e/ Respiration (Increased intensity; enzymes of glycolysis)

   f/ Synthesis of proteins (PR-proteins, enzymes)

   g/ Metabolism of secondary metabolites
      - accumulation of phytoncids (flavonoids, terpenoids, phenolic compounds, alkaloids)
      - synthesis of phytoalexins

   h/ Phytohormones (content and representation of active / inactive forms)
### Classification of Diseases

1. According to etiology
2. According to disruption of physiological functions

3. According to symptoms

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Function</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necrosis (cell death)</td>
<td>Whole metabolism</td>
<td><em>Erwinia</em> – soft rot of potato</td>
</tr>
<tr>
<td>Chlorosis</td>
<td>Photosynthesis</td>
<td><em>BMYV</em> - beet mild yellowing virus</td>
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<tr>
<td>Dwarfing</td>
<td>Whole development</td>
<td><em>BYDV</em> - barley yellow dwarf virus</td>
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<td>Permanent wilting</td>
<td>Water economy</td>
<td><em>Verticilium wilt of tomatoes</em></td>
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<td>Hypertrophy</td>
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<td><em>Plasmodiophora brassicae</em></td>
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<td>Hyperplasy</td>
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<td><em>Taphrina deformans</em></td>
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<tr>
<td>Leaf defoliation</td>
<td>Growth regulation</td>
<td><em>Sphaerotheca mors-uvae</em></td>
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<tr>
<td>Etiolation</td>
<td></td>
<td><em>Giberella fujikuroi</em></td>
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<td>Flowering inhibition</td>
<td>Reproduction</td>
<td><em>Epichloë typhina</em></td>
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<tr>
<td>Fruiting inhibition</td>
<td></td>
<td><em>Ustilago nuda, Ustilago tritici</em></td>
</tr>
</tbody>
</table>
Classification of Diseases

1. According to etiology
2. According to disruption of physiological functions
3. According to symptoms
4. According to localization of symptoms

- disease of seedlings
  - roots
  - stems
  - leaves
  - flowers
  - fruits
  - seeds
Classification of Diseases

1. According to etiology
2. According to disruption of physiological functions
3. According to symptoms
4. According to localization of symptoms

5. According to host plant species
   a/ disease of single species (wheat, potato, tomato)
   b/ diseases of groups of crops (vegetables, cereals, fruits, ornamental plants, trees...
Classification of Diseases

1. According to etiology
2. According to disruption of physiological functions
3. According to symptoms
4. According to localization of symptoms
5. According to host plant species

6. According to economical and ecological importance
   a/ detrimental to plants, but are useful for keeping natural ecosystems - in wild pathosystems disease do not threat the survival of plants
   b/ detrimental to plants, but usable for humans
      - diseases of weeds
      - diseases increasing the taste of grapevine - *Botrytis cinerea*
      - disease inducing resistance to other disease
      - disease producing metabolites usable in pharmaceutical industry *Claviceps purpurea*
   c/ beneficial for plants and humans - increase production under certain conditions – *Agrobacterium rhizogenes*
   d/ detrimental to the plant, and the man – most diseases
Etiology of bionosis

Causes of diseases

Causality

cause → effect

Cause of the disease:
1/ disease, without the harmful factor can not arise
2/ determines the specificity of the disease, its qualitative traits

Etiology
- (sensu stricto) study the causes of diseases
- (sensu lato) moreover study of conditions and events, leading to the manifestation of the disease
Host-pathogen interaction

Host

Pathogen

Environment

Host-pathogen complex

- Physical Interactions
- Chemical Interactions
  1. Substances present before contact
  2. Substances released after contact
  3. The compounds synthesized after contact

preformed substances
Enzymes, PR - proteins
phenolic compounds
Phytoalexins

AEGRIKORPUS
The disease triangle and tetrahedron
Interaction between susceptible plant, pathogen and environment

**Disease Triangle**

expresses the relationship between different criteria of epidemic development:

- the amount of susceptible plants
- abundance of virulent strains of the pathogen
- long-term favorable environmental conditions