KNOWLEDGE EXPECTATIONS FOR PEST CONTROL ADVISERS:
PLANT PATHOLOGY

I. GENERAL PRINCIPLES

A. Plant Disease

1. Define plant disease.
2. Describe the economic significance of plant disease.
3. Distinguish between the terms "pathogen" and "disease".
4. Distinguish between the terms "signs" and "symptoms" of disease.

B. Causes of Plant Disease

1. List some abiotic factors that cause plant disease.
2. List some biotic factors that cause plant disease.
3. Describe and give an example of:
    a. obligate parasites;
    b. facultative saprophytes;
    c. facultative parasites.
4. Define biotroph and necrotroph.
5. List Koch's postulates and describe how to use them.

C. Plant Disease Triangle

1. Define the three components of the plant disease triangle:
    a. environment;
    b. host;
    c. causal agent.
2. Describe the role of each of the three components in disease development.
3. Describe how humans can impact each of the three components of the plant disease triangle and epidemics.
4. Describe the impact on an epidemic when one component of the plant disease triangle does not come in contact and interact with the other two components.
5. Describe a management strategy that can be used to break each of the three legs of the plant disease triangle.
6. Explain how knowledge of the plant disease triangle can be used in diagnosis.

D. Epidemiology

1. Define epidemiology.
2. List the environmental factors that affect epidemics and explain how they do so.
3. Describe the importance of time in the development of an epidemic.
4. Describe how the following factors affect the development of an epidemic:
    a. type of reproduction cycle;
    b. dissemination.
5. Define and give an example of a:
    a. single (annual) cycle (monocyclic) disease;
    b. multiple cycle (polycyclic) disease.
6. Explain why single cycle diseases are less likely to result in a serious epidemic.
7. Describe how sanitation practices impact single cycle vs. multiple cycle diseases.

E. Terms to Know

1. Define:
    a. *formae specialis*;
    b. incubation period;
    c. infection;
    d. infestation;
    e. inoculum;
    f. latent infection;
    g. mummy;
    h. overwintering;
    i. pathovar;
    j. propagule;
    k. race;
    l. soil inhabitant/soil resident;
    m. soil transient/soil invader;
    n. vector.

II. BIOLOGY AND IDENTIFICATION

A. Fungi

- **The Distinguishing Characteristics of Fungi**

1. Define:
    a. apothecium;
    b. ascocarp;
    c. ascospore;
    d. basidiospore;
    e. chlamydospore;
    f. cleistothecium;
    g. conidium;
    h. Fungi Imperfecti;
    i. fungus;
    j. haustorium;
    k. hypha;
    l. mycelium;
    m. oospore;
    n. perithecium;
    o. pycnidium;
    p. sclerotium;
    q. sporangium;
    r. spore;
    s. teliospore;
    t. zoospore.
2. Describe fungal characteristics:
    a. are eukaryotic;
    b. have sexual and/or asexual reproduction;

c. do not photosynthesize;
d. have resistant survival stages;
e. mycelium is the vegetative state;
f. spores are reproductive propagules;
g. free moisture and high humidity is important for infection.

3. Describe how fungi are isolated and identified.

- **Specific Fungal Diseases**

4. For each of the following pathogens and associated disease, identify:
    a. the common name of disease;
    b. the Latin name of the causal agent;
    c. the class of the causal agent;
    d. the biology;
    e. life cycles—
        i. the sexual structure;
        ii. the asexual structure;
        iii. the resistant survival stage;
        iv. host range.
    f. signs and symptoms of the disease;
    g. methods of control.

Plasmodiophoromycetes (class)
- *Plasmodiophora brassicae* - clubroot

Zygomycetes (class)
- *Rhizopus* sp. - soft rot

Oomycetes (class)
- *Phytophthora* sp. - late blight of potato
- *Pythium* sp. - damping-off
- *Bremia* sp. - downy mildew of lettuce

Ascomycetes (class)
- *Erysiphe necator* – grape powdery mildew
- *Taphrina* sp. - peach leaf curl
- *Venturia* sp. - apple scab
- *Colletotrichum acutatum* – strawberry anthracnose
- *Sclerotinia* sp. – watery soft rot, cottony rot
- *Monilinia* sp. - brown rot

Basidiomycetes (class)
- smuts
    - *Ustilago* sp. - common smut of corn
- rusts
    - *Puccinia* sp. - stem rust of wheat
- *Armillaria* sp. - oak root fungus
- Root and stem rots
    - *Sclerotium* sp. - stem rot, southern blight, white rot of onion
    - *Rhizoctonia* sp. - damping-off, soreshin, brown patch

Fungi Imperfecti (class)

- *Botrytis* sp. - gray mold
- *Alternaria* sp. - tomato black mold
- *Verticillium* sp. - verticillium wilt
- *Fusarium* sp. - fusarium wilt and root rot

B. Plant Diseases Caused By Bacteria, Fastidious Vascular Bacteria and Phytoplasmas

- **Distinguishing Characteristics of Bacteria**

1. Recognize that all bacterial plant pathogens have the following general characteristics:
    a. prokaryotic;
    b. asexual reproduction;
    c. enter through wounds or natural openings (not healthy tissue);
    d. ooze is a sign of bacterial disease.
2. Describe how bacteria enter plant tissue.
3. Describe how bacteria reproduce.
4. Describe various ways that bacteria are disseminated or spread.
5. Describe how bacteria overwinter or survive when their host is not present.
6. Describe the environmental conditions favorable for development of plant pathogenic bacteria.

- **Bacterial Diseases**

7. List the two kinds of prokaryotes, bacteria and mollicutes, that cause plant disease and how they differ.
8. Name the two major groups of mollicutes. [spiroplasma and phytoplasma]
9. For each of the following bacterial diseases, identify:
    a. the common name of the disease;
    b. the genus of the causal agent;
    c. the disease cycle;
    d. means of survival;
    e. method of dissemination;
    f. mechanism of inoculation and infection;
    g. environmental conditions favorable for disease;
    h. symptoms and signs of disease;
    i. host range;
    j. methods of control;
    k. common, or Latin Name.
        - *Pseudomonas* sp. --bacterial canker of stone fruits
        - *Clavibacter* sp. --bacterial canker of tomato
        - *Erwinia* sp. --fire blight, bacterial soft rot
        - *Xanthomonas* sp. --black rot of crucifers
        - *Agrobacterium* sp. --crown gall

- **Fastidious Vascular Bacteria**

12. Define fastidious vascular bacteria and give an example of a xylem-limited and phloem-limited fastidious bacteria. [xylem-limited: *Xylella fastidiosa*; phloem-limited Huanglongbing]
13. For Pierce's disease and almond leaf scorch recognize the:
    a. life cycle;
    b. insect vector;
    c. disease reservoir.
14. Be prepared to identify the following diseases when presented with a photograph:
    a. Pierce's disease;
    b. Almond leaf scorch.

- **Plant Diseases Caused By Phytoplasmas**

15. Define phytoplasma (formerly mycoplasmalike organisms).

- **Common Phytoplasma-caused Diseases**

16. For each disease listed below, identify (if any):
    a. the insect vector;
    b. disease reservoir;
    c. alternate hosts.
    - **Corn stunt** – leafhoppers (vector)
    - **Cherry X-disease** – leafhoppers (vector)
    - **Aster yellows** – leafhoppers (vector)

C. Plant Diseases Caused By Virus and Virus-like Agents

1. Define:
    a. viroid;
    b. virus.
2. Describe viral transmission, infection, and symptoms.
3. Describe how the following techniques can be used to identify or detect a viral disease:
    a. electron microscopy;
    b. indicator plants;
    c. indexing;
    d. serology;
    e. ELISA testing;
    f. DNA hybridization;
    g. polymerase chain reaction (PCR).

- **Diagnosing Viral Diseases**

4. For each viral disease listed below, identify;
    a. symptomology;
    b. disease cycles;
    c. host range;
    d. methods of control;
    e. how the virus is spread.

Arthropod vectors

- Tomato spotted wilt tospovirus (pathogen); tomato spotted wilt (disease); thrips (vector)
- Beet curly top geminivirus (pathogen); Curly top disease (disease); leafhoppers (vector)
- Cucumber mosaic cucumovirus (CMV) (pathogen); cucumber mosaic (disease); aphids (vector)

Soilborne vectors

- Beet necrotic yellow vein furovirus (pathogen); rhizomania of sugarbeets (disease); soilborne fungus, *Polymyxa betae* (vector)
- Grape fanleaf nepovirus (pathogen); grapevine fanleaf (disease); nematodes (vector)

Seed

- Lettuce mosaic potyvirus (pathogen); lettuce mosaic (disease); aphids (vector)
- Bean common mosaic potyvirus (pathogen); bean common mosaic (disease); aphids (vector)

Grafting

- Citrus tristeza closterovirus (pathogen); citrus tristeza (disease); melon aphid (vector)

Mechanical transmission

- Tobacco mosaic tobamovirus/tomato mosaic tobamovirus (pathogens); tobacco and tomato mosaic (disease); insect, mechanical transmission, often by man and tomato seed (vector)

D. Plant Diseases Caused by Parasitic Seed Plants and Abiotic Plant Diseases

- **Plant Diseases Caused by Parasitic Seed Plants**
  1. Recognize the following parasitic seed plants. Know their host range and methods of control. Be prepared to identify them when presented with a photograph, common, or Latin name.
     - ***Arceuthobium* sp.** - dwarf mistletoe
     - ***Phoradendron* sp.*, Viscum* sp.** - true or leafy mistletoe
     - ***Cuscuta* sp.** - Dodders

- **Symptoms of Abiotic Plant Diseases**
  2. List the general types of symptoms associated with abiotic plant diseases.
  3. Describe the types of symptoms associated with:
     a. air pollution and other toxic chemicals;
     b. herbicide injury;
     c. mineral excesses and deficiencies;
     d. excess soil moisture;
     e. low soil moisture;
     f. high temperature;
     g. low temperature;

h. excessive exposure to sunlight;
i. wind.

III. DISEASE MANAGEMENT

- **Monitoring and Evaluating Plant Diseases in the Field**

1. Describe how patterns in disease, on the plant or across a field, can be used to evaluate the cause of the disease.
2. Describe how the following can influence disease occurrence:
    a. soil factors;
    b. irrigation factors;
    c. fertilizer/pesticides used;
    d. planting date;
    e. cropping patterns;
    f. crop rotation;
    g. weed populations in the area;
    h. previous crops and diseases.
3. Describe the importance of the following factors when collecting samples to send to the lab for disease confirmation:
    a. sample size;
    b. samples with a range of symptoms;
    c. dead and live tissue for cultures;
    d. labeling and handling of samples.
4. Define disease forecasting.
5. Define the critical parameters used in disease forecasting models for:
    a. fire blight;
    b. apple scab;
    c. grape powdery mildew [UC IPM Pest Management Guidelines: Grape].
6. Describe field sampling and treatment thresholds and how they might be used by a plant pathologist.

- **Exclusion as a disease management strategy**

7. Define:
    a. exclusion;
    b. quarantine.
8. Describe how the following methods can be used to evade the pathogen and give an example of each:
    a. host free period;
    b. planting date to avoid susceptibility;
    c. pruning;
    d. use of pathogen-free seed.
9. Define certified planting material.

- **Cultural Methods**
  10. Describe how host eradication can be utilized for the control of some pathogens and give an example.
  11. Describe how different irrigation practices can increase the susceptibility of crops to foliar disease and give an example of how the problems can be reduced.
  12. Describe how irrigation and soil drainage can affect diseases:
      a. Pythium damping-off;
      b. Phytophthora root rot.
  13. Describe how soil fertility can be used to manage:
      a. fire blight;
      b. Pythium damping-off.
  14. Describe how crop rotation can be used to reduce *Verticillium* populations in the soil.
  15. Describe how sanitation practices aid in reducing the spread of the pathogen in:
      a. late blight of potato;
      b. fire blight.
  16. Describe how pruning timing can be used to reduce the incidence of fire blight.
  17. Describe how controlling alternate hosts can aid in managing plant disease and give an example.

- **Biological Methods**
  18. Define:
      a. antagonist;
      b. mycopesticides;
      c. suppressive soils.
  19. Describe the biological control method used to prevent crown gall.

- **Physical Methods**
  20. Give an example of the use of soil sterilization by heat to control plant disease.
  21. Describe how soil solarization might be used to reduce soil-borne pathogens.
  22. Describe how refrigeration is used in post harvest disease control.

- **Chemical Methods**
  23. List the advantages and disadvantages of fumigation for the control of soil borne diseases.
  24. Be aware that fungicides/fumigants may harm honeybees and native pollinators.
  25. Describe disinfestation of warehouses for plant disease control.
  26. Understand why insecticides used against insect vectors are not generally effective in managing viral diseases.
  27. Describe methods to manage postharvest diseases.
  28. Give an example in which one of the following methods of application would be the most appropriate:
      a. foliage sprays and dusts;
      b. seed treatment;
      c. soil treatment;
      d. treatment of wounds.

29. Define:
    a. antibiotics;
    b. eradicants;
    c. plant defense activators;
    d. protectants;
    e. systemic fungicides.
30. Describe the proper time to use:
    a. eradicants;
    b. protectants.

- **Host Resistance to Disease**

31. Define:
    a. cross protection;
    b. immunity;
    c. induced resistance;
    d. resistance;
    e. susceptibility;
    f. tolerance.
32. Describe the use of resistant varieties to manage disease.
33. Describe the major cause for the breakdown of disease resistance.
34. Compare and contrast horizontal and vertical resistance.

- **Resistance of pathogens to chemicals.**

35. Define pesticide resistance.
36. Describe some methods for managing pest resistance.
37. Know why pesticide mode of action is important for resistance development and pesticide selection.