Diagnosing Plant Health Problems. Plants can get “sick”, just like people.

For this week’s Diagnosis lecture, please refer to Chapters 15 (Introduction to Plant Problems) and 21 (Diagnosing Plant Problems).
Plants don’t tell us what’s wrong. We need to study the plant and diagnose the problems. Once we know exactly what’s wrong, we can then try to cure or control it.
There are 6 main Causal Agents of Plant problems.

- **Insects**: can feed on plant, causing distortion or missing parts. Borers can girdle stem, killing the upper part of plant.
- **Microorganisms**: Pathogens – fungi, bacteria, viruses, mycoplasmas, etc.
- **Chemicals**: Herbicides and other pesticides; fertilizers (too much or not enough); road salt…
- **Mechanical injury**: girdling, cutting roots, “mower blight”, storm damage
- **Environment**: Heat/cold, flood/drought, soil compaction causing root suffocation…
- **Animals**: cause one of the other types of damage. Squirrels chewing on bark cause mechanical injury; female dogs urinating on lawn cause chemical injury, etc.
There are hundreds of possible causal agents that could be causing a plant’s problem. We need to narrow down the list. First, can we determine if causal agent is living (infectious) or non-living (non-infectious)?

Infectious means that the causal agent can be transmitted from infected/infested plants to non-infected plants. Example: fungus disease (black spot of rose), bacteria (fire blight), etc. These are "biotic", or living causes.

Non-infectious causal agents do not spread from one plant to another. Example: drought does not spread from one plant to another; nor does freezing injury. These are not transmitted. These are "abiotic", or non-living causes.
How a infectious disease gets into plants: Infectious diseases, caused by living organisms, need to invade leaf surface. Under right environmental conditions, organisms then multiply or grow, spread through around and through cells, and begin feeding on cell contents. Eventually, under right environmental conditions, organisms will produce reproductive structures and emerge from leaf, ready to spread to other plants.

All of this takes time!
The Biotic Triangle: See page 388.

In order for a living pest to attack a plant, you must have 3 major factors:

- **Pest.** This is the actual organism that causes the disease (fungus, bacteria, virus, etc.); can also be an insect, an animal, etc. Most organisms are very picky about which plants they can attack; a disease that can attack maples won’t attack lawns, or grape vines.

- **Susceptible host.** This is a plant that can physically be affected by the pest. Not all species can get the disease (oaks do not get rose spot); cucumber beetles don’t attack tomatoes. Some varieties are more resistant to a disease than others (scab-resistant crabapples).

- **Favorable environment.** All pathogens are alive, and must have specific environmental conditions in order to spread, infect leaf, and grow within the plant. For example, some diseases may require over 12 hours of moisture on the leaf when the temperatures are between 60 and 70 degrees in order for the spore to germinate and enter the plant.

All of this takes time!

To prevent attack from living (biotic) organisms, we need to block any one of the legs of the disease triangle…more on that next lesson, but see page 388 for now.
There are four major steps to making a diagnosis, according to the MG manual. See page 483-493.

I do not like how these 4 steps are developed.
There are five major steps to making a diagnosis. These are my preferred steps.
Diagnosis definition.

There are many pieces needed to put together the whole picture of disease diagnosis. Just as it is difficult to tell what the picture will be when all you have are a few random jigsaw pieces, it's nearly impossible to put together a correct diagnosis with just a few random clues.
Step 1. **Recognize normal growth.** How can you tell what's *wrong* with a plant if you don't know what the plant is supposed to look like? Example: Is this shrub turning yellow because it's sick or infested? Or maybe it's deficient in some nutrient? Or is this a Golden privet (*Ligustrum vicaryi*), which is *supposed* to look like this?
Understand what organs and adaptations are normal on your plant.

The bumps on the underside of the fern leaf are not insects or fungi. They are the fern’s reproductive organs: spore producing cases. Normal!

The weird corky growth on the stem of this winged euonymus (burning bush) are normal. It can also be found on sweet gums, burr oaks, and a few other plants.
Recognize normal growth...Know your host!
I have 2 conifers here: one with needles, one without. Do I have a problem?
What’s normal? Bald cypress is a conifer...but it is NOT an evergreen conifer, like the spruce. During the winter, it is NORMAL for the bald cypress to not have needles in Kentucky.
Now, if this was July, then we would say this is NOT normal.
So...know what’s normal for all times of the year.
Know what’s normal: This white pine has brown needles forming on the inner branches. Is this normal, or is this a sign of trouble?
Answer: Normal fall needle drop on white pine. Although called an “evergreen”, white pines only hold their needles for two seasons. In the fall of year 2, older needles turn brown and drop...sometimes very noticeably.
Step 2: Observe symptoms and signs. What actually are you seeing? Most customers will just say "my tree is dying," but we need more specific information than that.
Although used interchangeably, Symptom and Sign mean two different things.
Symptom: what is the plant doing in response to the causal agent? Ex: wilting, turning color, not growing as fast.
Sign: a piece or evidence of the causal agent. Ex: holes in the leaf, insect excrement, tooth marks on branch.
Symptoms of plant problems. These are things that the plant itself is doing in response to a causal agent. Let’s look at each of these.
**Spot**: A dead or injured area on a leaf or fruit. Many different types, colors, shapes.

**Blight**: Any sudden, severe, and extensive spotting, discoloration, or destruction of leaves, flowers, stems, or entire plants, usually attacking young, growing tissues. (In disease names, often coupled with the name of the affected part of the host; e.g., leaf blight, blossom blight, shoot blight).

**Blotch**: A blot or spot, usually superficial and irregular in shape and size, on leaves, shoots and fruit.

**Fleck**: A small, white to translucent lesion (spot) visible through a leaf.

**Speck**: A small, brown, dead spot less than 1/16” or 2 mm across. Specks often occur in groups of many.
**Chlorosis**: Yellowing of tissue that is NORMALLY green. Could be all over, or just between the veins.
**Distortion:** Abnormal plant growth resulting from the unequal development of plant tissue. Covers a wide range of symptoms, including twisting, swellings, puckering….

Note: some people will sometimes see some of these twistings, and say that the plant is wilted. Wilting is a different symptom, and will be covered later. Ask your client if the plant is limp and drooping, like cooked spinach (wilted), or if the plant is still turgid (full of water), crisp, leathery, etc.
**Wilt**: Loss of rigidity and drooping of plant parts. Leaf is limp and drooping, no turgor pressure, like cooked spinach. Could be caused by insects or pathogens damaging the vascular tissue, drought, root injury…. Basically, anything that is preventing water from moving up from the soil to the top of the plant.
**Gall:** A pronounced localized swelling or outgrowth, often more or less spherical, composed of disorganized plant cells. Often caused by insects or pathogens. Clockwise from top left: Crown gall (bacteria), corn smut (fungus), maple bladder gall (insect), root knot nematode galls (caused by microscopic worms called nematodes).
Horned oak gall—caused by an insect (tiny wasp).
Canker: A definite dead area on a stem, branch, twig or root of a plant. Usually sharply defined and surrounded by live tissue; often sunken and discolored.
Mosaic: Disarrangement of the chlorophyll content of plant tissue, especially the leaves, resulting in areas that are dark green and light green or yellow, forming a variegated pattern. Typical symptom of some viral diseases.
**Stunting (dwarfing):** The underdevelopment of any organ of the plant, or the entire plant itself. You may notice that the leaves are not as large on your tree as other, non-infected plants.
Rot: Disintegration, discoloration, and decomposition of plant tissue, caused by decay organisms. If the decay is firm and dry, it's called a “dry rot” or “hard rot” (Example: blossom end rot of tomato, upper left). If the decay is watery and foul smelling, it's called a “wet rot” or “soft rot” (Example: brown rot of peach, upper right, or bacterial soft rot of potato, lower left).
**Dieback**: Progressive death of branches or shoots, beginning at the tips and moving back toward the main stem or trunk. Often first noted at the top of the plant. Usually associated with woody plants.
**Signs**: Evidence of the causal agent. Often, some of these signs are called “symptoms” in the literature, but purists want us to make sure we know the difference.
Signs of fungal disease: rust spores (bottom left), gray mold spores (upper left). Powdery mildew disease on lilacs (upper right); on lower right is an electron micrograph of powdery mildew on a leaf surface. Plant does not make spores, pathogen does...that's why spores are considered signs.
Signs of lacebug infestation: fecal matter (black, shiny dots), cast off skins.
Don’t Jump to Conclusions...

Don’t jump to conclusions by just looking at symptoms. Easy to be fooled!
A good diagnostician knows to NEVER try to diagnose a problem ONLY by looking at the symptoms. Symptoms can vary depending on species, environmental conditions, secondary problems, etc.

Example 1: Look alike symptoms. Two different causal agents may produce nearly identical symptoms. The two pictures show tomato leaves. Which is caused by a virus, and which is caused by 2,4-D, a growth-regulator herbicide?

Answer: I’ve got no idea….
Symptom variability: two different plants can react differently to the same pathogen. Ex: Sudden oak death (*Phytophthora ramorum*). Gum oozing from trunk on oak tree (left), and foliar leaf spots on rhododendron (right).
Number 3: Look for patterns: random or uniform distribution of symptoms.
Random vs. uniform distribution of symptoms.

In general*, if the symptoms are scattered randomly on the leaf, on the plant, or in the landscape, chances are it’s caused by a living (biotic) causal agent, and is therefore infectious. Think of fungal spores randomly blowing in the wind.

In general*, if there is some sort of uniform pattern to the symptoms on the leaf, on the plant, or in the landscape, chances are it is caused by a non-living (abiotic) causal agent, and is non-infectious. How can fungal spores land on all of the leaves with such precision…?

* There are always exceptions to these rules, but they are a good place to start.
Symptom distribution: Uniform or Random?

Random Patterns are most likely caused by **biotic** (living) agents.

Are the symptoms distributed uniformly or randomly in these pictures? Random! Some spots are on edge of leaf, some in center; some cross the veins, some don’t. Different size lesions.
Symptom distribution: Uniform or Random?

Uniform Patterns are most likely caused by *abiotic* (non-living) agents.

Are the symptoms distributed uniformly or randomly in these pictures? Uniform! All lesions are scattered on leaf edges or between veins, all about same distance from veins, all about same size.
Row of pines, all show browning on one side, all on lower 5 feet of tree. Random or uniform? Uniform! Caused by ice-melting salt splashing/spraying from road.
Random vs. uniform damage on spruce.

Spruce on left shows random damage. Much of the injury is in lower 1/3 of tree, but also shows up in different amounts all around tree. Probably needle cast disease, possibly spider mites.

Spruce on right is uniform: all new shoots that emerged this year are wilted and turning brown. Caused by late frost.
Random vs. uniform on spruce needles.
Left is random. Not all needles are brown, some are yellow, some are still partly green. Could be needlecast disease.
Right is uniform. All needles show same amount of browning on all needles, all at tip of needle. Probably drought stress, salt injury (soil).
**Infectious vs. Non-Infectious**

<table>
<thead>
<tr>
<th></th>
<th>Infectious</th>
<th>Non-Infectious</th>
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<tbody>
<tr>
<td><strong>Distribution</strong></td>
<td>Random</td>
<td>Uniform</td>
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<tr>
<td><strong>Plant Type</strong></td>
<td>One</td>
<td>Many</td>
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<tr>
<td><strong>% Infection</strong></td>
<td>1 - 20%</td>
<td>~ 100%</td>
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Infectious vs. non-infectious chart.

**Distribution**: random vs. uniform…covered before.

**Plant type**: If only one type of plant (maples) is affected, it could be an infectious disease problem, because most pathogens are very host-specific. If many different unrelated species are affected (maples AND crabapples AND dandelions), it most likely is a non-infectious problem, like chemical drift or freeze damage.

**% Infection**: If only a small number of plants or plant parts are initially affected, and this number grows with time, it’s most likely an infectious disease (because it takes time for spores to blow into field, germinate, infect plant, spread through plant, and cause symptoms….). If nearly all of the plants or plant parts that ever will be affected are affected at the same time, it’s got to be non-infectious… for example, freeze injury.
• Apical/terminal bud affected: calcium deficiency? Insects?
• Young leaves, top of plant: nutrient deficiency, growth regulator herbicide?
• Patchy and random: fungal/bacterial diseases
• Old growth, base of plant: fungus disease splashing up from ground; nutrient deficiency; old injury from chemicals, frost, etc., that the plant has since outgrown
• Unilateral: one side of plant only: Fusarium wilt? Chemical drift?
Step 4. Confirm which part of plant affected. Just because symptoms are showing up in foliage, doesn't necessarily mean that this is where the injury occurred. Trees are very hard to diagnose, because the cause of the problem could be 100 feet from where the symptoms show up.

Example: what is causing the scorching, wilting, browning, and dieback on this tree? Dieback...caused by root injury from the new parking lot being built next door!
Dieback in upper tree or shrub can be caused by (clockwise, from upper left) canker, mower injury, or girdling root.
Don’t just look up when diagnosing a tree problem…look down!
Step 5. Ask questions…and listen to the answers.
Your client has a lot of information on the history and environment of the plant and its problems…things that may not be noticeable or visible.

See handout for sample questions.
Questions to Ask

1. Cultural Practices
   - What is the age of the plant?
   - How long has it been at this site?
   - History of the problem?
   - Previous Plantings?
   - Pesticides/fertilizers?
   - Varietal Differences?
   - Watering Practices?
   - Sanitation?

Cultural questions to ask.
Age of plant? When planted? Not always the same thing!
History of the problem? When was it first noticed? How has it progressed?
Previous Plantings? What was here previously (farm field? Old house?)
Pesticides/fertilizers? What was applied, when, how much?
Varietal/cultivar Differences?
Watering Practices? Are they watering??? How much, how often? Chemical analysis of water?
Sanitation? Are they practicing it? Or does the client have debris that provides nesting places for rodents, etc.?
Weather conditions. A drought or late freeze can cause long-term problems that may not show up for a year or two. Also, note that most of us are not gardening out at the airport, so knowing the “official” temperature or rainfall (usually measured at the airport) doesn’t always help us.
Questions to Ask

1. Cultural Practices
2. Weather Conditions
3. Area/Site Problems
   - Drainage?
   - Soil type?
   - pH/salts/nutrients?
   - Exposure (sun, wind)?
   - Topography?

Area/Site problems.
General soil drainage (clay = poor, sandy = too well drained).
pH, salts, nutrients: when did they last do a soil test, and what were the results?
Exposure: dogwoods in sun, burning bush in shade?
Topography: low areas can hold water, act as frost pocket
Questions to Ask

1. Cultural Practices
2. Weather Conditions
3. Area/Site Problems
4. Neighboring Plants
   - Similar symptoms?
   - Same types of plants affected?
   - Patterns?

Neighboring plants.
Don’t be afraid to ask dumb questions! Because sometimes, people make dumb mistakes!

Ex: I visited an estate that had 3 full-time gardeners (not to mention the 2 chauffeurs, dozen maids, butler, etc.) to examine some dying yews (*Taxus*). I didn’t want to ask insultingly stupid questions to full time people who had been working for this estate longer than I’d been alive, so it took me over 3 hours to realize that the shrubs had been planted a year ago, but nobody had cut off the twine or burlap around the root balls!

…or the time I found someone had forgotten to take the container off before planting a potted shrub…

…or the case where someone thought Roundup was an insecticide and sprayed their shrubs with it…. 
Putting the pieces together. In order to make a proper diagnosis, you should use all five steps every time!
Where to get help: what do you do with all the data, observations, and other information you've gathered?
Use the UK and Purdue websites to download publications on the most common problems and their control.
Develop a good library of reference books (ask your extension staff or university specialists for suggestions).
Color picture sheets: sometimes provided free of charge by chemical dealers, hoping that if you see your disease on one of the pictures, you'll buy their product.
Master Gardeners: good resource for home gardeners; however, they are not allowed to advise commercial landscapers, farmers, etc.
Your county Extension Educator is a valuable resource! Find their office and use them!
If your local Extension Educator doesn't know what's going on, they'll turn the samples over to the university diagnostic lab, who will in turn send it to various specialists.
If there is a possibility of pesticide misapplication, the Office of the Indiana State Chemist will be brought in.
Pest control...next week.