

University of Texas Invitational: Botany B/C Exam:

Answer Key

Tie-Breaker Criteria:

- Look at the Scilympiad Exam
 - Division B Questions 73, 83, and 87
 - Division C Questions 69, 74, 84, 88, 91, and 100
 - Question 72: Spelling, Answer, N/A
 - Stem FRQ: Whoever got the most points.
 - Question 61: Point/ No Point

Fill-in-the-blank:

- Duckweed and Watermeal are not synonymous.
- Phototropism and Photoperiodism are not synonymous.

Stem: 8 points

- **Order does not matter.** It did before, but I changed it. This should not change the way students answer the question because if they cared, they would at least give some answer.
- Apical or Terminal Bud
- Axillary or Lateral Bud
- Internode or Growth of two years ago.

C3 and C4 Graphs: 7 points

- +1 for correct identification of C3 plant (Species 2- lower graph).
- +1 for correct identification of C4 plant (Species 1- upper graph).
- +2 for valid justification. For example, photorespiration (loss to process fixate carbon for subsequent carbohydrate synthesis): C3 plants are less efficient than C4 because as CO₂ levels increase, photorespiration is suppressed.
- +1 for correct C3 plant (e.g. rice, wheat, barley, potato).
- +1 for correct C4 plant (e.g maize, sugar cane, millet, corn).
- +1 for correct CAM plant (e.g. pineapple, agave).

Tylosis: 10 points

- +1 for identifying the tyloses growths.
- +1 for identifying the relative location (pith-paring connections made in the lumen of tracheids or vessels of the secondary xylem.
- +2 for valid description of tyloses formation. For example, balloon-like outgrowths of parenchymatous cells formed when a plant is stressed by a drought or infection.
- +2 for valid reason; environmental response. For example, they will fall to the side and "dam" or block up the vascular tissue to prevent further plant damage. Another, prevent water leakage through damaged xylem. Another, assist in the formation of heartwood.
- +1 for valid reason of ergastic substance use. For example, they produce odors which protects the wood from termites and mites.
 - One team said: Ergastic substances can help defend the organism, maintain cellular structure, and/or substance storage. For example, cellulose is a crucial part of the cell wall and starch is a reserve material in the protoplasm.
- +1 for identifying an ergastic substance. **Maximum of 2 obtainable points.** For example, tyloses accumulate resin, gum, and other secondary materials in their protoplasm, like tannins and taxols.
 - One team said: Ergotamine and LSD
- +1 for correctly connecting this to CODIT. CODIT helps arborists analyze the dangers posed by damaged or decaying trees. For example, when a tree is wounded, cells undergo changes to form "walls" around the wound to slow or prevent the spread of disease. Tissue runs up and down the length of the stem to slow the vertical spread of decay.
- Example of 8/10:
 - They are parenchyma cells with large vacuoles. They are around the vascular bundles. They are formed from damage to the vascular bundles releasing cytokinin to promote growth. They protect against future damage to vascular bundles. Ergastic substances are chemical deterrents to foragers as they cause various negative effects on animals. Ergotamine and LSD Doing too much LSD gives you CODIT.
- Example of 9/10:
 - Tyloses, found in a xylem vessel These are formed when there is a lot of turgor pressure that causes the protoplast of parenchyma cells to balloon into the vessel. This is caused by the pathogen moving through these conduits. These are formed as a means of preventing water and minerals through the xylem conduits. 2 ergastic substances are resins and tannins and they can help to stop this issue and fix the protoplasm.

Dutch Elm Disease: 2 points

- +0.5 if competitors just identify a valid treatment. **Maximum of 1 obtainable point.** OR
- +1 for describing valid treatment. **Maximum of 2 obtainable points.**
 - Mechanical: Pruning and burning diseased timber, Wrapping trees.
 - **One team said:** Burning of material from affected trees, thereby destroying eggs/larvae that may be present in the bark, and application of preventative pesticides that kill beetles who come in contact with the chemicals could protect elms from Dutch Elm disease.
 - Chemical: Spraying DDT or dieldrin. Injecting Liganasan BLP into the base of the tree using specialized equipment.
 - Biological: Use of Dutch Trig; nontoxic, suspension of fungal spore strains in distilled water. This is then injected in the elm to induce an immune response through pathogenicity (**induced resistance**).
- *A couple of teams said cross-breed or something related to genetics, but that's kind of elusive because the problem asked for management treatments. In other words, we need quick treatment plans put into action. Genetic innovations have been made in the last twenty years, but still in the works.
- **No cultivar** is "immune" to Dutch Elm Disease, even highly-resistant cultivars can become infected.

Seed Germination: 4 points

- +1 if competitors simply identify a human practice. **Maximum of 2 obtainable points.** OR
- +2 for describing valid practice. **Maximum of 4 obtainable points.** For example, in stratification, gardens nudge the seeds in the right direction by putting seeds in a refrigerator for a month or in a heated propagator. In scarification, gardeners are more aggressive. They rub the seed coat with a file or with small seeds placed and shaken in a screw-lid jar lined with sandpaper. Cutting, chipping, or pin-pricking the seed coat are other options. In soaking, this can remove natural chemical inhibitors like abscisic acid.
- Not genetics. Genetically engineering seeds with genes that easily break seed dormancy takes several years, and quite frankly, there are alternatives that people use, especially people who heavily depend on growing crops.

C4 and CAM Photosynthetic Pathways: 12 points

- +1 for correctly implementing a term in explanation. **Maximum of 5 obtainable points.** Refer to my overall answer key for example combined with knowledge of these pathways. It has to be with detail.
- +2 for describing spatial or temporal differentiation.
- +1 for discussing the role of stomata.
- **Example:**
 - **C4 Plants**
 - This adaptation evolved independently. Think about adaptation to the environment. Named C4 plants because they preface the **Calvin cycle** with an alternate mode of carbon fixation that forms a four-carbon compound as its first product. The leaf from a C4 plant includes two distinct types of photosynthetic cells: **bundle-sheath cells** and **mesophyll cells**. The former are arranged into tightly packed sheaths around the veins of the leaf. Around that are the latter, arranged mesophyll cells. Calvin cycle is confined to the chloroplasts of the bundle-sheath cells. Calvin cycle is preceded by the incorporation of CO₂ into organic compounds in the mesophyll cells.
 - **Steps:**
 - **PEP carboxylase** adds CO₂ to phosphoenolpyruvate (PEP), forming the four-carbon product, oxaloacetate. PEP carboxylase has a much higher affinity for CO₂ than does rubisco and no affinity for O₂. Therefore, PEP carboxylase can fix carbon efficiently when rubisco cannot- that is, when it is hot and dry and the stomata are partially closed, causing [CO₂] in the leaf to lower and [O₂] relatively higher.
 - After CO₂ is fixed in the mesophyll cells, malate is exported to bundle-sheath cells through plasmodesmata.
 - Meanwhile CO₂ is released and re-fixed into organic material by rubisco and Calvin Cycle. Pyruvate cycled into the mesophyll cells to produce PEP through a coupling reaction by using ATP.
 - **The initial cycle can be seen as an ATP-powered pump that concentrates CO₂ to minimize photorespiration and enhance sugar production. Especially advantageous in hot regions with intense**

sunlight, where stomata partially close during the day.

- **CAM Plants:**
 - Mesophyll cells store organic acids during the night in their vacuoles until the morning, when the stomata close.
 - During the day, when the light reactions can supply ATP and NADPH for the Calvin cycle, CO₂ is released from the organic acids made the night before to become incorporated into sugar in the chloroplasts.
- **C₄ vs CAM Plants:**
 - Both cycles occur in the same cell for CAM plants unlike in C₄ plants.
 - Spatial separation of steps vs. Temporal separation of steps.
 - C₄ plants may have partially-closed stomata whereas CAM Plant stomata are completely closed.
 - One team said: C₄ plants maintain photosynthesis with partially open stomata on hot, dry days. CAM plants however separate the light independent and dependent reactions using temporal differences. This means that it is not necessary for them to open their stomata on hot and dry days
- +1 for identifying a correct biome. **Maximum of 2 obtainable points.**
 - C₄ Plants: Grasslands, warm temperate zones, and tundras.
- +2 for explanation of the given biomes. **Maximum of 2 obtainable points.**
 - **One explanation for both biomes is fine.**
 - Hot environments to maintain low oxygen levels due to their CO₂-concentrating system.
 - One team said: C₄ plants dominate the deserts, because the wasteful nature of Rubisco can be amplified in conditions susceptible to water evaporation. Only gave one biome though.

Agrobacterium Engineering Is The Future: 17 points

- +1 for identifying the correct answer (Option 2 only) Would be option 3 too but A. tumefaciens causes crown gall disease in plants, not hairy root disease. A. rhizogenes causes the latter disease.
- +1 for identifying the correct phenolic compound (Acetosyringone).
 - ****Part of taking an exam is carefully looking at images. Apparently I forgot to delete the answer. I thought I did though.****
 - **I will also accept phytoalexins, but know that the role of this compound is still somewhat elusive.**

- **Methylsalicylic acids is a valid answer.**
- +1 for valid description of one step. **Maximum of 5 obtainable points.** For example, when *Agrobacterium* detects acetosyringone, the vir genes on the Ti plasmid are expressed. The vir genes encode enzymes needed to introduce the T DNA segment of the Ti plasmid into the genome of nearby plant cells. A single-stranded copy of the T DNA is synthesized and transferred to the plant cell, where it is converted to duplex DNA and integrated into a plant cell chromosome. The T DNA encodes enzymes that synthesize both plant growth hormones and opines. Expression of the T DNA genes by transformed plant cells thus leads to both aberrant plant cell growth (tumor formation) and the diversion of plant cell nutrients to the invading bacteria.
- +1 for identifying correct step. **Maximum of 5 obtainable points.**
- +1 for correct description of a correct step. **Maximum of 2 obtainable points.**
- +1 for identifying correct metabolite. **Maximum of 3 obtainable points.** Auxin, Cytokines, and Opines.
 - Phenolic and polyphenolic compounds. Nitrogen-containing compounds like nicotine. Terpenoids, Alkaloids, and any other secondary plant metabolite.

Opine Synthesis: 2 points

- +1 for identifying correct reagents. **Maximum of 2 obtainable points.** Amino acids and ketoacids or Amino acids and hexose.

Tree Pruning Essentials: Figure 1: 6 points

- +1 for naming the correct pruning technique; crown-raising.
 - 0.5 points for mentioning bottom-up pruning.
- +1 for valid description. The crown of the tree is elevated to accommodate pedestrian or vehicular access, structural conflicts, line of sight, safety, or appearance. Removing the lower tree branches is an important pruning process requiring some knowledge of tree growth. The lowest branches remaining will be the lowest branches on the tree as it matures; proper selection is critical. This tree goes beyond something called live crown ratio. Lower than 60% or excessive elevation of branches should be avoided so that trunk taper is not affected adversely. Also, a low LCR can result in greater susceptibility to failure during high winds.

- Large pruning wounds compromise healing, promote decay, leave defects, and increase the likelihood for failure in the tree. On larger trees, careful consideration of branches is important to prevent excessive removal of live tissue and large pruning wounds. There's a car and a house nearby that are prone to injury and pedestrians walking by the neighborhood.
- +1 for valid health issue. **Maximum of 2 points.** If mentioned before that's fine because sometimes these short answers are best if competitors answer all in one paragraph. Risk for decay and trunk cracks can form.
- +1 for valid solution. **Maximum of 1 point.** Solution for this tree is to, if possible, allow the canopy to grow more to at least a 60% ratio.

Tree Pruning Essentials: Figure 2: 7 points

- +2 for valid description of tree's branches. There are multiple codominant leaders to which the trees are more likely to split during storms because there is an improper, or higher proper branch aspect ratio. **OR**
 - 1 point for simply identifying where the branch is below or in front of the trunk.
- +1 for valid potential risk. More likely to split = increased chances for decay.
- +1 for valid branch aspect ratio. 50% or less. At least a 2:1 ratio. This tree has a ratio of about 3:1
- +1 for valid explanation. **Maximum of 3 obtainable points.** For example, structural pruning -> +1 Select the dominant stem in the center of the tree that is healthy and free of any defects. -> +1 Identify any stems that may be competing with that central dominant stem -> +1 Remove those competing stems and branches with a reduction cut.
 - One team's strategy: I can cut the leaves of the angled branch off to reduce the weight on the branch. Then I can slowly bend this branch upward to make it more in line with the trunk as a whole. I can also cut the leaves above the trunk to help reduce the effects of phototropism which makes the tree branch grow at an angle.
 - Modifying branch structure in this way to create a safe environment works well!

Pharmacognosy: 9 points

- +1 for valid definition. The practice of making crude drugs of poorer quality through deliberate or unintentional reasons (e.g. inferiority, spoilage, admixture, lack of knowledge)

- **0.5 points for leaning towards one side.** For example, explaining the definition as through deliberate reasons such as to make modified drugs more cheaper and effective.
- +1 for correct identification. Admixture
- +1 for valid description. **Maximum of 2 obtainable points.** Inferiority-replacement with a substandard drug. Ginger vs. Japanese ginger. Adulterants resemble the original crude drug morphologically, chemically, therapeutically but are substandard in nature and cheaper in cost. Sophistication- the addition of spurious or inferior material with an intent to defraud. For example, adding wheat flour to powdered ginger, with enough capsicum to restore pungency and curcuma to maintain the color.
- +1 for valid example given through above description. **Maximum of 2 obtainable points.**
 - 0.5 for valid example if competitors gave no description at all. **Maximum of 1 obtainable point.**
- +1 for valid non-economic reasoning. **Maximum of 2 obtainable points.**

Pharmacognosy: Tiebreaker: 4 points

- +2 for valid description. For example, The pH value of an aqueous medium may be defined as the common logarithm of the reciprocal of the hydrogen ion concentration expressed in gram per liter. It was done by a digital pH meter. The pH meter was stabilized for 15-30 min. Now the electrode has been immersed in a standard buffer solution of pH 4.0 and stabilized for 1 min. and reading was adjusted at pH 4.0. The electrode was rinsed and immersed in the sample. The reading displayed on the monitor was noted. The measurement of pH was 5.86 which is weakly acidic.
- +1 for reasonable measurements in the description.
- +1 for clear physicochemical identification.

Plant Biochemistry: 17 points

- +1 for correct identification. Chorismates like phenylalanine, tyrosine, and tryptophan. **Maximum of 2 obtainable points.**
- +2 for valid description of a precursor's pathway. For example, in plants, tyrosine is produced via prephenate. Dehydrogenase oxidatively catalyzes prephenate through decarboxylation but retains the hydroxyl group to give p-hydroxyphenylpyruvate. Transaminase transaminates this using glutamate as a nitrogen source to produce tyrosine.

- A team somewhat described the glycolytic pathway.
- +2 for using correct specific compound(s) and terms.
- **Depending on the pathway.** Protein synthesis, Catabolism, Specialized metabolism. Tyr-derived plants synthesize compounds used in human medicine (e.g. morphine) and nutrition (vitamin E).
- +1 for valid identification of a phenylalanine-containing food. **Maximum of 2 points.** Protein-containing foods milk, eggs, cheese, beef, pork, etc.
- +2 valid description of flavonoid synthesis. Phenylalanine and tyrosine are precursors in phenylpropanoid synthesis which then produces flavonoids, lignin, and tannins.
- +2 for using correct specific compound(s) (Must include all of the underlined compound)
 - 0.5 points for a specific compound.
- Quercetin synthesis: Phenylpropanoid metabolic pathway where phenylalanine produced CoA. These combined with malonyl-CoA provide the backbone of flavonoids. This is the general statement so +1 if this something that competitors provide. Anyways, after this reaction, tetrahydrochalcone is formed and converted into naringenin using chalcone isomerase. I'll be lenient on the enzymes used like no need to say 7,2'-dihydroxy-4'-methoxyisoflavanol synthase when forming the "backbone" to tetra[...]. Naringenin -> eriodictycol -> dihydroquercetin -> quercetin using flavanol synthase.
- +1 for valid difference. *Roundup* Ready are the GMO seeds resistant to glyphosate-based herbicide, Roundup.
 - 0.5 points only for incomplete differentiation.
- +1 for identifying genetic difference about EPSP.
- +1 for identifying the enzyme. *Monsanto* scientists have successfully altered the gene of the EPSP enzyme in plants to make it glyphosate-resistant. New version of EPSP: CP4 EPSPS.
- +2 for describing the effect of Roundup. Glyphosate is a competitive inhibitor of PEP, an EPSP substrate, that binds more tightly to the EPSPS-S3P complex than PEP and inhibits the shikimate pathway. Shuts down the enzyme's catalysis. Weeds will die from lack of essential aromatic acids (as mentioned before). Since *Roundup* is GMO'ed, the opposite effect will happen. There will be no effect on crops because they have the glyphosate-resistance gene. *Roundup*, a glyphosate-based herbicide, will therefore kill non-glyphosate resistant plants (e.g. weeds).

Plant Evolution: 9 points

- +1 for correct identification of Figure 1; Charophyte.
 - 0.5 points for saying something similar like algae.
- +1 for valid characteristics. **Maximum of 2 obtainable points.** Ring-shaped cellulose arrangement, flagellated sperm appear very similar, sporopollenin polymer (helped zygotes retain water when exposed to dry conditions).
- +1 for valid advantage. **Maximum of 2 obtainable points.** More access to CO₂, more nutrients due to erosion, unfiltered sunlight by water and plankton.
- +1 for valid challenge. **Maximum of 2 obtainable points.** Relative scarcity of water and a lack of structural support against gravity.
- +1 for correct definition. In charophytes, a layer of durable polymer which prevents exposed zygotes from drying out.
- +1 for valid explanation of their land existence. Accumulation of such traits by at least one charophyte algae population, enabled their descendants- the first plants- to live permanently above the waterline, opening a new frontier to terrestrial habitats that offered enormous benefits.

Plant Diversity: 12 points

- Figure 1:
 - +2 for valid description. Best to be answered by reversing the statement. If competitors don't do that, that's fine.
 - **Meiosis** occurs in mature sporophytes and haploid spores develop in the capsule. When the capsule is mature, its lid pops off, and the spores are released.
 - 1 point for meiosis
 - 1 point for mitosis
 - Spores develop into threadlike protonemata. The haploid protonemata produce "buds" that divide by **mitosis** and grow into gametophytes.
 - +1 for correct identification. Rhizoids.
 - No to playing a significant role.
 - +1 for correctly naming sex organs. **Maximum of 2 obtainable points.**
 - Antheridia and Archegonia.

- +2 for valid explanation. To avoid self-fertilization. If the archegonia and antheridia mature at the same time, there would be a good chance that the sperm would fertilize the eggs of the same gametophyte. Self-fertilization would decrease variation in a population, and reduce the chances of survival for the species.
- Figure 2:
 - +2 for valid differentiation. This figure shows the fern life cycle while Figure 1 shows the moss life cycle.
 - Gametophyte is reduced and independent (photosynthetic and free-living).
 - Sporophyte is the dominant structure.
 - +1 somewhere for distinguishing this cycle.
 - +1 for valid explanation for why ferns are taller than mosses.
 - Ferns have vascular structure whereas mosses do not. Mosses are incapable of carrying in water and nutrients.
 - +1 for correct identification. Should be #14 if I'm not mistaken.
 - +1 for valid explanation. Independent of the mature sporophyte.