Bonsai Trees & Growth Hormones
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ON THE COVER: Black Pine (Pinus thunbergii) courtesy of Michael Hagedorn, bonsai artist, teacher and writer, Portland, Oregon.
A Message from the President

Our annual BSF Convention is one of the most important activities sponsored, planned and executed by the Bonsai Societies of Florida. This is the activity which brings us together as a state; unified in purpose to enhance our participation in bonsai and to continue and forge new friendships with those people who share a passion.

As with any organization, there are differences of opinion in bonsai; be it style, speakers, pots, specimens or management activities. Regardless of what side of a debate you are on, one thing you can be sure of is BSF is here to stay. I say we stand together, being proactive in the improvement to bonsai and BSF and actively participating in BSF development in the future, planning for the future leaders to step into their roles seamlessly.

I believe the Board of BSF has taken the necessary first steps; our technology improvements provide quality, service, and longevity to our operations. Yogi Berra once said, “the future ain’t what it used to be.” As we add technology and multiple methods of communication among the membership, we will disregard what does not work, change what needs improvement, and continue to strive for the right combinations of technology and activities which improve our organization. Decisions will be made through experimentation, experience and knowledge, not fear of change.

With the right attitudes, knowledge, activities, and perseverance, continued success will come to BSF and all of you committed to bonsai in Florida.

All of us should take pride in the quality of the many Bonsai club shows throughout the state and the quality of Bonsai exhibited, they are really mini-conventions. The ability for these shows to exist is by virtue of the experiences created through BSF conventions. These shows prove that dedication and hard work pay off. Congratulations to all the clubs with shows.

This leads me to remind you about our 2011 Bonsai Societies of Florida Convention to be held in June. Flyers and specific information will follow, but it will be a large, quality event, once again held at the Ramada Celebration in Orlando. Having the convention in the same location provides us with a degree of consistency and an understanding of the facility to run an efficient and secure convention. A good time will be had by all.

As a point of information, changes have been made to our website and it will shortly return to activity. If anyone out there is willing to help with our website, please contact me.

For that matter, we welcome your feedback on how we are doing and with your constructive suggestions.

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Sometimes all you need is a week away to recharge and get inspired. This happened to me. I went to San Jose, California to attend the Golden State Bonsai Federation’s annual convention. The theme this year was New Faces in Bonsai. The headliners were Ryan Neil, Michael Hagedorn and Peter Warren. Ryan and Michael have both settled in Portland, Oregon, and Peter resides in Great Britain.

It was great to experience these young artists sharing their knowledge and techniques. All three speakers apprenticed in Japan, learning their craft from their respective teachers. Ryan just completed over six years of study with Masahiko Kimura. Michael Hagedorn studied two and one-half years with Shinji Suzuki and Peter studied for over five years with Kunio Kobayashi.

I’m looking forward to seeing Ryan at our next convention in 2011 in Orlando. I know our membership will be thrilled with his level of enthusiasm. He is a dynamic speaker who is dedicated to sharing his experiences with everyone. I had the best intentions to visit all the workshops while at the convention, but found myself glued exclusively in Ryan’s workshops, and listening intently as he shared his expertise with each participant. They worked on yamadori Ponderosa Pines. The trees they produced were truly amazing by the end of the workshop. The information he shared about the species was invaluable to their new owners. Louise Liester was there with me, and shared the same level of excitement experiencing Ryan’s talent.

I urge everyone to attend our next convention in June 2011, to take advantage of Ryan’s willingness to share with his fellow enthusiasts. This is a special issue of Florida Bonsai. We have published a manuscript submitted by Rosemarie Voelker, our District 1 Trustee. At the last BSF board meeting the Trustees were charged to return to their districts and find materials suitable for publication in our quarterly magazine. Within a week Rosemarie had submitted compilation of material by Mac Caruthers. The Fort Walton Beach club uses this material as a successful teaching tool for newcomers to the club.

I thank Mac for his submission and hope our readers find this information helpful in understanding the biology of their trees. This will be an issue that you will want to keep as a reference guide for many years to come. The next issue of Florida Bonsai will contain further supplemental readings to accompany this issue’s contents.

As we approach the end of the year, I’d like to wish all of our readers a very Happy Thanksgiving and a wonderful holiday season. Enjoy your holidays with family and those special bonsai friends.
How Trees Adapt and Respond:
The Growth Cycle Via Hormones

By Mac Caruthers

ACKNOWLEDGEMENTS

This article was inspired by the work of Brent Walston, proprietor of Evergreen Gardens. Brent was one the first Bonsai writers to introduce “Hormone Growth Regulation” into the Bonsai literature.

I am indebted to following people:

Dr. William Chaney, Purdue University, who graciously shared his time and knowledge of pathways with me via the phone. To the Arbor Day Foundation for use of their figure. To Michael Hagedorn, Crataegus Bonsai for use of his photograph. To Rosemarie Voelker, Fort Walton Beach Bonsai Club, for her artwork. To Brent Walston, EverGreen Gardens, for his review and encouragement. To Harry Harrington, bonsai4me.com, for graciously giving me his permission to reprint his article. To all the members of the Fort Walton Beach Bonsai Society who reviewed the article and corrected my many mistakes. To Steve Pilacik, Matsumomiji Gardens, for his review and encouragement. To Gary L. Wade, Ph.D., Professor and Extension Horticulturist, Department of Horticulture, The University of Georgia, for use of their figure. To courtesy of Bill Cook, Forester/Biologist, Michigan State University Extension, for use of their figure.

PURPOSE

To introduce new enthusiasts of Bonsai to trees and the principles of how trees adapt to changes to their external environment, and make appropriate responses to those events. This information has been narrowed down to the main items of interest to the Bonsai community.

This article mainly deals with woody trees that grow from their apex (tips). However, some of the techniques and information must be modified for the branch development on Pines.

INTRODUCTION

The evolution of knowledge involving the growth mechanisms that regulate the growth of trees.

The tree is a system and one needs to understand how the tree’s system operates and how it responds to events in its environment. It is responsive to, and dependent upon, its external environment; hence, it is a subsystem of the earth’s environment that includes man and his actions. The principles of the “growth control regulators” in the horticultural literature need to be incorporated into our Bonsai training and writing, as a supplement to our current educational approach.

The early Bonsai Masters grew the art of Bonsai through thousands of years of observations, trials and errors. Since they had no knowledge of what went on inside the tree, they concentrated their focus on observing the exterior of the tree. This approach required them to learn hundreds of different scenarios by rote. Each scenario was learned as a separate event, prune a limb, prune a root, pinch a bud, etc. Then there was a different outcome for different trees and a different scenario for each different season of the year,
It was not until the 1970s,\(^5\) that the research literature began to have numerous articles about hormone controlled growth principles. They now acknowledge that it is the internal mixture of hormones that occur within the tree that control its growth and its response to external events.

It is through the understanding and application of the trees’ internal processes, in addition to the existing Bonsai teaching approach, that we may move the teaching of Bonsai forward into the twenty-first century. The addition of such models and principals in our teaching and literature may empower our new members to progress in the art much faster and with greater ease and confidence. Such ease, confidence and speed of learning may well reinforce the early efforts of novices, thus keeping their enthusiasm strong enough for them to continue to grow and become long-term contributors to the art of Bonsai.

At times you will find information repeated. Repetition is still one of the strongest tools used in education and training. The following information should be approached as a reference. ... sitting. Some sections may require that you read them several times depending on your current knowledge of the subject.

Our counterparts in the fields of horticulture, forestry, botany, biology, etc., have made slow but definite progress in beginning to understand the principles of how trees grow, respond to events in nature, and die. They have accomplished this by changing their focus from the external of the tree to the internal of the tree. In the 1930s,\(^2\) the hormone Auxin was identified as a growth hormone and since it appeared to be the only one, all growth was accredited to it. It took another ten years, the 1940s, until the hormone Cytokinin was identified,\(^3\) since then four more growth hormones have been added to the list. If you are interested in learning more about hormones, a chart appears in the supplemental readings at the end of this article that describes the different hormones.\(^4\)

Because the tree as a whole is too complex to comprehend at a functional level, we must use simplified models to understand the tree reactions to change.\(^9\)

Dr. Kim D. Coder, Professor Silvics/Ecology, May 15, 1997\(^1\)

When we know basic plant physiology, you can answer most of your own questions about pruning and growth. Understanding the physiology of woody plants is in fact a very powerful tool for the artist’s toolbox. When you understand how trees grow and respond, you are no longer limited to cookbook formulas for pruning, potting, learning by rote, etc.\(^9\)

Bret Walston, proprietor of Evergreen Gardens and prolific Bonsai writer, February 1, 2008\(^6\)
In any course of study it is necessary to understand the language used in that field; called the jargon. It is also necessary to understand the definition of various operational terms. You will hear these items discussed in your club and encounter them in the literature you read. Below, you will go through some i) definitions and ii) descriptions of how various functions operate within the tree, and later, iii) examples of how to use the information presented here in your Bonsai work. Early in the article you may begin to wonder how any of this relates to learning how to care for and develop a Bonsai; that will become obvious when you get into the examples. There is a lot of information to digest. Hopefully you will view the article as a reference that may be reviewed as many times as needed.

SECTION I
DEFINITIONS

In this section you will cover some basic definitions that will be used throughout this article and other Bonsai writings. No need to try and memorize the definitions as the items will also be defined in the material that follows. This material assumes that as a new Bonsai club member you know next to nothing about the growth of trees. No insult intended.

**Trunks, Limb, Branches and Stems:** Limbs are attached to the trees’ trunk; branches are attached to the limbs and stems are attached to branches.

**Energy:** A term associated with growth.

**Node:** A node is where leaf or flower buds appear and grow.

**Internode:** An internode is the bare section of a stem between the leaf sprouts or buds on a stem.

**Buds:** The bud at the very end of a limb is called a terminal or apical bud (Fig. 1). The others buds on the limb are referred to as lateral buds (Fig. 1) or adventurous buds and may be scattered throughout the limb, often not visible. The stem in between lateral buds is called internodes.

**Bud Break:** When a bud opens it is said to break.

**Back-Budding:** back-budding occurs when new buds appear on “old” wood. Many trees will back-bud as the result of the tips of a branch being pruned or after a trunk chop.

**Apical dominance:** Refers to the fact that the apical bud generates a hormone that keeps the buds on the limb behind it from breaking. This makes the apical bud the dominant growth point on the limb.

**Latent Buds:** Buds that are on the bear stem between leaf stems; often invisible.

**Meristem:** On the very tip of a bud or a root there is a section called a meristem. The cambium is also a meristem. The meristem is made up of millions of undifferentiated living cells. They are equivalent to stem cells in humans.

**Cambium:** A small amount of green material just under the bark that is made up of millions of undifferentiated cells and wraps around the entire tree.

**Pathways:** The pathways inside the cambium ring are called the Xylem (pronounced zı–lem). The pathways outside of the cambium are called the phloem.
(pronounced fló–em). These two pathways conduct fluids up and down the tree.

Flush: To flush means a strong burst of growth.

Ramification: Ramification is a technique whereby numerous small twig-like branches are developed so that they are in proportion with the scale of the Bonsai tree.

Pads: A large area of ramified branches may take on the look of a pad of growth. Pads are used a lot in the development of pine Bonsai.

Transpiration: The process by which water is drawn from the roots by relative humidity, up the tree and out of the leaves into the atmosphere.

Differentiation: The process by which a certain mixture of hormones causes undifferentiated cells to form specific material that the tree needs. These could be stems, buds, flowers, seeds etc.

Movement: The curves in a trunk or limb are referred to as movement.

Taper: When a trunk decreases in diameter as it goes up the tree, it is referred to as taper. Both taper and movement are highly prized in Bonsai.

Up-pot: To transfer a tree from a smaller pot to a larger pot, usually without pruning its roots.

Tree in training: You will almost never find a tree ready to go right into a shallow Bonsai pot. It is normally be necessary to grow your tree in the ground and/or in an over-size pot or container for a number of years while you work on developing it. Such a tree is said to be in training. An over-size pot is said to be a training pot.

Food: Fertilizer is not food. Fertilizer is comprised of the nutrients and minerals that the leaves of the tree will convert into sugars and carbohydrates that the tree will use as food. When you see the term food in the literature or hear it mentioned in your club meetings, it is the sugars and carbohydrates that are being referred to; not fertilizer. Warning: the term food is commonly often misused.

Escape: Escape means to let the roots grow out of the drain hole of a pot and go into the ground.

High-energy limb: A limb that demonstrates strong growth.

Reverse taper: A portion of the trunk has a larger diameter than the section below it. That condition is considered a negative feature.

Root Rot: a condition that occurs usually when trees are over-watered. The roots stay too wet resulting in a decaying root system. The roots are typically brown or black in this condition, and should be removed to protect the health of the tree. Symptoms are usually yellowing foliage and poor growth. Unfortunately, when symptoms are visible, severe damage may already have occurred.

ITEMS OF INTEREST ON THE TREE

1. A High energy Limb is usually a limb growing very vertical. High energy is another term for very strong growth.
2. Water Sprout is a vertical growing stem from the top of the old section of a branch.
3. Low energy limb is usually a limb growing less vertical and weak growth.
4. Lower energy limb is usually a limb bent very low.
5. Sucker from the root is a sprout growing straight up from the roots or lower trunk.
6. N/A
7. Limb of moderate energy.
8. Apical branch at the apex of the tree, usually the highest energy branch on the tree.
I n this section you will be introduced to the basic components of the tree. Be sure and concentrate on the discussion of pathways.

**Objectives:** You should know the function of the three components of the tree. You should be able to identify which pathways feed the tops and which feed the roots and function of the cambium.

The Tree is composed of three active and interactive components which comprise the tree’s three growth zones: They are dependent upon and reactive to each other.

- **Leaves** (See Crown above)
- **Connecting tissue** (the cell pathways inside the trunk) (See Trunk above)
- **Absorbing roots**

These three components interact with each other in such manor that any change in one will cause a change in the other two.

I believe that everyone is generally familiar with leaves and roots. The leaves manufacture food for the tree and roots support the tree as well collecting the minerals, nutrients and water that the leaves use in the process of manufacturing food. Because of the importance of pathways and the lack of information on them, I will spend some time on that subject to be sure that the reader understands their function. Currently the importance of pathways, their development and maintenance, is seldom discussed in Bonsai literature. Let’s look at the inside of the tree:

**THE ANATOMY OF A TREE**

A. **The outer bark** is the tree’s protection from the outside world. Continually renewed by the phloem from within, it helps keep out moisture in the rain, and prevents the tree from losing moisture when the air is dry. It insulates against cold and heat and wards off insects.

B. **The inner bark, or “phloem”, is pipeline through which food and hormones are passed down from the leaves to the rest of the tree. It lives for only a short time, then dies and turns to cork to become part of the protective outer bark.**

C. **The cambium cell layer is the growing part of the trunk. It annually produces new bark and new wood in response to hormones that pass down through the phloem with food from the leaves. These hormones, called “auxins”, stimulate growth in cells. Auxins are produced by leaf buds at the ends of branches as soon as they start growing in spring.**

D. **Sapwood or the xylem is the tree’s pipeline for water and minerals moving up to the leaves from the roots. Sapwood is new wood. As newer rings of sapwood are laid down, old inner cells lose their vitality and turn to heartwood, (dead wood).**

E. **Heartwood is the central, supporting pillar of the tree. Although dead, it will not decay or lose strength while the outer layers are intact. A composite of hollow, needle like cellulose fibers bound together by a chemical glue called lignin, it is in many ways as strong as steel. A piece 12” long and 1” by 2” in cross section set vertically can support a weight of twenty tons!**
The two pathways are a series of vascular cells in the trunk of the tree that transport water, nutrients, minerals and hormones to the leaves and food and hormones down to the roots. Generally speaking they serve the same purpose as human vascular system of veins and arteries. As the interior pathway cells (xylem) die, they become the deadwood that supports the tree. Almost 95% of a tree is comprised of dead tissue leaving only about 5% tissue that is the living portion of the tree. As the exterior pathway cells (phloem) die, they become the bark of the tree.

The pathway structure inside the trunk is similar to a divided highway (Fig. 4). Such a highway has three parts. It has one lane going in one direction, a divider, and one lane going in the opposite direction. In a tree the cambium is the divider between the two pathways. There is one pathway, inside the cambium, going up the tree, called the xylem from the roots to the leaves. There is another pathway, outside the cambium, coming down the tree, called the phloem, from the leaves to the roots. These two pathways are comprised of vascular cells. Dividing them is the cambium. The cambium is the green stuff just under the bark between the two pathways. The cambium is comprised of undifferentiated living cells that surround the trunk and the branches. Like human stem cells, these cells are capable of becoming anything that the tree may need. Since the cambium wraps around the tree, for our discussion, it may be considered a circle. The pathway inside of the circle formed by the cambium is called the xylem. The job of the xylem is to conduct water, nutrients and minerals from the roots to the leaves, (called the “root to shoot connection”). The pathway outside of the cambium called the phloem conducts food from the leaves (called the “shoot to root connection”).

It is the job of the cambium to grow new pathway cells for both the xylem and the phloem each year, thereby growing the diameter of the trunk, limbs and branches. The cambium will also form a callus and eventually becomes new bark to cover a wound in case of injury to the tree’s trunk or branches. It is with the aid of the mixture of the different hormones within the tree that the inside part of the cambium can differentiate new cells into what becomes new pathway material.
over time they die and form the bark of the tree.

It is important you understand the action of the pathways because they comprise one of the two major “growth control regulators” that will be discussed in detail.

By understanding how each of the three main components of the tree, leaves, pathways and roots interact with each other, the outcome of any Bonsai activities can be planned and predicted ahead of the event. No single one of the tree’s three components acts in isolation; any change in one component evokes a change in the other two. Thus the tree’s hormones are constantly rebalancing themselves to respond to the changes to its environment.

Those who practice the art of Bonsai have in the past viewed the results of their actions such as top pruning, root pruning etc., after the event. It is more desirable to be able to predict these results before such activities are performed. To do so requires a basic knowledge of the main “growth control regulators” within the tree.

That’s why you are reading this article; you want to get ahead of the curve by managing, planning and anticipating the results of your actions.

In this section you should gain an overview of the internal elements of the tree and how they strive to keep the tree balanced as a system.

Objective: Understand the mechanism that enables the tree to react to external events. Understand how the tree interfaces with the earth and it’s atmospheric environment.

Unlike humans, the tree is immobile and also lacks the manual dexterity of humans. Therefore, it must meet every challenge in the environment with only its internal chemistry on which to rely. Down through the centuries the tree’s genetics have developed programming responses to every event that may impact the tree. It does this primarily through the use of hormones.

The tree is a composed of hormones, enzymes, peptide, and proteins, etc. As a system, it strives to maintain a balance of this chemistry. Any change in the external environment will upset the balance and cause an internal change in the mixture of the tree’s chemistry. It’s chemistry will then react and strive to respond to the external event. This will often cause an external event to occur on the outside of the tree; a bud will break, a limb will increase in diameter, a root will grow, etc.

The tree may also be viewed as a subsystem interfacing with the earth’s upper environment (sun, heat, humidity and wind) and lower environment (ground). The leaves are the primary interface to the upper environment. The upper environment provides sunlight, carbon dioxide (CO$_2$), heat, oxygen and some moisture. The trees’ leaves bring in CO$_2$ through the stomata, (small holes in the leaves). The leaves, with the aid of...
the CO₂, sunlight, nutrients and water, produces food, in the form of carbohydrates/sugar, and in the process releases oxygen and water through the stomata into the upper environment. Movement of water, minerals and nutrients from the roots to the leaves is performed by a mechanism called transpiration.

The roots are the tree’s primary interface to the lower environment. They provide an anchor for the tree. The roots also take in oxygen, water, nutrients and minerals from the soil. The roots collect these items and send them along with various hormones up the xylem pathways to the leaves. In turn the roots receive hormones and food manufactured by the leaves via the phloem pathways. The roots store the food as a reserve for future use by the tree. The roots also use some of the food to grow new extensions of the root system. This expansion of the root system is necessary in order to bring in the new nutrients and water that is required by the tree’s new growth. The growth of the roots is controlled by the hormone auxin, which is sent down the phloem along with food from the leaves.

SECTION IV
THE TWO MAJOR “GROWTH REGULATOR FIELDS”

In this section you are introduced to the two major growth regulating components and the two of the growth hormones that control the trees’ growth.

Objectives: Be able to identify the two major “Growth Regulators” and how they function. Be able to identify the two major growth hormones and how they are generated. Be able to identify which parts of the tree are affected by a dominant ratio of any specific hormone. Be able to identify how the temperature throughout the year effects the strength of the “Growth Control Field.”

The “Growth Regulator fields” are responsible for regulating the growth of all the separate parts of the tree as well as the tree as a whole.

The two fields are called: The “Growth Control Field,” (usually, it is just referred to as the “control field”) and the “Growth Control Pathways.”

THE “CONTROL FIELD”

Below you are introduced to the balancing action of two of the growth hormones; Auxin and Cytokinín. Upon completion you should be able to predict the outcome of pruning the top branches and the results of pruning roots on these hormones. You should also be able to predict the results of changing the balance between the two hormones.

The “control field” is said to serve the tree at the cellular level. That is to say that each leaf, branch and root tends to have its own individual pathway leading down to its individual roots. This autonomy becomes more pronounced as the tree grows older. Hence, it may be

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said that each limb, stem, etc. is autonomous. It does not share its’ food or water with any other limb. It is not usually affected if another branch is pruned or dies. A branch’s individual health is dependent upon the health and the strength of its own leaves, pathway and the on the health and growth of its own roots. You will learn how to help care for, and develop, these pathways and how they perform the work of the “control field.”

The “control field” is comprised of three hormones.
1. Auxin, (əkusn)
2. Cytokinin, (sī–tō–kī–nen)
3. Abscisic Acid, (ab–sī–zik)

These three hormones are constantly present throughout the tree. What is crucial to the “control field” is the ratio of the mixture of the three hormones. Different mixtures of the three hormones produce different results. A bud may break, roots may grow, a branch may die, etc. If an individual practicing the art of Bonsai understands the outcome of the different mixtures, he or she can predict the outcome of various actions such as pruning, wiring and bending a limb, allowing a limb to grow, pinching a bud, etc. The “control field” varies in strength during different times of the year as you can see below.

**ANNUAL “CONTROL FIELD” MODEL, SPRING THROUGH WINTER**

This information covers the variance of the strength of the “control field” throughout the year. This variance is due to the fact that efficiency of the leaves and roots varies with the temperature throughout the year.

1. Winter: Very low “control field” strength. This is a dormant period; most of the tree activity is suspended.
2. Very early Spring: Low “control field” strength. Roots start to grow.
3. Spring thru early Summer: High “control field” strength. Strong shoot growth and root growth, also new pathway connections are fashioned, and spring wood in the tree is produced as the xylem grows.
4. Mid thru late Summer: Moderate “control field” strength, due to the effect of heat on the roots and leaves, thus the tree may become semi-dormant.
5. Early Fall: Intermediate high “control field” strength. Leaves, stems and roots renew their second growth cycle. This produces one last short flush of growth before late fall and winter.
6. Mid to late Fall: Very low “control field” strength. Only slight growth activity; primarily root growth. The trunk and branches may thicken.

**AUXIN AND THE BONSAI ARTIST**

Auxin like the other hormones serves many different functions. This article will only discuss the ones that are of most importance to the understanding of the person studying Bonsai.

1. **Auxin** hormones are involved in plant-cell elongation.
2. **Auxin** creates apical dominance by suppressing bud break behind the apical bud.
3. **Auxin** stimulates root growth.
4. **Auxin** hides from sunlight; it concentrates on the shady side of the tree.
Apical dominance means that the Auxin produced by the buds at the apex, (end of the branches) tries to suppress the growth of any bud break behind it; these other buds are called latent or adventurous buds.

The presence of Auxin causes cells to elongate. It does not cause them to divide but they do grow in length. Auxin travels down the phloem of the tree to the roots. When the ratio of Auxin becomes higher than that of Cytokinin, it signals the roots to grow.

The flow of Auxin is driven by two systems – one is gravity, the other is the proton pumps within the cells. The flow of Auxin is strongest when the two systems are working together at their maximum efficiencies. This occurs when a limb is growing absolutely vertical. The less vertical a limb grows the more the effects of gravity are reduced, thereby reducing the flow of Auxin. In the case of limbs bent below 45º the flow of the proton pumps is also somewhat reduced due to the resistance of pumping uphill to get the Auxin to the main trunk.

Limbs that grow very vertical are referred to as high energy limbs (See Fig. 2, branches 8, 1, 7, 2 and 5).

Note: Though all of these are considered high energy limbs, 7 has lower energy than 1 and both are lower than 8, 2 or 5 because 7 and 1 are not as vertical. The lower a limb is bent away from vertical, the weaker it becomes; it is said to be a low energy limb below 45º (See Fig. 2, branches 3 and 4). Number 5 is called a sucker and 2 is called a water sprout. Both will be discussed later. Understanding the energy level of the various limbs will prove to be very important to your Bonsai work. Fig. 6 shows “water sprouts and “suckers” in red. The branches in Fig. 6 are mainly high energy branches but the less vertical they are the lower their energy. The very tip is the apex of the tree and is the highest energy limb on the tree.

Cytokinin as Part of the “Growth Control Field”

The major affects of the hormone Cytokinin are discussed. Cytokinin performs functions other than the ones described here. This discussion is limited to the aspects of Cytokinin that are helpful for the person practicing the art of Bonsai to understand.

One of the main jobs of Cytokinin when mixed with Auxin is to promote cell differentiation which causes undifferentiated cells to become specific material; such as a leaf, a stem or a new cell, whatever the tree needs at that point in time. When Auxin and Cytokinin are present in the right mixture they promote cell division; which is how the tree grows and/or replaces dead or injured cells.

When the ratio level of Cytokinin is higher than that of Auxin, it signals the tops of the tree to grow. Cytokinin is produced by root growth. Remember root growth is signaled by high Auxin ratios. The Cytokinin produced by the root growth travels up the xylem to the tips of the branches; where it signals for the tops to begin or keep growing. This changing balance between Auxin and Cytokinin forms the growth cycle of the tree.
These two hormones act like the old playground seesaw. At any moment in time Cytokinin may be higher, later Auxin may be the higher. During each of these transitions either tops are growing or roots are growing. They operate in an opposing cycle; roots don’t grow while tops are growing and tops don’t grow while roots are growing. The literature refers to this as an “episodic out-of-phase cycle.”

Let’s take a moment to be clear on the distinction between hormones and food.

1. Hormones are like traffic lights, they provide signals.

2. Food provides the energy to perform the act called for by the hormone signals. Without food the act called for by the hormones will not happen. If food is available, the amount of food available will determine how much growth will occur. It is a large amount of food available that creates long internodes in the stem growth. A low amount of food creates short internodes. Short internodes are very desirable in Bonsai trees. The techniques used to develop and control the internodes’ growth is outside scope of this article.

SECTION V

THE “GROWTH CONTROL PATHWAYS”

In this section the physical mechanism that prioritizes the distribution of the food from the roots throughout the tree is discussed. The fact that priority is always given to the strongest components of the tree follows nature’s rule of survival of the fittest. Understanding this priority is extremely important to the practitioner of Bonsai.

Objective: You will be able to describe how the pathways supply the most resources to the leaves and limbs that supply the most food. You should be able to describe how limbs may be strengthened, weakened or caused to die over time.

The “growth control pathways” determine where in the tree the tree’s resources are used and or stored.

It is the job of the “pathway control” to supply the largest amount of resources to the limbs which are most beneficial to the tree’s health and survival prospects. In conjunction with the roots, the pathways decide which limbs live or die; as well as which limbs grow strong or weaken. It does this by allocating where the water, minerals, nutrients and other resources are directed. The stronger a particular pathway the more water and nutrients go to the limb connected to that xylem pathway. This system rewards each limb in proportion to the amount of food produced by the leaves on that limb. The more food the leaves of a limb produces, the larger the xylem pathway connecting the roots to that limb in order to increase the transport of extra water and nutrients to support further growth for that limb and it’s leaves. The pathways of the limbs that produce less and less food shrink overtime. At some point the flow may become so
small that the roots shut down that pathway and that limb weakens and dies. The reasons behind a limb producing less food are many. It may have been damaged, or it’s roots diseased; often it has gotten shaded out by another limb or adjacent tree. In the latter case it’s no sun, no food. If you were to cut into the trunk and look at the pathways (often called annual rings), you find that some have a larger diameter and some smaller. The size of the pathways is how the largest resources are distributed to the limbs/branches/leaves that are the most important to the tree’s survival and growth. The size of the pathways are constantly being adjusted by the amount of food it’s limbs produce via the quantity of it’s leaves. (Ref: Phone conversation with Dr. William Chaney, Purdue University 5/19/2009)

If you are still with me, you have been through a large amount of information. I admire your persistence. Finally comes the fun part, we see how all this information can be used.

First let me introduce some of the key questions that you may want to ask yourself before you undertake any action. The answers will give you some insight to the tree’s reaction to the abuse you intend to inflict upon it. After a brief introduction, we will see how one goes about using this knowledge to achieve desired results.

QUESTIONS TO ASK YOURSELF

Asking yourself these questions may help you arrive at a full understanding of what the end result of your planned activities may be.

What are you trying to achieve?
What season is it?
What action are you going to take?
How will that action upset the tree’s hormone balance?
What will be the tree’s reaction to this unbalance of its hormones?
Will that reaction give you the results you seek?

SECTION VI
DILEMMAS

In this section a small number of various scenarios are offered as just some of the examples of how you might use the information you have gone through to help answer the ever present question of “What happens if I do XYZ to my tree.” The examples are presented as “Dilemmas”.

Objective: When you have finished the exercises below you should be able to apply the principals of “growth hormones” to most of the Bonsai situations you may encounter. Go through exercises until you are comfortable that you can put the information to practical use.

The practitioners of Bonsai never seem to be happy unless they are doing something to some poor unsuspecting tree. So, let’s go through some the more common activities that you will find yourself asking questions about. But before we go there...

A REVIEW OF SOME THINGS WE LEARNED

1. Top growth produces Auxin.
2. Root growth produces Cytokinin.
3. High ratios of Auxin signals root growth.

DILEMMA ONE

Q: I have a limb that is too long. What happens if I cut it back?

A: Remember the Auxin in the “control field”? One of it’s jobs is to suppress any bud break behind the apical bud. Whether you cut just the tip off of the limb or a section of the limb, you remove the apical bud and drastically reduce the Auxin mixture in the “control field” of that limb. Now there is little or no Auxin to suppress the latent buds on the limb from breaking. Breaking means that the buds open. Since you have reduced the Auxin, the Cytokinin ratio is now dominant. The higher Cytokinin ratio gives the latent buds a grow signal. The result of your cut will most likely be that a number of buds will break to form new branches on your shorter limb.
**DILEMMA TWO**

**Q:** I have a rather tall tree that I think it would make a great bonsai. What happens if I cut the trunk off to make it shorter?

**A:** The larger part of your question was answered in *Dilemma One*. The difference is the exaggerated results. In *Dilemma One* you reduced the *Auxin* in a single limb. In this situation you are going to almost eliminate the *Auxin* in the entire tree. This leaves the *Cytokinin* levels extremely high. Therefore the growth signals to the tops are very strong. With an extremely low level of *Auxin* left in the trunk, almost every latent bud on the trunk will try to break.

Given that the tree has been well fed in the past, it has enough food stored for the whole pre-cut tree. All of the food now has nowhere to go except to the growth of the new breaking buds. This will support an explosion of new growth.

All of this new growth sends a large amount of *Auxin* down to the roots. This signals strong root growth, which in turn results in a large amount of *Cytokinin* being sent back up to the top of the tree to signal more top growth. All of this new leaf growth now begins to generate a large amount of food to fuel even more growth. This exaggerated cycle of growth continues until the summer heat slows it down or the food supply runs out. The tree will experience another flush of growth in the fall. It is not unusual for the tree to put up a six foot or taller leader in just one growing season. This technique is called a “Trunk Chop.” You will use this technique to shorten trees and/or to create taper and movement in your tree’s trunk. “Creating taper” is another technique you will use quite often. Creating taper will be covered later.

**WARNING:** In the spring following the chop, a large number of shoots may break right at the cut. Choose one of these as your new leader and cut the others. If you let all of them grow in this one spot they may thicken this area into a large knot. Should a bud break below the cut near the root, you may wish to keep it to help thicken the lower trunk.

1. You need to be sure that a higher limb does not shade out the limb you’re wiring down. Remember, no sun equals no food production, so the lower limb could continue to weaken further and eventually die.
2. You need to be sure to rotate your tree so that your low limbs are not all ways on the shady side. These two items are especially important for pines.
3. You will want to encourage lots of new growth on this lowered limb. The more fine branching you create the more food the limb will produce. The more food that is produced the stronger the pathway remains. Producing fine branching is called “ramification.” Ramification also allows you to create pads of foliage on your limb, which increases the number of leaves/needles and apical buds to generate food for that limb (Fig. 7). This dense foliage increases or maintains the health/size of that pathway and ensures that excess food is available for increasing the diameter of the

![Figure 7. Photo courtesy of Michael Hagedorn.](image)

*You will find Bonsai containers and heat and their effects of temperature on tree growth, in Supplemental Readings to be published in the next issue of *Florida Bonsai.*

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**WARNING:** pines are different. You must never cut a pine limb back so far that no needles are left on the limb. That limb will die! This means that you may have to reduce your pine limb back a little at a time over several seasons. However, the same growth principles are still at work on pines. Cutting off the tip of a branch to induce new buds to break on the shortened limb, is a technique called “Back Budding” and you will use it very often in your Bonsai work.

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**DILEMMA THREE**

**Q:** My number one lower limb is too vertical. What happens if I wire it down much lower?

**A:** At this point you need to learn a little more about *Auxin* and review a little pathways info.

1. The more vertical the orientation of a limb the stronger the *Auxin* flow.
2. These are called high energy limbs.
3. The subsequent growth cycle caused by strong *Auxin* flow causes a larger, stronger pathway to develop.

Now back to your dilemma. The lower you wire the limb down, the weaker you may make the limb. This is because it is difficult for *Auxin* to be pumped uphill and this also has the diminishing effect of gravity. It is possible that the reduced *Auxin* flow may reduce the growth of that limb which may weaken it’s pathway. Thus, there are a number of precautions.

4. This dense foliage increases or maintains the health/size of that pathway and ensures that excess food is available for increasing the diameter of the
trunk and branches. The techniques of creating ramifications and pads are beyond the scope of this article. Below is example of how, through ramification, a dense pad of foliage is created across the branch using ramification. Observe the lower limbs. With care your wired limb should be just fine. Watch out for the wire cutting into the bark as the limb grows.

**DILEMMA FOUR**

**Q:** I have just brought a nice plant from the nursery. It is about 8” tall. If I put it in a bonsai pot how long before it will be a beautiful Bonsai like I see in the books?

**A:** I take it from your question that you do not want to keep this tree the size as it is now. I assume you want to grow into something that gives the appearance of an old tree of great character with a large trunk. If that is the case then the answer is never. This is one of the most general misconceptions of people just staring out in Bonsai. Putting a tree in a shallow bonsai pot is almost the final act that you will perform on a tree after it’s development and training period. Lets review some of our growth regulation theory.

1. **Auxin** signals root growth.
2. **Cytokinin** in turn signals for more top growth.
3. **Cytokinin** in turn signals for more root growth.

For roots to produce **Cytokinin** they must grow. By putting the tree in small bonsai pot you have severely restricted it’s root growth. The strength of the growth cycles between the tops and the roots will get smaller and smaller over time.

There will reach a point where the tree is so root bound that there is practically no growth. The Auxin and Cytokinin signals are diminished and roots are taking in only small amounts of nutrients and water. Much smaller internodes and leaves are produced; therefore much less food is produced. Putting the tree in a bonsai pot is the primary way to slow it’s growth so that it remains virtually as it is. At that stage it is considered a finished bonsai. A tree may be in development (training) for 15 to 25 years before it is put into a bonsai pot. See developing a Bonsai below. Yes, there are always exceptions.

**DILEMMA FIVE**

**Q:** I am told that I must prune the roots periodically. Why? I thought I need the roots to get maximum top growth.

**A:** You are correct; if you prune the roots the top of tree may stop growing for a period of time while the roots reestablish themselves. Almost anything you do to the tree will stop its growth while it rebalances itself. That’s the price you pay for altering the tree. The reason you repot is to refresh the soil in your pot, which will breaks down over time and may become compact and clog up the drainage holes. As to why you must prune, because in time the roots outgrow the pot. After a time the tree becomes so root bound that the tree may weaken and eventually die. See **Dilemma Four**. By cutting back the roots you can use the same pot and yet new roots now have room to grow. That means the new roots can now take in more water and nutrients from the new soil you placed in the pot. They can also now produce stronger **Cytokinin** signals which will encourage top growth. The tree is reenergized through these stronger growth cycles and the pathways are strengthened or at least maintained. There will be a short period of no top growth while the roots re-establish themselves but if repotting is done at the proper time this should be a relatively short period.

**WARNING:** When you cut off the roots you remove a certain amount of stored food; this is usually not a real concern unless the tree is already weak. One does not work on weak trees. However, you also reduced the root’s ability to take in water. If, through transpiration, the tops are losing more water that the roots can replace, the tree may be stressed and damaged. As general rule take off the same ratio of tops as you do roots unless the amount of roots you remove is fairly small.

**DILEMMA SIX**

**Q:** A year ago someone at the club wired a limb down for me. I later took the wire off to keep it from cutting into the bark but now the limb is rising up again. What did I do wrong?

**A:** Nothing. I am going to assume that the tree or perhaps the branch is fairly young. At least young enough that the pathways inside the limb are not old enough to have hardened to the point that they are very difficult to bend. Now let’s review a little about **Auxin**.

1. **Auxin** does not like sunlight.
2. **Auxin** concentrates in areas away from the sun.

If the limb was bent fairly low, it means that top of the limb’s surface, which is now more or less horizontal, is exposed to sunlight. In order to avoid the sun light, **Auxin** is concentrated in the under part of the limb away from the sun. As was stated before, **Auxin** elongates cells. The high concentration of **Auxin** in the under part of the limb elongates the cells on the under side while cells on the upper side of the limb remain stationary. This forces the branch to curve up. Even if the branch is too ridged to be curved upward you will notice that the younger tips of the branch will turn up. It is not unusual to need to rewire a young vigorous branch a number of times across several seasons. This is especially true in climates with long growing seasons like Florida.
Your wire cannot be left on long enough to do the job in one season. In these climates guide wires are very useful in that they can be left on for an extended period of time without damaging the trunk or branch.

**DILEMMA SEVEN**

Q: I have a new tree that I need to style. A lower branch is just in the right place to be used as a permanent, Number One branch. However, it has been growing under a higher branch that has shaded it out. As a result the branch is smaller in diameter than the other branches I’ll be saving. It looks out of place. Is there a solution?

A: Yes, but it will require patience on your part and a little luck. Perhaps you should have bypassed this tree when you looked it over. Either you did not notice the flaw or the tree has such strong potential that you wanted to work with it regardless. With a little cooperation from nature, you may still make it work. Let’s review some of the information you’ve been over.

1. By now you recognize that the internal growth process is a cycle. Top growth produces Auxin; Auxin produces root growth; root growth produces Cytokinins; Cytokinins produce top. Then the cycle repeats itself. During the process the pathways are enlarged and strengthened in order to meet need. The limb may need to approach 5’ to 8’ in length.

2. Food is needed to create growth.

3. To make food the limb needs sun.

4. For the sun to make more food, the limb needs more leaves.

5. More leaf growth equals more food and more Auxin.

6. Auxin will encourage root growth which will produce more Cytokinins and water which will strengthen the pathways. The leaves should be able to increase an excess of food thus allowing the branch to thicken.

7. Auxin hides from sunlight.

So, the key is to generate strong growth on the weak limb. If the limb is shaded from the sun, it is not producing enough food for the limb to grow. Remember that secondary growth, (diameter), is the tree’s last priority for the allocation of food. The pathway on this limb and its roots may be getting weaker each season.

1. The first thing will be to cut off or bend the limb that is shading the weak limb out of the way. At this point the weak limb needs all the sun it can get.

2. For deciduous trees let the weak limb grow wild until the diameter is close to the size you need. The limb may need to approach 5’ to 8’ in length.

3. When you are convinced that the limb is the right size, is currently healthy and the tree is well-fed cut the limb back to about two or three buds near the trunk. Each time the limb grows 5 or 7 new buds, cut it back leaving two of the new buds. This technique develops taper and movement in your limb. Continue this growing and cutting back until the limb is the correct length for your tree. A method of speeding up the development of the limb if this tree is in a early developmental stage is to cut back most of your other limbs so that they don’t compete too strongly with the weak limb. In the case of pines, remember your “back budding” lesson in Dilemma One. Again you want to let the limb grow wild until it reaches the correct size.

But now you must work this long limb back a little at a time by “back budding”. You want to try and force latent buds to break in order to get more branching for more needles closer to the trunk. If the limb is bent low, there is probably very little Auxin on the top of the branch, due to the increased sunlight. Now there is a good chance that some latent buds will break. You increased this probability when you removed the affects of the Auxin produced by cutting the apical tip. If you get some buds to break on the bare part of the limb, you need to create many fine branches on them in order to produce more food to strengthen the limb then cut the apical tip again.

Repeat until the limb is the correct length. Do not attempt to back bud more than once a year. During this process keep the tree well-fed and watered. How far back you can cut a pine limb when your back budding depends on how young and vigorous the tree is. You must exercise caution when dealing with an older pine. Seek out the advice of a more experienced club member.

The chance of any buds breaking on old wood is always problematic. If you do get breakage, the process of thickening the limb is long-term. This depends of course on just how much smaller the branch is compared to the others you are saving as permanent limbs.

**NOW: A WALK ON THE WILD SIDE**

You may wish try a couple of advanced and rather unorthodox ideas for Dilemma Seven.

To increase the probabilities of getting buds to break, you may want to try a “Bud Notching” approach. Growers of orchards that produce fruit, citrus, nuts and grapes need to develop as many branches on their trees as possible. Using their understanding of the suppressing powers of Auxin, they have developed a technique called bud notching.
The following technique may be considered somewhat controversial. You will use the same scoring cut as you did above. However, this time instead of making your cuts off center, you cut straight across the top of the branch. The scoring technique you employed before will produce branching a little on either side of the limb. With this technique you are trying to get a bud break on the very top of the limb. A bud growing right from the top of a limb is called a “Water Sprout.” Water sprouts are considered bad news and almost any literature you read will tell you to get rid of them immediately. Water sprouts grow on limbs. If they grow on the lower part of the trunk or from a root, they are called suckers.

**A REVIEW OF INFORMATION**

1. Limbs that grow straight up vertically are high energy limbs.
2. Because of their high Auxin flow they quickly produce strong pathways and roots; therefore grow quickly.
3. Because they are strong growers they consume a lot of resources.
4. They rapidly increase the diameter of the limb that supports them.
5. The high energy limbs shown on the branches in red are called “water sprouts.” The lower on the trunk and roots are called “suckers.”

The rate of success in getting buds to break has been as high as 70%. A few Bonsai practitioners in the Fort Walton Beach Bonsai Club have used a variance of that notching technique, called “Scoring” with good success. Remember, notching carries no guarantees, but you will increase the probabilities of buds breaking.

The intention is to try and make all these so-called negatives work for us in a positive manner. As you have already learned any strong growing limb must create a strong pathway to keep it nourished.

Increasing the strength of the pathway increases the food and diameter of the trunk and/or limb to which the water sprout is attached. This is exactly what this limb needs.

**WARNING:** Water sprouts, because of their vertical orientation, grow very quickly as do the limb to which they are attached. You must watch the sprout very carefully; as the limb to which it is attached approaches the size you need remove the sprout immediately. The limb will become oversize if the “water sprout” is left on too long. Depending on how large an increase you need in the limb, the sprout may well do its job in less than one growing season.

You should also keep a close eye of the portion of the limb beyond the water sprout. If the end of that limb seems to weaken (this is rare), remove the water sprout immediately and try the process again next season when the end of the limb has recovered its strength with good feeding and sunlight.
DILEMMA EIGHT

Q: The people in my club constantly talk about taper. None of the plants that I’ve seen in the nurseries have any taper. Where do I get a plant with taper?

A: The answer to this would fill several articles. Unless you buy a plant from a Bonsai nursery you most likely will not find any plants with taper. Most Bonsai practitioners normally buy a plant from a local nursery or grow one from seed and then develop the taper over several years. It is a matter of growing the lower trunk of the tree to the size you want, then chop off the top of the tree at the desired height, adding a little height for die back. The desired height for this first section of trunk should be one-third of the total planned height of your finished tree, plus a little more for die back. That’s right, you must plan ahead. Also this will be the site of your first lower branch; if you are lucky enough to have one of the new sprouts break there. For correct branch placement see “The Rules of Bonsai” in the next issue of Florida Bonsai.

Remember that the first thing you do when you get a new tree is to decide the front of the tree, then how tall you’re going to make the finished tree. Remember in Dilemma Two this technique of cutting off the top of the tree was identified as a “trunk chop.” Once the chop has been made, you let a new leader grow until the trunk of the new section is the size you want and then chop it again. The new section of trunk should, of course, be smaller than the first section; thus creating taper. Chop again. When the trunk of the third section reaches the size you want, you cut the last leader off to the height you had planned for tree, plus a little for die back. The two new sections you have created should be progressively smaller in diameter as they go from bottom to top. This is how you create taper. Because the new leading sprout will break from the one side of the old section of trunk, it will be growing offset from the old section, thereby creating what is called movement, or curvature, in the trunk. Normally two “trunk chops” will do the job. That gives you three sections but the number of chops is arbitrary. It depends on what you are trying to achieve. This is a very general answer. You need to reference an article devoted to “trunk chop.” Generally speaking you have already learned about the hormone action and growth cycles of a “trunk chop” in Dilemma One. The chop is normally done at the beginning of spring growing season. This will give you the full benefit of its strongest growth period.

Normally, you grow a tree to be trunk chopped in the ground or in a five gallon container and let it escape. Escape in this case means to let the roots grow out of the drain holes of the pot and go into the ground. This is almost as good as planting the tree directly in the ground. The advantage of being able to control the surface rootage in the container.

You must continue to water and fertilize from the top of the container even though the lower roots are in the ground. For a step-by-step illustration of a trunk chop see the article in the next issue of Florida Bonsai. Not all trees respond to a “trunk chop” with the same results. Before performing a “trunk chop” seek the advice of a more experienced club members.

DILEMMA NINE

Q: Everyone in my club is talking about pinching candles on their pines. I not sure I understand the importance of this.

A: There are a number of reasons to pinch candles, so I’ll break it down into different parts.

PART 1: The reason to pinch. In deciduous trees such as Maples, Elms, Bald Cypress, Oaks etc., the length of a branch, or even the creation of a branch, can be accomplished by pruning. Sometimes all the branches on such deciduous tree may be pruned off in hopes that the new ones will sprout in a more desirable position. This cannot be done with Pine trees. To get all the branches on a Pine in the proper place and the proper length, the branching is best developed from the time that the tree is a seedling. Even if you have limb in a desirable position the length and density of the limb must be controlled. The Pine will try to keep growing from the tip; this must be stopped.

Additionally you want to encourage many small branches, not just a few longer ones back down the branch. Creating many small branches on a limb as you recall is called “ramification.” To start the pinching process, allow the candle to grow five of six inches in the spring. Remember this type of growth creates a strong Auxin signal and the health and vigor of the pathway is maintained or increased. Next step in the process, you pinch the candles off at the base. Later new buds will develop at the base where you pinched off the candle.

Generally there will be four new buds. You keep two of the buds; one on each side of the branch. You eliminate the buds that are oriented front and back, unless you want the limb to grow longer. If you want the limb to grow longer, then the forward facing bud should also be left on. If you have left only the two side buds you now have created two new lateral branches on the original branch; each growing in opposite lateral directions. You do this to each of the new branches every growing season until you have created a wide pad of small branches across the limb. This normally involves the lower and middle limbs. See page 31 for example. Notice how the branches take the form of a triangle. A large number of small twigs cover the limb.
to create pads of greenery. These will become denser over time.

Therefore the control of growth and direction, and the density of branches on a Pine, is accomplished by candle pinching, not pruning. The one exception is “back budding,” which you covered in Dilemma One. Please read articles devoted to the pinching of pine candles because there are timing considerations that are beyond the scope of this article.

PART 2: Introduction to the equalization of energy levels across the entire Pine tree. By timing the candle pinching on different parts of the tree, you can control the energy levels. Currently there are three models employed. One is a vertical model and the other a horizontal model. The third concentrates on the vertical orientation of each individual branch. In the wild, Pines usually grow with their middle and lower limbs bent low. The literature that describes energizing the tree uses the following vertical model. Remember high energy levels equal strong growth levels. It is growth that increases the size of the individual “path way,” which in turn increases the energy level of the branch.

This illustration (Fig. 9) divides the tree into three vertical sections. It refers to the top third of the tree (Blue) as the high energy section. The middle third (Yellow) is a medium level and the lower third (Red) is a low energy section. This is a fairly useful model to follow because of the way we grow limbs on our trees. We normally bend the limbs on pines lower and lower as we go down the tree, thus lowering their energy. Remember the lower a branch is bent the lower it’s energy.

The literature also describes energizing the tree using a horizontal model on the individual limbs. Instead of just going up and down the tree vertically, this model also looks at each branch horizontally from the apical tip of the branch back to the trunk. Notice that the two branches closest to the trunk have low high-energy levels. This is because branches close to the truck are considered low-energy branches. You should take both models into consideration when deciding which candles to pinch and when.

Both models approach the tree or the branch in sections. The vertical model describes the tree as being strong at the top and declines in strength as you come down the tree in thirds. The horizontal model describes the branch as being strong at the tip and declines in strength as you approach the trunk. Both of these models no doubt were developed from observing how pines, as well as other trees, grow.

However, useful the vertical and the horizontal models may be, we will ignore them for the moment and consider the information that you have learned above which will give you a good review of what is going on inside the tree, as well as adding another tool to your bag of knowledge.

First, it is not the vertical section of the tree that defines the strength of a limb or branch. As you learned earlier, it is the orientation of the limb to the trunk or the branch to the limb. The more vertical the orientation of a limb or branch the higher its energy level will be; no matter the where on the tree it is growing. This of course is due to the stronger Auxin flow on vertical limbs. With this rule you can evaluate each limb accurately; no matter where it is located on the tree. It is generally true that the limbs in the top section grow more vertical than limbs in the mid or lower section. This fact makes the vertical model useful. But as usual, there will all ways be exceptions – two glaring examples are the “water spout” and the “sucker.” Water sprouts are likely to grow on any limb that is bent over 60° from vertical. The lower the limb, the more likely a “water spout” may occur, especially if you have cut the apical tip in order to try and “back bud.” Since it is vertical, it will grow out of proportion as will the limb to which it is attached.

A sucker grows from a root at the bottom of the tree or low on the trunk and is usually oriented straight up. Because of its vertical orientation it sucks up a large amount of the tree’s resources and should be eliminated as soon as spotted, unless you want to use it thicken the lower...
section of the trunk. In that case leave it until you are satisfied with the trunk size. However, you should only use this approach if the sucker is very low on the trunk. If you let it grow higher up the trunk, you may create reverse taper or a large bulge. You need to evaluate each limb and branch accurately, to avoid letting some general rule lead you astray. You will probably find yourself using all three approaches.

**SUMMARY**

This has been only a few examples of how you can use your knowledge of “Growth Control Regulators” to predict the outcome of any action you intend to perform on a tree. In all cases, you must keep in mind the current health and condition of the tree, as well as the time of year.

The material provided in this article is general in nature. Each tree, like each human, is different. Through the literature and the members of your local club, you will learn the esoteric difference of various trees and their specific needs, and the dos and don’ts. The material you have just read should provide you with a solid base from which to launch your Bonsai career and/or enable you to ask questions.

The material in this article is not meant to replace current literature or training approaches, but to act as an addition and supplement to the existing information and teaching methods.

**REFERENCES**

1. Crown Pruning Effects on Roots; Dr. Kim D. Coder; Professor Silvics/Ecology; Warnell School of Forest Resources; The University of Georgia; http://warnell.forestry.uga.edu/warnell/service/library/index.php?docID=146
2. How Trees Grow; Dr. William Chaney, Purdue University; http://www.fnr.purdue.edu/inwood/pastissues/howtreesgrow.htm
4. Colorado Master Gardeners Program; Colorado Gardener Certificate Training; Colorado State University Extension; Garden Notes: #145; http://cmg.colostate.edu/gardennotes/145.pdf
5. Plant hormone; Wikipedia, the free encyclopedia; http://en.wikipedia.org/wiki/Plant_hormone
6. Understanding Pruning; Brent Walston; http://www.evergreengardenworks.com/pruning2.htm; Art of Bonsai Project Forum; Profile: Brent Walston by Will Heath; http://www.artofbonsai.org/forum/viewtopic.php?t=483
10. The Living Forest & Anatomy of a Tree; Courtesy of the Arbor Day Foundation; Arbor Day Foundation; http://www.arborday.org/trees/livings/forestlivingforest.cfm
11. Basic Principles of Pruning Woody Plants; The University of Georgia; Cooperative Extension; http://pubs.caes.uga.edu/caespubs/pubcd/8949-W.html
12. Plants; Oracle Foundation; http://library.thinkquest.org/15215/Friend/plants.html
13. Response to Internal and External Signals; Cummings; Copyright © 2002 Pearson Education, Inc., publishing; as Benjamin; http://74.6.239.67/search/cache?ei=UTF-8&p=Auxin+uphill&u=www.dls.ym.edu.tw/lesson/plan3s.pdf&w=Auxin+Auxins+uphill+%22u p+hill%22&d=O7qhXvReRdSZ&icp=1&.intl=us
15. Response to Internal and External Signals; http://74.6.239.67/search/cache?ei=UTF-8&p=Auxin+Auxins+uphill+%22u p+hill%22&d=O7qhXvReRdSZ&icp=1&.intl=us
17. The Principles of Good Bonsai Design; photo; Robert Steven; http://www.artofbonsai.org/feature_articles/designprinciples.php
18. Developing Informal Upright Trunks for Deciduous Bonsai; www.bonsai4me.com; Harry@Bonsai4me.co.uk; http://www.bonsai4me.com/AdvTech/1DevelopingTrunksforbonsai.htm

**EDITOR’S NOTE**: There will be a continuation of this series in the next issue of Florida Bonsai. It will consist of Supplemental Reading selections including: Food, Plant Hormones, Bonsai Containers and Heat, Rules of Bonsai and Creating Bonsai from Using a Trunk Chop. We hope our readers enjoy this series of articles and find them useful and informative.

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