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LET THE CHIPS FALL WHERE THEY MAY

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JOAN HUNTER, *President,* 1956-1957

One of the most important jobs of the teacher is to inspire his students. He must help them to see themselves and their work as a part of a whole picture, to develop a relative sense of values, to develop a sense of humor, to find the area of work for which they are best suited, and to help them develop the necessary foundation skills with which to do their best work. But above all, the student must be so inspired that he becomes willing to spend time and effort working to develop skills necessary to do his work well, not only in the teacher's field of interest but in other fields in which he is involved.

Because my primary interests are in the biological sciences I should like to apply this viewpoint more directly to the teaching of biology.

The longer I teach the more I am convinced that the job of a high-school biology teacher is not only to cultivate a scientist but to develop a person. This does not imply that we should not seek and encourage those with ability and interest to become scientists. It does mean that the boy or girl without this particular inclination should learn to appreciate the work of the scientist and should learn to apply scientific methods to his daily problems. We must help him to see that no matter which occupation he chooses, biology can enrich his life. Because we have potential scientists in our classes, we must teach biology as though all our students were planning a career in science. But since we know that most of our students are not going to be scientists, we must also teach biology as a cultural course.

It is not enough to sit back and say that Mary Jane cannot do very well because of low ability. We must see to it that all the Mary Janes in a class get the most of which they are capable. This is also true of the students of average ability; it isn't enough that they do passing work. They must be encouraged to find their level of ability—not just get along. They should be developing interests and whetting their appetites for knowledge. The above-average students must be encouraged to broaden their horizons, to develop their originality, and to go beyond the work of the class.

This then is the challenge. All students must be inspired to work to their full capacity and to find joy in learning.

Most members of the high-school biology class are sophomores and my remarks will be made with them in mind. What is a high-school sophomore? To me, he is a livewire of 14 or 15 years all wired for sound, who at times thinks the world is his oyster now that he is no longer a freshman and who at other times is very unsure of himself and wants the voiced approbation and support of his parents or teacher. He is a bundle of curiosity and uses the words "how", "why" and "what if" more often than the general populace. He wants to know what is the "biggest", the "smallest", the "fastest", and the "best" of everything. He comes to biology with the idea that the book is always right and leans heavily on it for proof. He is a serious-minded person with high hopes and ambitions. He is a dreamer and a sentimentalist, but he is also very practical.

He wants to take part in everything — sports, music programs, plays, dancing and dating, church work, and academic work. He is a great competitor, downhearted at criticism but willing to try again.

A sophomore is one who wants to please his teachers, although he will try out each of them to see how much he can "get by with". He wants to be liked and will usually work toward gaining the personal interest of his teachers. If he knows that he has their consideration, he will aspire to many things—except putting away equipment he has used to carry on his own investigations! After numerous reminders he may even learn to do this.

But there are many exceptions to this description of a sophomore. There is the boy who has not developed the emotional maturity of most

other sophomores and finds it more fun to plague his teachers than to get his work done. There is the girl whose emotional problems drown her other interests. There are boys and girls who have been promoted socially but have not developed the necessary skills in writing and reading. There are the lonely boys or girls. And, of course, there are the boys and girls who are not capable of doing very much academically. These too, must be taught! And inspired!

Biology teachers have an advantageous position for doing just that. There is already a natural curiosity about living things. Maintaining this interest in the face of the hard work involved in learning new words, facts, and methods is a different story. Relating biology to other fields of study helps maintain this interest and is one method of inspiring students to put a value on all learning.

Most high-school students regard each subject as an entity with no relationship to other subjects. This is not necessarily a fault; rather, it is a natural condition of their years. It is up to the teachers to help the students relate facts learned in one course to problems and ideas arising in another. The teacher must help them gain an appreciation of knowledge so that they may make that knowledge a part of themselves rather than a collection of facts to be laid aside once the final examination is passed.

It is the purpose of this paper to present some examples of these relationships. During one year a teacher is not likely to use all of these illustrations, but they may be used as a storehouse to be brought out when needed. Relating biology to other areas builds a bond between student and teacher and helps the student see a teacher as a person who has other interests besides the one with which the student usually associates him. This personal feeling encourages students to achieve.

Some of these illustrations may better be used elsewhere, as in science club activities, after-class discussions, or in a camping situation.

Care must be taken to use these illustrations judiciously. Otherwise, they may turn out to be instances of the tail wagging the dog. The fact remains that one must teach biological facts and scientific methods first and best. These illustrations are only embellishments for the basic material in most cases. Perhaps this paper should have been entitled "Incidental Teaching in Biology". However, I prefer to think that we can "hew to the line" by teaching the basic concepts of botany and zoology and "let the chips fall where they may" by bringing in incidental materials when and if appropriate.

Biology teachers, no less than other teachers, must encourage good grammar, spelling and composition. It is apparent that many students regard grammar and spelling as subjects rather than as tools. They treat punctuation marks as though they were butterflies and let them alight anywhere. Some have a defeatist attitude toward spelling. They say, "they never could spell", "their mothers had trouble with spelling". They are slow to adopt new forms of speech in everyday conversations. Only as teachers in other areas insist that students use these tools will their use become habit.

Projecting written papers on a screen and subjecting them to class criticism and suggestion is one of the best methods I have used for improving written work. Compliments on success also encourage continued improvement.

Since the ability to tell others your thoughts is important and since there are so many things in biology that students want to tell, cultivation of the ability to speak before a group has a natural place in a biology class.

As far as the spoken grammar is concerned, one has the problem of deciding just how many interruptions a recitation may have without losing its biological value. Certainly, gross errors, such as "he don't", "I seen", and "it ain't" should not go by without comment. I suggest that students organize for better speech. They use co-operative efforts for learning to dance, to play cards, to sing. Why not for better grammar?

Students with spelling and vocabulary difficulties need help and encouragement, rather than constant criticism. Stress should first be put on the importance of learning those words which will be in repeated use instead of on words which are little used. Students with real spelling difficulties have trouble with college preparatory biology because of the many new words involved. Since students with the worst difficulties do not usually go to college, a course designed with fewer scientific terms can satisfy the cultural value of biology for these non-collegiate students. All learning must not be forfeited because a student does not have the ability to spell!

Because it is easier to say things in biology when one knows the proper term, even if the word is a long one, students learn to add to their vocabularies and because so many biological terms are spelled as they sound, students lose some of their fear of long words which they have hitherto avoided. They can be made to realize the fact that longer words are combinations of syllables which actually express a thought, as Echinodermata which means "having a spiny skin" or "a skin like a hedgehog". They can also be taught that it takes just as long to say "Echinodermata" as it does to say "I am going to town" and that the pronunciation of each syllable is as important as the pronunciation of each word in a sentence. Thus students gain confidence and improve in the use of words.

This brings up another "chip" that flies frequently in biology. That is, the derivation of words. There is no better place to convince students that they can make good use of languages, especially Latin and Greek. Vocabulary growth is rapid, once the students grasp the idea that the same syllable from Latin or Greek is used over and over in combinations with other syllables to form English words. Even some of the slower students become fascinated with the organization of words and enjoy building words to use in biology.

The first approach to this can be made in the fall when students are formally introduced to the "ologies" —biology, zoology, herpetology, ornithology, and so on.

The unit on insects is not only one of high interest with which to begin

the course but so many basic things can be taught during its study.An early lesson in observation, note-taking, and classification is a necessary part of this unit. This also offers a good opportunity for word study. After collecting a number of insects one can observe them and find characteristics common to all. Then using the characteristic of jointed appendages, the name of the phylum can be derived. Usually, someone in the class will be able to supply the syllable "ped" meaning foot. Then, upon being asked the name of the disease affecting the joints, they produce the word "arthritis". From these two words the word "Arthropoda" is formed

After the common characteristics are discovered, students are asked to separate the insects into groups according to the kinds of wings which they have. After discussing this grouping, the scientific names of the orders are developed. Students are told that "ptera" is derived from a Greek word meaning "wing" and that we need to add a prefix describing the wing in order to have the scientific name of the group. Some of these they can get when other words with which they are familiar are brought to mind. Orthoptera is associated with orthodontist, Hemiptera with hemisphere, Neuroptera with neurology, etc. It becomes a game and the students are all attention. It doesn't take them long to learn names this way, and it helps the students correlate tool subjects with working subjects. Sometimes this is not as simple as it sounds. In an attempt to get the meaning of the syllable "mono" I once asked a girl what monogamy was. She said she thought it was a kind of wood!

Many fine works of literature necessitate biological interpretation. Quite often the problem is one of ecology as we find in Henry W. Longfellow's "Evangeline". Maps and pictures taken in Acadia show the student the ecology and conservation practice of this land when the following description is read.

"In the Acadian land, on the shores of the Basin of Minas, Distant, secluded, still the little village of Grand Pre Lay in the fruitful valley. Vast meadows stretched to the eastward,
Giving the village its name, and pasture to flocks without number.
Dikes, that the hands of the farmers had raised with labour incessant
Shut out the turbulent tide; but at stated seasons the flood-gates
Opened, and welcomed the sea to wander at will o'er the meadows
West and south there were fields of flax, and orchards and cornfields
Spreading afar and unfenced o'er the plain; and away to the northward
Blomidon rose, and the forests old, and aloft on the mountains
Sea-fogs pitched their tents and mists from the mighty Atlantic
Looked on the happy valley, but ne'er from their station descended.
There in the midst of its farms, reposed the Acadian village."

Sometimes a quotation placed upon the blackboard can be the lead for a discussion. For example, this one from Ralph Waldo Emerson's essay on "Nature" has led to a discussion on conservation. "Only as far as the masters of the world have called in nature to their aid, can they reach the height of magnificence."

Without involving religion, many Biblical references can be explained in biology. The"fiery serpent" mentioned by Moses was probably the guinea worm, a parasitic worm of tropical Africa, Arabia, and India.

As a child, it always seemed an ignominy to me that while Christ was on the Cross and asked for a

drink of water the soldiers not only gave him vinegar to drink but offered it to Him on a sponge. Years later I found that the sponge was a common drinking utensil of the Roman soldier.

Biologically, the whale being a plankton eater could not swallow a man. When this surprising fact is announced, the students immediately ask about Jonah.

The manna of the Israelites is a lichen which grows in Northern Africa and western Asia. A strong wind sometimes loosens the lichen and pieces of it are blown about. When ground it makes a fine flour for bread.

Mathematics seems to be very difficult for a large number of students. Any applications of this subject would certainly make students realize the importance of studying it. The arrangement of buds on a branch, the spirals on the shell of a snail, and the spirals of an unfolding fern frond are good examples of the golden mean. Checking the speed of a bird by using trigonometry and the placing of biological data obtained by experimentation into graphs and tables are other uses of mathematics. Many mathematical terms such as symmetry, radial, tangential, and concentric are used directly in biology. The way a student's eyes light with previous knowledge when mention is made of tangential cuts of wood is one of the pleasurable moments of teaching.

Many students enjoy studying history. The development of the civilizations of the world has depended upon the biological resources of an area. Primitive man roamed the forests subsisting on the plants and animals which he found there. His food consisted of small game, fish, fleshy fruits, nuts and herbs. What little clothing and shelter he had were skins, plaited grasses, and bark. He used shells and ivory for ornamenting them. As man domesticated animals he took up herding. Later he learned the function of a seed and began to farm. The more kinds of crops he domesticated the more kinds of animals he could domesticate and put to his use.

The changes in the centers of civilization in more modern times are directly connected with conservation of natural resources, particularly those of the soil. China, at one time an important center of culture, lost its place when its overused lands failed to support its people. In an attempt to overcome the low crop production, human wastes are used on the fields and thus parasitic worms are spread among the people who walk barefoot in the rice paddies planting their rice. Disease and lack of proper food are thus contributing to China's economic status.

In Greece and Italy the same overuse of land can be witnessed. Will the United States take the same road? Students need to be made aware of the long-range effects of poor conservation.

The settlement of various parts of the world was brought about partly by the differences in the flora and fauna of certain regions. Our own country was discovered in the European's search for spices which he could not grow at home. Canada was opened up by the presence of large quantities of codfish. The search for furs helped to open up the West.

The paths taken by animals to salt

licks were the origins of many important roads built upon the advent of the white men. Even some of our present highways follow these old trails.

The course of history might have been changed if it had not been for the malaria-carrying mosquito found in the Panama Canal Zone and for General Gorgas and his experimental studies of the disease.

History is also found in the study of genetics. An example of this is the story of hemophilia in the royal families of Europe. Queen Victoria, who apparently was a mutant for the trait, introduced the disease into the royal family. By marriage it spread to the Russian and Spanish royal families. A granddaughter, who was also a carrier, married Nicholas II, Czar of the Russians and became the mother of a hemophilic son. The mad monk, Rasputin, was called in to cure the child and thus worked himself into the most powerful position in Russia and probably touched off the Russian Revolution of 1917. A daughter of Queen Victoria married Alfonso XIII of Spain. They had five sons, four of whom were hemophiliacs. This probably played an important part in the overthrow of the Spanish throne.

An understanding and appreciation of the peoples of the world can be furthered by introducing biology students to some of the different eating habits of people whose differences exist because of their environment. Students squirm when told that insect eggs and larvae are considered delicacies in some parts of the world and that seaweed, jellyfish, squid, and octopus are eaten by many people who live near the sea. The story of the American visiting in the Orient clearly illustrates the fact that although people's customs differ from our own they are not necessarily more peculiar than our own. This American asked a Chinaman, "How does it happen that you put food beside your people when you bury them? They can't eat after they are dead." The reply came quickly, "No, but dead people can't smell flowers either."

Appreciation of people can also be brought about by the study of men of science. The variety of nationalities involved shows that no one nation has a monopoly on intelligence. The importance of international exchange of scientific information can also be stressed.

Students must realize that knowledge grows upon knowledge and discoveries do not usually come overnight. The contributions of ancient peoples cannot be overlooked. Three thousand years ago the Hindus used *Rauwolfia* to treat fever and snakebite. It was later used to treat insanity and the people of India even gave it in small doses to their children to put them to sleep. Ghandi used it during his periods of passive resistance. Medical men of more enlightened countries are just beginning to appreciate the knowledge of these earlier people and have begun to study *Rauwolfia* and other herb medicines.

Students must not feel that all the exciting discoveries were made before they were born. Let them compare the romance of the conquest of polio with that of smallpox. The two and in results which may eventually followed, in prejudices to overcome, are almost identical in procedures

be the same. The part today's students are playing in the fight against polio is just as romantic as the part played by the people of Edward Jenner's day. Our teenagers, too, are a part of history although their names will not appear in print!

There is much psychology which can be taught through through biology. Using insects as an example, one can show how the actions of a few can influence the reputation of the group. This applies directly to the actions of high-school students who are often under fire by some adults.

The degeneration of tapeworms because of their parasitic habits can be likened to the parasitic habits of some human beings.

Theoretically, the study of courtship behavior among birds can be compared to the students' own reactions. A brief discussion helps them to view some of their emotions and awkward reactions in a somewhat objective and humorous light for a greater understanding of themselves. The mature, biological approach to the problem helps guide them toward emotional maturity.

The need for making decisions and for telling the truth is important for good mental health. Both are important parts of any science course. The need to develop self-confidence is important. To timid students I quote James B. Conant, "Behold the turtle. He makes progress only when he sticks his neck out."

Music and art make use of biological materials. Without tools, natural objects became important in making early musical instruments. One of the earliest was made of a tortoise shell with four strings. Another was a gourd with bamboo tubes of different lengths. Reeds of varying lengths made the pipes of Pan which, according to legend, he called a syrinx after his lost sweetheart. Today we call the voice box of a bird a syrinx.

Students are interested in the many materials used in making musical instruments today and in discovering why certain materials are preferred to others. For instance, they are interested in finding out why horse hairs are used in violin bows and why spruce wood is preferred to oak for making sounding boards for pianos.

Biology played a part in the artistic appearance of early instruments for many of them were shaped like animals. The early zither, for example, was shaped like a crocodile.

Natural music is found in the trees as the wind passes through the leaves. Landscape architects sometimes express the idea that evergreen plantings give a more relaxing effect than do the hardwoods with their rustling leaves.

In such musical compositions as "Autumn Leaves" and "Flight of the Bumblebee" natural sounds have been imaginatively put into musical form. I have never heard an orchestral arrangement of the frogs in a pond. Perhaps someday one of the music majors who has listened to the recordings of frogs' voices in a biology class will be inspired to put the piccolo-voices of the spring peepers, the bass viol-voices of the bullfrogs, and the brass-voices of the leopard frogs into a musical composition complete with all the antiphonal effects one hears at a frog pond.

When students have difficulty

remembering the scientific names of the animal phyla I often wonder why someone doesn't set the list to music. Teenagers often learn monosyllabic, nonsensical sounds when they are set to music. Why not scientific syllables?

One of my students a few years ago had difficulty remembering the relative positions of the xylem and the phloem tissues in stems. One day she volunteered the information that she now sang "phloem on the outside; xylem on the inside" instead of the popular song version "laughing on the outside; crying on the inside."

To some this may seem trite, but I believe flights of fancy keep the students' imaginations alive and unfettered until they mature and can be put to practical use in a creative way.

Because plants and animals were, and are, so closely associated with the lives of people, many designs of plants and animals are found in baskets, pottery, woven mats and jewelry. From some of this natural history, art knowledge of ancient peoples has been obtained, as witness the hunting scenes found in caves, the animals woven into the Eskimo baskets, and the plants of the Incas painted on their pottery.

The artistic use of natural materials such as the use of plants and animals in making dyes is of interest. Birch baskets embroidered with porcupine quills or trimmed with sweet grass elicit admiration and curiosity.

Perhaps the rarest and most unusual natural object used as an art medium is the web of a spider or caterpillar. Paintings were done on these webs in a Tyrolean valley more than 200 years ago. The thicker, fall web was cleaned and stretched across a piece of cardboard and was sometimes sized with milk diluted in water. A miniature technique was used and parts of the web were left unpainted to show the unusual fabric. As far as I know this is a lost art. Could an art student be inspired through biology to revive it?

The relation of biology to other fields might be extended to the use of biological objects as symbols in the religions of the world, in furniture and cloth designs, popular expressions, stamp and coin collections, and no doubt, in many others.

For my final point I should like to say that even the comics and cartoons come to biology class. Occasionally I have found cartoons which illustrate some biological principle. These I keep and often use on an examination with the instruction "explain what is wrong" or the question "what biological principle is involved here?" For example, I have one showing a little boy looking at a row of beans which have just sprouted. His comment is, "Look, Mommy, all the beans have come unplanted."

I have one showing Nancy, of the comic strip of the same name, tying the long ropes of a swing to the low branch of a very small sapling. An empty bottle of fertilizer lies on the ground beside her. My question is "Why is Nancy going to be disappointed?"

A cartoon which I enjoy using on the bulletin board just for the humor involved is a picture of two caterpillars crawling along the ground. Overhead is a butterfly. The legend shows one caterpillar

saying to the other, "You won't catch me up in one of those things".

In all the areas touched upon in this paper many more examples could be given. I have related a few and have tried to show that a biology class can offer inspiration to all students whether they are interested in music, literature, art, history, semantics, religion, sociology, psychology, or science. It can be a place to whet the appetites for knowledge and to keep the creative imaginations alive, if teachers will take the time to let a few chips fall where they may while they hew to the line of basic scientific training.