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**THE LINK BETWEEN APPLIED AND BASIC RESEARCH**

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"But how useful is your research? Will it really benefit someone or something?" These are

appropriate and important questions to ask and they deserve to be answered.

Such questions, however, presume that all research should have a specific benefit. Taking the process a step further, this reasoning implies that all research should be applied, in some way.

Before deciding that we have

taken an appropriate direction in our analysis, let's define both applied and basic research.

Applied research is intended to solve a specific problem or produce a specific benefit. Basic research, on the other hand, does neither. Basic research is done for the same reason a person climbs a mountain — because it is there. In other words, basic research offers the challenge to answer questions no one ever could solve before.

So what good is basic research other than to satisfy the people who do it? It has a very important role: to provide a foundation for applied research. I would like to support that view with one of my favorite examples.

There is a protein, found in many cells, called carbonic anhydrase. This protein solely functions to hold a molecule of water and a molecule of carbon dioxide (CO<sub>2</sub>) close together in the correct orien-

tion so that the two substances can be combined rapidly. The result is formation of carbonic acid. Proteins which catalyze reactions, such as this one, are called enzymes. The enzyme, carbonic anhydrase, is shaped like "pac-man," resembling the video game cursor-control character that "eats up" opponents. It is round and has a uniquely shaped mouth into which water and CO<sub>2</sub> fit perfectly.

Carbonic anhydrase is utilized in the body in a number of clever ways. Red blood cells employ this enzyme to assist in moving CO<sub>2</sub> from respiring cells, such as muscle cells which produce a great deal of CO<sub>2</sub>, to the lungs where CO<sub>2</sub> is released. In other cells, such as stomach lining cells and bone resorbing cells, carbonic anhydrase is oriented in such a way that the acid produced is combined with chloride and is secreted as hydrochloric acid.

Some cells, such as those that form saliva (or spit), secrete the acid produced into the bloodstream, where it is readily neutralized, allowing salivary cells to secrete a slightly basic solution.

How did we come to know all this about carbonic anhydrase? It began with basic research done during World War II in order to develop a substitute for blood to help save soldiers lives. Reasonably good blood substitutes were eventually developed and the basic information acquired also provided a basis for pharmaceutical

companies to develop drugs to treat ulcers, glaucoma, and osteoporosis by finding ways to target carbonic anhydrase.

Does understanding carbonic anhydrase help the poultry industry? Yes, indeed. One important way is in the area of egg production. It is by the action of carbonic anhydrase that CO<sub>2</sub> in the form of bicarbonate arrives in the shell gland to form calcium carbonate, the porcelain-like material which comprises 98 percent of the eggshell. If the action of carbonic anhydrase is inhibited, for example, by a contaminant in water or feed, eggs encased only by shell membrane will be laid and the hen will go out of production in about six days.

Not all basic research can or should be expected to lead to an application. But when economics improve as a result of a particular new application that has resulted from basic research, some dollars can be channeled back to support more basic studies.

A small fraction of taxes are used to support basic research. Let me say "thank you" to the tax-paying public and also to the part of the private sector that supports basic research.

Doing basic research is a wonderful adventure for those of us who are involved in it. I hope I've provided some insight into how basic and applied research are linked — that one often fosters the other.

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