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EGGSHELL FORMATION IS A DYNAMIC AND SENSITIVE PROCESS

Carol V. Gay, Ph.D.
Avian Physiology
Professor of
Molecular and
Cell Biology
And Poultry Science
Penn State

Fred D. Gay, M.S.
Agricultural Engineering
Penn State Alumnus

An eggshell consists primarily of calcium carbonate. The manner by which calcium arrives at the eggshell was described in an earlier article (*Lancaster Farming*, May 14, 1994).

To review briefly, calcium is derived from food, is absorbed by the intestine, and is passed into the bloodstream. As blood passes through the shell gland, calcium leaves the blood, moves into and through the shell gland tissue, and precipitates onto the surface of the egg. Calcium is a positively charged ion and consequently precipitates out of solution when it interacts with appropriate negatively charged ions, such as carbonate.

Where does the carbonate ion come from? The short answer is from carbon dioxide, a metabolic waste product derived from the

breakdown of glucose. Carbon dioxide is produced by all tissues and is expelled from the body mainly through exchange for oxygen in the lungs. The shell gland utilizes carbon dioxide produced by its own metabolism as well as by using CO₂ present in the bloodstream for making an eggshell. The conversion of CO₂ into carbonate requires combining CO₂ with water (H₂O). This results in the formation of carbonic acid (H₂CO₃). Carbonic acid spontaneously breaks down or dissociates in two steps to form two hydrogen ions (H⁺) and a carbonate ion (CO₃⁼). When the latter structure combines with a calcium ion (Ca⁺⁺), the ions precipitate out of solution.

Crystalline calcium carbonate is quite insoluble in water even though it precipitated out of an aqueous solution. It is relatively inert chemically because of the plus and minus charges balancing each other electrically in a dynamic equilibrium. About 100 million CO₃⁼ ions fitted end to end would be an inch long and Ca⁺⁺ ions are of a comparable size. The many replications of the CaCO₃ crystal structures interlock with each other in a three dimensional lattice-work called aragonite to form the eggshell. The chemical composition and crystal structure of the eggshell is similar to high quality limestone or high purity neat hydrated Portland cement. This gives a suggestion of how an eggs-

hell can be such strong material, especially when in compression.

Carbonic acid forms whenever CO₂ and water are present. However, in the shell gland the spontaneous conversion of CO₂ into carbonic acid and subsequently into carbonate ions is not fast enough to support daily eggshell formation. This problem is solved by the presence of an enzyme in shell gland, carbonic anhydrase, which catalyzes (speeds the process without itself being consumed) carbonate formation. This catalytic material is a protein that is also found in many body tissues. It assists in the formation of carbonate-rich fluid in the chambers in the eye; it helps foster gas exchange in the lungs and the kidneys to form urine, to mention a few of the many roles of carbonic anhydrase.

When carbonic anhydrase is inhibited, different tissues are affected in different ways. Pressure build up in eyes during glaucoma can be relieved by inhibiting carbonic anhydrase. On the other hand, carbonic anhydrase inhibition causes the breathing rate to increase and causes the kidneys to form a watery urine. In the shell gland, inhibition of carbonic anhydrase causes a marked and rapid cessation of eggshell formation. Consequently, the hens' body must have an elaborate control mechanism to regulate metabolic CO₂ and resultant CO₃⁼ so that sufficient quantities are available for timely eggshell formation.

Various chemicals can affect carbonic anhydrase adversely. A relevant example is the problem that fish-eating birds had before the banning of DDT, which was relatively stable and therefore persistent in the environment. DDT was washed from the land into bodies of water where it entered fat stores in fish. Birds eating fish, such as ospreys and bald eagles, received high doses of DDT. Eggshell formation and subsequent development of the offspring was

gravely impaired because of the inhibitory effect of DDT on carbonic anhydrase.

A final point concerns the importance of body levels of CO₂ for good eggshell formation. Birds maintain body temperature, not by

sweating, but by panting. During bouts of hot weather or other types of heat stress panting rates can be high enough to cause a reduction in total body CO₂ to a level that results in thin-shelled eggs.

United Soybean Board Selects CEO

ST. LOUIS, Mo. — John Becherer has been selected as the new chief executive officer by the 63-member United Soybean Board (USB). Becherer serves as the senior director for development and programs at the Conservation Technology Information Center (CTIC), West Lafayette, Ind. He will begin his duties on October 1.

The all-farmer board selected Becherer by unanimously approving a recommendation from their search and executive committees at their quarterly meeting. "John is a consensus builder who can help unify the industry," said USB Chairman and Fulton, Mich. farmer Barry Mumby. "John will work to more closely involve states with USB activities and programs. We want to assure state organizations that there's a two-way street at USB and that we look forward to their participation in USB projects. John's history as a consensus builder will be instrumental in that effort."

Becherer views his new position as an opportunity to continue his career-long crusade to help

farmers farm more profitably. "I want to help make soybeans as profitable as they can be," said Becherer. "I look forward to working with an organization that promotes the profitability of agriculture producers."

Prior to working for CTIC, Becherer worked as a consultant for Demeter Inc., the nation's 10th largest grain merchandising firm. The position helped Becherer develop an international view of the challenges that face soybean growers. "We don't live in a microcosm. We're in a global economy," said Becherer. "To make soybeans profitable, we must continue to research for new uses of soybeans and expand export markets."

Becherer looks forward to a smooth transition into the CEO slot at USB. "I don't anticipate any rapid change," he said. "USB is in a situation where they're moving forward in a positive and appropriate manner. I think soybean farmers will recognize USB as an organization that truly meets the needs of the farming community. I invite input from all soybean farmers in that regard."

Youth Production Class Set For Barrows

HARRISBURG (DAUPHIN CO.) — The Keystone Interna-

tional Livestock Exposition will be held October 6-10 here at the Farm Show Complex.

Exhibitors from Pennsylvania can enter one or two pigs in a barrows class, plus other animals that would be entered in the regular junior barrow show.

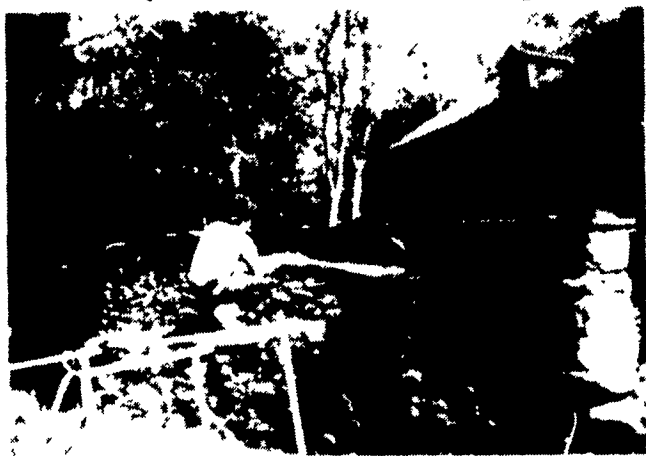
In June the pigs were weighed and identified at the farm. Now they have been brought to the exposition for final evaluation.

Pigs will be judged on-foot, but they will also be judged on the basis of weight gain and carcass merit. This will reward junior exhibitors not only for good genetics, but sound swine management as well.

To date, approximately 43 animals have been entered in this class, representing about 28 Pennsylvania youth. All pigs weighed in June had to be less than 50 pounds.

Premiums in this class are \$500 for the champion and \$250 for the reserve. The primary purpose of this class is to tell how much muscle an animal puts on each day, thus giving breeders more information on feed conversions and feed efficiencies.

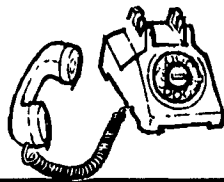
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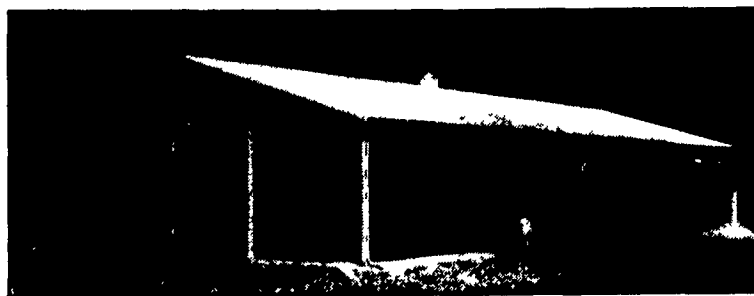
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