

W.O. Atwater:



The energetic values “4”, “4”, and “9” calories/gram, (respectively for carbohydrates, protein, and fat) were derived by W.O. Atwater over the course of more than a decade of calorimetric experiments conducted through the 1890's. These values, seen today on a Nutrition Facts Label, were once called **Atwater General Factors**.

The U.S. Congress funded Atwater's calorimetry work – under his provision as Special Agent of The U.S. Department of Agriculture and head of Nutritional Investigations - from 1894 to 1903.

Americans Read the Word Calorie for the First Time!

Americans Read the Word 'Calorie' for the First Time

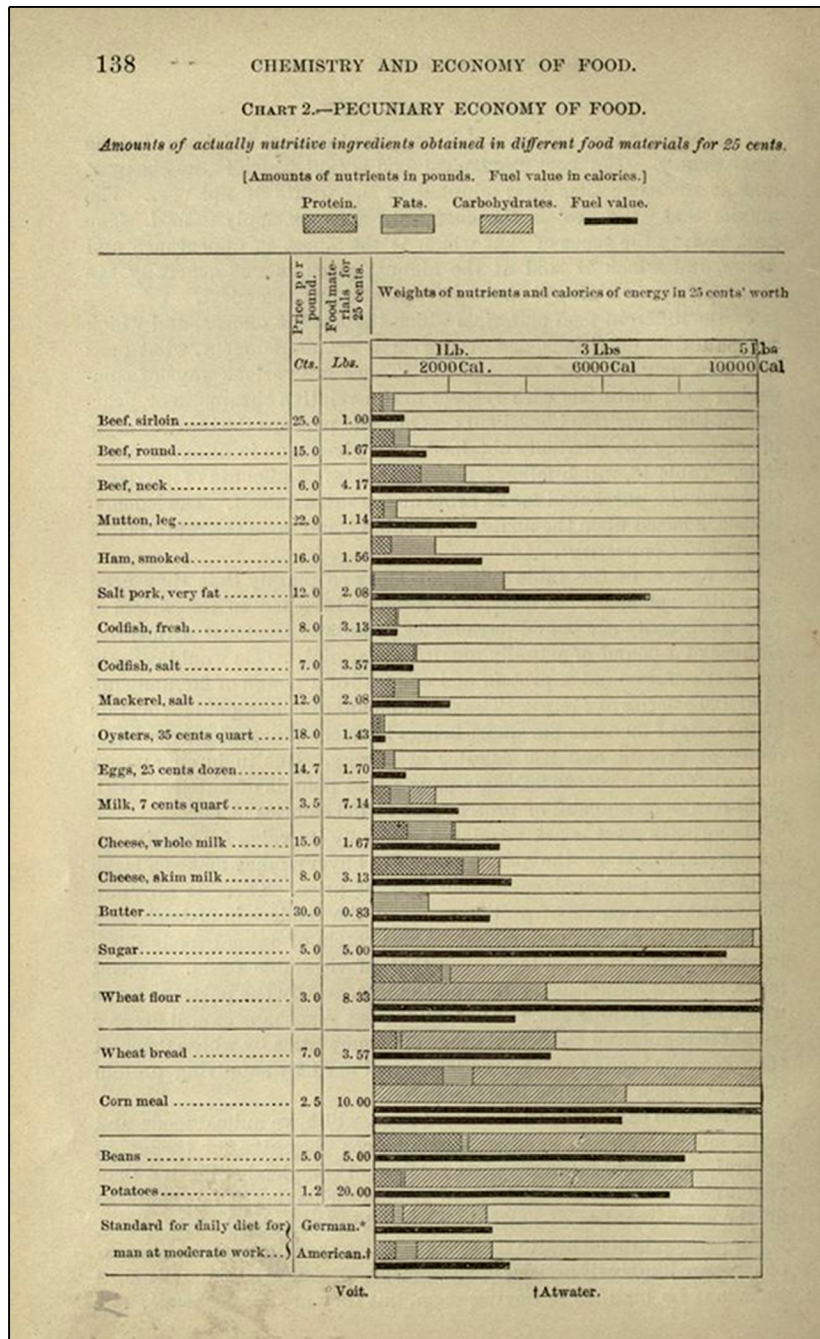
The Calorie, which is the unit commonly employed in these calculations, is the amount of heat which would raise the temperature of a kilogram of water one degree centigrade (or a pound of water 4 degrees Fahrenheit). Instead of this unit of heat we may use a unit of mechanical energy, for instance the foot-ton, which is the force that would lift one ton one foot. One Calorie nearly corresponds to 1.53 foot-tons.

POTENTIAL ENERGY IN NUTRIENTS OF FOOD.		
	Calories.	Foot-tons.
In one gram of protein.....	4.1	6.3
In one gram of fats.....	9.3	14.2
In one gram of carbohydrates.....	4.1	6.3

This excerpt - from a popular magazine called New Century, introduced the word 'calorie' and their respective values to the American public for the first time. Published 1887.

Atwater was paid \$7,500 (in today's money) for each single article, (in a series of five articles) named "The Chemistry of Food and Nutrition" He was perhaps the most famous scientist in the U.S. during the late 1800's. *For a time his name was synonymous with the word calorie!*

Page from Atwater's Book: 1895



Atwater was considered the driving force to persuade the U.S. government to establish an Agricultural Experimental Station (AES) in each state; he was made Director of these stations. In 1887, The Hatch Act provided \$15,000 for each station.

By 1906, over 7,600 foods had been analyzed for their chemical composition, as well as their energetic content.

Notice in the graph to the left - Atwater assigned a "Bang for the Buck" value for each food. Thus, we can see how economics were already interweaved in terms of the production of food, and the cost of consumption for the 'common man'.

When alcohol was found to supply energy for the human body (7 cal/g), Atwater received harsh criticism!

Atwater avoided answering politically charged questions, preferring to engage in just the science of human metabolism and nutrition.

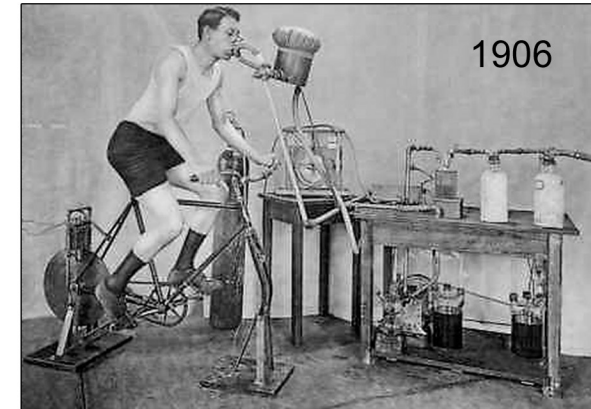
He knew the next challenge would be figuring out how the human body burns the energy in food, relative to work performed.

Thus, around 1904, Atwater was provided with tens of thousands of dollars to design and conduct the most expensive scientific investigation (privately financed) in the history of United States, at the time.

The Carnegie Institute provide the cash.

The Roots of Integrative Nutrition and Wholistic Principles Originate from Measuring the Transformation of Matter and Energy Within Energetic Systems.

A man on one of the World's First Bike Ergometers.

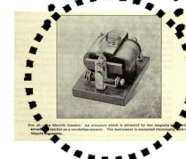


The man on this bike (or possibly a different man) ate, slept, and "worked out" on this bike ergometer which was placed inside the sealed respiration chamber in an environmentally controlled laboratory room, seen below. His ratio of oxygen inspired to the ratio of carbon dioxide expired was measured. This in turn reveals - to a very exact degree - the percentage of fat and carbohydrate your body burns at various work rates.

Copper Disk Wheel of Bike Ergometer Rotates in a Magnetic Field to Measure Power Output



FIG. 4.—The Bicycle Ergometer. The rear wheel of a bicycle is replaced by a copper disk which can rotate in the field of a magnet. The strength of the magnet can be varied by the quantity of electricity passing through the field coils. The principle is that of the electric brake.



Conducting these experiments were extremely expensive. They required the precise unification of several branches of physics and the design of many machines and instruments.

This feat – considering the time period – is considered by some, to rival the effort of putting a man on the moon.

The armature wasn't just a brake - it measured the power output produced by the man. The heat loss due to the resistance of the wire was also accounted for in terms of energy lost!

The Laboratory: Bike is Inside a Sealed Chamber



FIG. 4.—Laboratory Room. View from east side. Rear of Respiration Chamber showing Food Apertures, Absorbing System and Pass at right.

Credit must be given to the Physicist, Edward Bennett Rosa - who understood the science of energy transformation, and made it possible to 'account' for and measure practically all the "energy in and the energy out". These men left no stones unturned - even gravitational force due to the lab's position on Earth was considered!

Bike Ergometer Inside Sealed Chamber

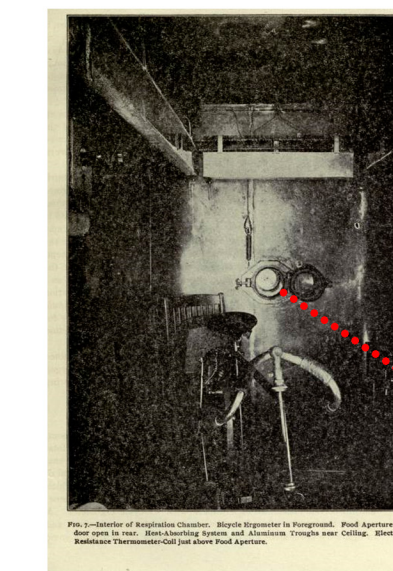
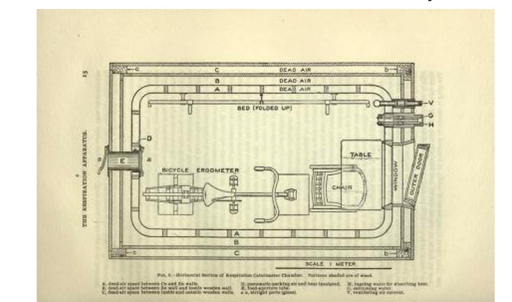


FIG. 5.—Interior of Respiration Chamber. Bicycle Ergometer in Foreground. Food Apertures with four apertures in rear. Non-absorbing system and Absorbent Traps near Ceiling. Absorbent Reservoir Transmitter-Cell just above Food Apertures.

Schematic of bike inside the respiration chamber



Aperture through which man was fed during the experiment. He slept in a bunk bed that was folded up against the wall, like in a train car.

Unfortunately, Atwater was severely incapacitated by a stroke at the beginning of these experiments. His colleague, Francis Benedict completed these experiments, and continued researching metabolism for 30 more years.