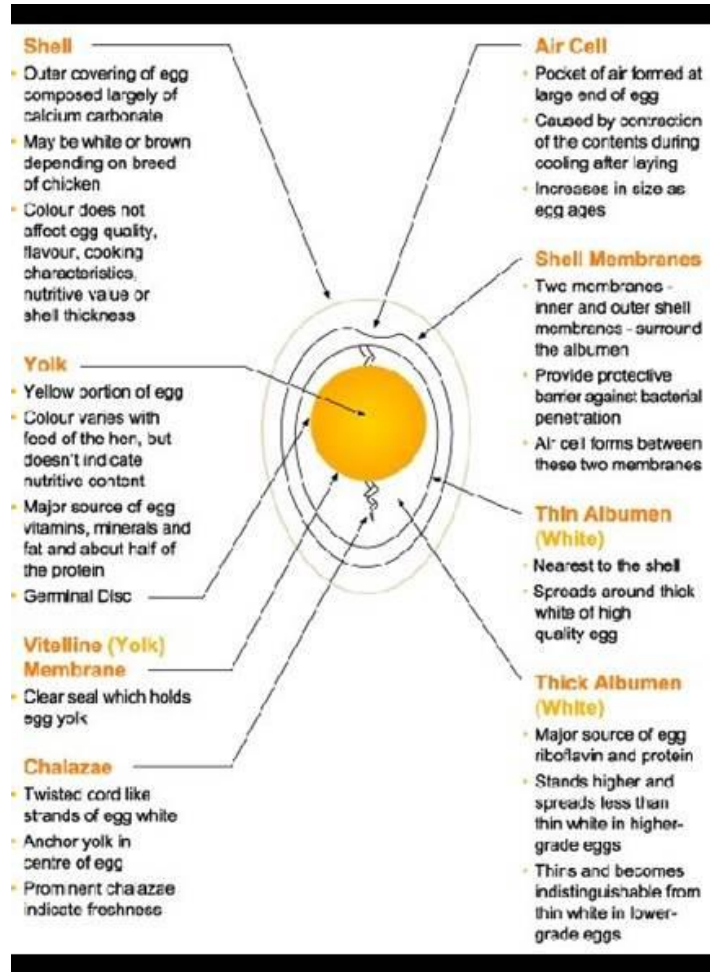


Structure and composition of egg

The egg consists of four distinct structures:

- ↪ Ovum or yolk (which has, on its surface, the germs cells or blastodisk)
- ↪ Albumen or white, consisting of thin and thick regions, plus chalazae
- ↪ Shell membranes, separate inner and outer layers
- ↪ Shell which is comprised of separate, identifiable layers



The ovum or yolk



The yolk is formed from one of many hundreds of oocytes, small cellular structures on the surface of the ovary. The oocytes develop sequentially. Early development is quite slow, but for a period of 6-10 days before ovulation (the process whereby the newly formed yolk is detached from the ovary) the yolk accumulates its rich content of fats and proteins. These are laid down in layers corresponding to days of development. The germ cell is located on the surface of the ovum and remains there, awaiting fertilization, which, in the case of commercial eggs, seldom if ever happens. The ovum or yolk is contained within a transparent membrane which remains intact when it is released from the ovary and is important in preventing the yolk material from escaping into the rest of the egg contents.

Egg white



The albumen is laid down over a period of 3-4 hours while the developing egg passes through the magnum region of the hen's oviduct. There are two distinct layers, the inner thick and outer thin layers. The egg white is mostly water and protein. In addition to the thick and thin layers, the chalazae also form part of the egg white. The chalazae are twisted strands of thickened protein that are arranged so as to hold the yolk in its central position within the egg.

The egg shell



The egg shell is formed in the last 20-22 hours before the egg is laid. The eggshell has a protective function, maintaining the embryo within a carefully controlled environment. In eggs destined for human consumption, the shell protects the contents from damage or spoilage. The shell consists of about 97% calcium carbonate. However, the remaining 3%, which is mostly protein, has a major effect on the structure of the shell, and has been widely studied by researchers in the past two decades.

At the microscopic level, the egg shell consists of a mammillary layer, which is closely integrated with the outer shell membrane. The mammillary layer forms the foundation for the palisade layer, which consists of columns of calcium carbonate crystals. Outside of this is a vertical crystal layer and finally, a cuticle. In the case of brown eggshells, the colour is laid down beneath the cuticle and is an extremely thin structure.

Gross Composition of the Egg

The gross composition of the egg is given in Table 1. These data can serve as a good estimate for large-scale calculations. However, composition of eggs does vary with breed, age of layer, and even nutrition, within certain limits that will be discussed later.

Table 1

%	water	protein	fat	ash
whole egg	74	13	11	1
white	88	11	0	0
yolk	48	17	13	1

Table 2

Component	%
shell	9
yolk	29
albumen	62
fat/complete yolk	33.0
protein/complete yolk	15.7
yolk solids	51.0
albumen protein	10.5
albumen solids	11.8

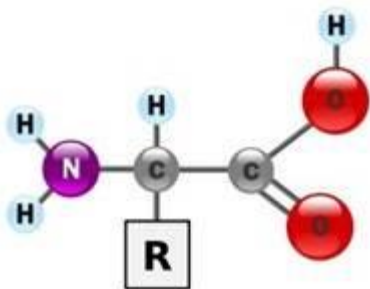
Adapted from Tharrington et al, 1999. Poultry Science, 79, 591-594

The edible portion of the egg, i.e. the white and the yolk, have very different analyses. All of the fat and the fat-soluble vitamins are contained in the yolk, while the white is composed of a large amount of water, plus protein. In addition to fat and protein, eggs contain all of the known vitamins with the exception of Vitamin C.

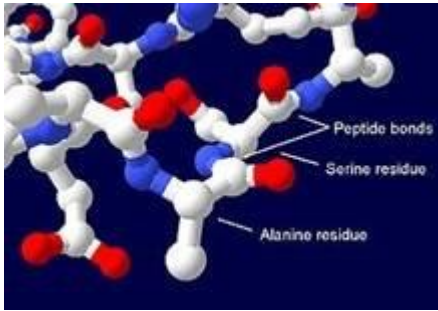
Table 3 shows the major nutrients in one 60g egg, and Table 4 shows the micro-nutrient content. These may vary slightly depending on the age, nutrition and environment of the hen, but can be used with confidence in most circumstances.

Table 3

Major Nutrients in 1 egg (weighing 60g)



Nutrient	% r.d.a.*	
Protein (g)	6.7	12
Energy (kcal)	78	11
Energy (kjoules)	324	11
Fat	6	n/a
PUFA (g)	1.17	12
MUFA (g)	2.46	20
Saturated fat	2	n/a



PUFA=polyunsaturated fatty acids-MUFA=mono-unsaturated fatty acids.

Contents of these may vary considerably depending on the diet of the hen, and may be deliberately altered by feeding specific diets.

See the following section on Nutritionally Enhanced Eggs.

VITAMINS			MINERALS/TRACE ELEMENTS		
		% r.d.a.*			% r.d.a.*
Vitamin A(µg)	180	30	Calcium (mg)	35	9
Vitamin D3 (µg)	0.95	19	Phosphorus (mg)	125	18
Vitamin E (mg)	1.6	16	Iron (mg)	1.3	4
Vitamin K (mg)	0.01	0.8	Zinc (mg)	0.8	9
Vitamin C	0	0	Iodine (mg)	0.04	20
Thiamin (Vit.B1)(mg)	0.05	4	Selenium (µg)	0.6	11
Riboflavin Vit.B2 (mg)	0.27	19	Chlorine (mg)	83	3
Niacin (mg)	0.05	0.3	Sulphur (mg)	93	n/a
Pyridoxine (mg)	0.14	7			
Folic acid (mg)	0.04	40			
Vitamin B12 (µg)	1.6	160			
Biotin (µg)	12	48			
Choline (mg)	410	90			

* r.d.a. = recommended daily allowance.

This figure may vary in different countries, and with age, gender and physical activity – data here are averages. Pregnant and lactating mothers have higher requirements for many of the micro-nutrients.

In addition to the minerals and Vitamins listed above, eggs contain many unique proteins that contribute to their nutritional and health values. Some of these, for example lysozyme and ovotransferrin, have antibacterial properties.

Commercial processes are available to separate some of the egg white proteins for medical or industrial use. Lysozyme is used as an antibacterial in the production of some cheeses and in wine making. Some egg proteins have the ability to bind other chemicals, for example avidin, which binds to biotin, and ovoflavoprotein, which binds to riboflavin. Phosvitin, present in the yolk, binds to iron and has significant antioxidant properties.



These and many other proteins may be extracted from eggs for a variety of purposes.

Egg Component Functionality

Eggs are used in many food manufacturing processes because of their unique functional properties. The egg yolk is structured in such a way that it can be used as an emulsifier. Once mixed with other food ingredients, many of the fatty components are held in suspension indefinitely, for example in mayonnaise. The egg white has the capability to gel and is frequently used as a binding agent in prepared foods. When cooked partly or wholly, the egg white proteins form a more or less solid structure, useful in many foods either prepared in the home, or industrially. In egg further processing, the whites and yolks are often separated and used for different food applications. They may be enhanced by the addition of sugar or salt, depending on the use for which they are intended. Further processing of eggs began as a way of using un-sold fresh shell eggs, but the industry has developed to the point at which production from some layer flocks is destined exclusively for further processing.

In many markets in the world, more than 40% of eggs produced go for further processing. The development of the further processing industry has led to new demands on egg producers, and the breeders and nutritionists who supply them. Attention must be paid to the composition of the eggs, and the yield of solids when eggs are broken for further processing.