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On the anatomy of the breast - Of the effects of gestation and lactation on the breast

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OF THE EFFECTS OF GESTATION AND LACTATION ON THE BREAST.

THE breasts at this time receive much larger quantities of blood, and they generally swell and become painful, feeling heavy; they are tender to the touch, and painful in themselves, and if small before, they now undergo their evolution.

The nipple grows, and its papillæ become foliated and protuberant. *See Plate* 2.

The areola becomes darker in its colour, thicker in its substance, and its diameter increases from one to two inches. The darkness of its colour arises from a great accession of the rete mucosum, which is now easily perceived, demonstrated, and separated. The increase of the areolar diameter is owing to a real growth, and to the skin being stretched by the increase of the gland; and its greater thickness arises from the developement of the papillæ of the areola.

The tubercles and glands of the areola and those of the surrounding skin of the breast are rendered much more distinct and prominent than before.

When sections are made into the mammary gland, at the commencement of lactation, it is found to be exceedingly loaded with blood, and to be from this cause of a red colour.

The ducts are much larger, and capable of readily receiving injection.

The cellules are not at first developed, and therefore the breasts of women who die from puerperal fever are not the best subjects for injection.

When the arteries and veins are injected, they are found to be exceedingly enlarged upon the surface, and in the interior of the gland, and are rather tortuous in their course.

When lactation has commenced, and is established, and after a few weeks' suckling, the nipple becomes very large and truncated at its apex, so as to form a broad flat surface, upon which the orifices of the lactiferous tubes are evolved; and the areola, as well as the nipple, can be in a great degree drawn between the lips of the infant when it is sucking. The papillæ of the areola become of larger size, and increase the adhesion of the lips, and the sensibility of the part. The ducts and reservoirs enlarge, and milk cells can be discovered and injected in all the glandules.

Of Sucking.

The act of sucking is performed by the infant's lips and tongue embracing the nipple and areola, by its gums compressing them, and by some exhaustion of air being produced in its mouth. The gums and tongue draw the

mamillary ducts into capillaries, by which the passage of the milk is further facilitated: the exhaustion of the air in the infant's mouth induces additional atmospheric pressure upon the surface of the breast. It is certain, however, that a child is able to suck who has a deficient lip and palate, as in the hare lip, if the defect is not of the worst description.

No muscular power resides in the ducts, but they possess considerable elasticity in many animals; and in women, if the ducts be distended with mercury, it returns with some force when the injecting pipe is removed.

A defective nipple sometimes prevents sucking, although the nipple must be very imperfect which forbids it.

In the first few days after the birth of the child, nurses are in the habit of preparing the breasts for the child, by gentle friction and by drawing them out, and, as they express it, *by breaking the strings.*

The child assists the escape of the milk by its little hands, which are employed in compressing and pulling the breast, to empty the ducts, and to produce a further *vis a tergo* upon the milk tubes.

Of the Milk.

This is a white fluid, secreted in certain glands of the class Mammalia, for the nourishment of their offspring.

The component parts of this fluid unite the qualities of animal and vegetable matter, and are diluted and combined by a watery solvent. As a food, the milk is the chief, and often the only support of the offspring, and generally most conduces to render it healthy.

Its colour depends upon a number of oily globules, which float through the fluid when it is first drawn, and form an opaque emulsion with the caseous matter. These globules may be so far separated by filtration as to leave the serous parts of the milk quite clear, as I have several times done by repeated filtrations with good blotting paper, and rendered the remaining fluid clear and transparent.

The first change which milk undergoes, after it has been drawn and kept at rest, is of a mechanical nature: the oily matter of the milk is not chemically combined with it; hence it soon rises to the surface of the milk, and forms a layer of cream, and the fluid is thus unequally divided into cream and milk.

If the cream be separated, exposed, and dried, it forms the solid food which is called cream-cheese.

If the milk be suffered to stand after the separation of the cream, it sooner or later, according to the temperature, undergoes a chemical change, which consists in the production of an acid termed lactic acid, and a precipitation of the

animal, caseous, or albuminous matter of the milk, whilst a clear liquor remains above, and in this manner the milk is divided into curds and whey.

Thus we have already seen cream, curd, and whey, produced from the milk by means, partly mechanical, partly chemical.

The whey thus separated and submitted to slow evaporation, leaves a quantity of sugar, so that the whey is composed principally of water and sugar. But if milk be further decomposed by ignition, an ash remains, which is composed of alkaline and earthy salts.

Although the above is the mode in which milk spontaneously separates, or is changed by other processes, yet still the separation is not complete: some cream remains with the milk; some curd and butter continue with the whey.

The cream resembles a vegetable fixed oil in its elements. The sugar is also of a vegetable nature. The albuminous element, or as it is now called, caseum, from its being the basis of cheese, is composed of the constituents of animal substances, and earthy matter is contained in it, fitted to become one of the component parts of the bones; whilst these vegetable and animal components of milk are suited to the nutrition of the child, the water of the whey dilutes and

holds them in a state of minute suspension or solution, and fits them for passing through very minute vessels.

Of the Cream.

This is the oily part of milk, and it also contains a little curd and a good deal of whey.

It is composed of oily globules, which differ from those of the blood, in their colour, which is white instead of red; in their specific gravity, which enables them to float whilst the red globules sink in serum; and in their inequality, as regards their size, for they are of very different magnitudes as regards each other.

The proportional quantity of cream to milk in cow's milk is from one-eighth to one-fourth, but usually the former, in twenty-four hours; but a certain portion continues to separate even for several days.

Butter.

By the agitation of cream in a churn or bottle, it separates into a solid and fluid part: the solid is butter; the fluid is what is called butter-milk.

The butter first forms in little lumps, which gradually aggregate until it becomes a large body by attraction of

aggregation, or the union of one small body with another, and then the butter-milk can be squeezed from it.

If butter be melted at 180°, and a quantity of curd be separated from it, which it does by falling to the bottom, the butter will keep for a great length of time; but if the curd remains, the butter becomes acid and rancid.

It is oily and inflammable; but it makes a very excellent and nutritious food, only it requires considerable digestive powers to convert it into nourishment.

It yields, by distillation, oil, water, and a pungent volatile acid, the sebacic.

It forms soaps with alkalies, giving rise to the formation of a series of fatty acids, described by M. Chevreul.

A quart of good cream makes a pound of butter.

The butter-milk which is left when the butter has been separated in churning, has a sourish taste, and is a kind of emulsion. It may be cleared by repeated filtrations.

Of the Curd, Albuminous Element, or Caseum.

It is called the latter, from its being the most important constituent of cheese.

This, the solid matter, is of an animal kind, which spontaneously separates from the milk by a chemical change, during which the milk becomes sour.

The usual mode of separating the albumen or caseum, in making cheese, is by rennet.

Rennet is made by pouring warm water upon the digestive stomach of the calf, putting it in salt and water, and set by for use; and when this is mixed with milk, it coagulates it, especially with the aid of heat. The albuminous portion, or curd, may be also separated by alcohol, wine, sugar, and acids, by nitrate of silver, alum, sesqui-chloride of iron, and tincture of galls.

The caseous matter contains a considerable quantity of nitrogen, like other animal substances.

A lactometer to estimate the cream, and an hydrometer the curd in solution, become good means of estimating the quantity of each.

Curd or caseum differs from true albumen, as white of egg, in being precipitated from its watery solutions by acetic acid: it is to a certain extent soluble in the caustic alkalies and lime-water. Ammonia dissolves cheese, and acids precipitate it from its alkaline solutions.

Curd, the basis of cheese, is white, insipid and inodorous, insoluble in water, but very soluble in the alkalies. Like albumen, it is precipitated from its solution by alcohol; but unlike albumen, it is coagulated by acetic acid. It appears, indeed, that curd bears as much resemblance to albumen and

fibrin, as in the vegetable kingdom, starch does to gum and sugar.

Of the Whey.

This is the fluid which remains after the separation of the cream and caseum, and it consists of water, sugar of milk, a few salts, and still a little curd.

It is of a blueish-white colour and sweetish taste, and of an agreeable flavour.

Of the Sugar.

When the whey is evaporated slowly it leaves a substance which appears like honey, and when this is further dried it looks like brown sugar.

It is a little gritty upon the tongue, its taste is saline, and also resembles that of brown sugar. When digested with alcohol, and evaporated, it forms white crystals. It contains twelve per cent. of water.

This sugar possesses the remarkable property of being converted into lactic acid, by digestion with certain animal products; and this fact explains the developement of that acid in milk, during the spontaneous coagulation and separation of the curd.

Of the Salts in Milk.

Some are soluble in water, others are not.

The salts soluble in water are, chlorides of sodium and potassium, sulphate of potass, phosphates of potass and soda, with lactates of potass and lime.

The salts not soluble are, phosphates of lime and magnesia, with very small quantities of phosphate of iron.

Human Milk.

The account which I have thus given is from the cow, but we will compare this history with the milk of the human female, so far as I have observed it, and I have been often supplied with it for the purpose of observation.

Human milk, when first drawn, appears more blue in its colour than that of the cow indeed, it resembles whey, or cow's milk much diluted with water.

It has a sweetish, but also a saltish taste. Soon after it is drawn, like cow's milk, it changes, if it be at rest, by a mechanical separation, from the less specific gravity of cream; the cream separating upon its surface so that it divides itself into cream and milk, but with this striking difference, that the milk in the human subject appears semi-translucent like whey, instead of being white and opaque as in the cow, so that it may be almost said to divide into cream and whey.

During the first ten days of its remaining at rest there is abundance of cream, and a little curd separated from the development of lactic acid.

In thirteen days there is a little more curd separated.

In twenty-two days a greater quantity of curd appears, some floats and some sinks to the bottom of the vessel.

At the end of a month, the cream floats upon the surface—loose and clotted curd floats in the whey.

In five weeks a considerable quantity of curd is produced, and still more in two months.

Milk kept for a year in glass stoppled bottles divides into cream, curd and whey, but is not further changed in appearance.

If cream be exposed for a fortnight, oil begins to separate, so that in a month, oil, cream, curd and whey, become developed.

Lastly, it vegetates, producing abundance of confervæ upon the surface.

Of the Cream.

Its specific gravity is 1·021.

The quantity of cream is abundant, if the woman be healthy; but it varies according to the age of the child, the habits of life, the food, the health and tranquillity of mind of

the mother. In these respects women widely differ from other animals.

The quantity of cream in several experiments was as follows :—

8	measures of human milk gave	2	measures of cream.
22	„	5	„
17	„	6	„
26	„	6	„
8	„	2	„
17	„	4	„

So that the cream in comparison with the milk is from one-fifth to one-third, varying with the health, the food, the habits, and state of mind of the mother.

The quantity of cream also varies as the time elapses from the birth of the child.

	Measures of Milk.		Measures of Cream.
On the 8th day	17	gave	6
At 2 months	14	„	2
„ 4 „	17	„	$2\frac{1}{2}$
„ 5 „	21	„	$2\frac{1}{2}$
„ 7 „	14	„	2
„ 8 „	16	„	$2\frac{1}{2}$
„ 9 „	14	„	2
„ 12 „	25	„	4
„ 14 „	14	„	3
„ 16 „	14	„	4
„ 17 „	13	„	4
„ 18 „	11	„	3

A woman who was very poor, and had an exfoliation of the os frontis,

7 measures of milk gave only 1 of cream.

A woman highly fed,

9 measures of milk had $3\frac{1}{2}$ of cream.

The cream of human milk, agitated for a length of time, did not produce butter; but milk and cream mixed together produced, by long agitation, a white and soft solid, in small bodies, which became an aggregated white butter; but with difficulty, and after a length of time.

In five minutes, there were formed minute bodies; in ten minutes, larger; in a quarter of an hour, yet larger; and in twenty minutes, a large lump of a white solid, which, when warmed, separated an oil.

Of the Curd, or Albuminous Element.

This appears less early than in cow's milk, but separates gradually after ten days or a fortnight, and continues to do so for a length of time.

Rennet warmed with human milk produces pellicles of curd after a short time.

Boiling also separates pellicles of curd.

Acetic acid curdles it abundantly.

Sugar of Milk.

When the cream and curd are separated, the whey is found to contain abundance of saccharine matter, which is the sugar of milk.

To render the sugar pure, it must be repeatedly dissolved and crystallized.

It dissolves in water slowly, and requires three parts of boiling water, and nearly double of cold water, for the purpose.

It is a little soluble in alcohol, but more if it be weak; when evaporated from water it is brown, but from alcohol it is white.

Sugar of milk is converted by nitric acid into the oxalic.

The sugar of milk affords a large proportion of nutriment, and of the mildest vegetable kind.

I sent to my friend, Dr. Rees, of Guildford Street and of Guy's Hospital, several specimens of human milk.

Its specific gravity, 1035·8.

Its solid contents, 12 per cent.

Exposed to galvanism, the caseum coagulated in flocculi, but it did not adhere around the positive pole, as it does in cow's milk, which was probably owing to the less coagulability of the caseum of human milk, by the acid generated at the positive pole of the battery.

The quantity of curd or caseum was small in these specimens.

The colostrum, or milk which is at first produced after parturition, appeared at first of a yellow colour, and thick consistence; but when it had stood twenty-four hours, it separated abundance of imperfectly-formed cream upon its surface.

9 measures gave 6 of cream and 3 of milk.

The milk had a slight tinge of red, the cream a somewhat deeper tint.

The colostrum of the cow contains a great number of particles of various sizes, apparently made up of numerous cohering globules, so as to present an extremely granular appearance: these granular bodies, which are absent in ordinary milk, are completely soluble in ether, and consequently are composed almost exclusively of fatty or oily matter.

Being myself unequal to minute chemical inquiries, I requested my friend, Dr. Golding Bird, Lecturer on Natural Philosophy at Guy's Hospital, to send me an analysis of what had been done in the chemical history of milk, as well as the result of his own inquiries; and for the following observations upon that subject, I am entirely indebted to him, as I also am for an admirable analysis of the milk of the porpoise, which I believe had been never previously examined. Dr. Bird writes as follows:—

" Milk is a white opaque fluid possessing a bland, sweetish taste, secreted by certain glands in Mammalia, and designed for the nourishment of their offspring.

" The specific gravity of cow's milk, which may be assumed as the type of the different varieties of this secretion, is about 1·030. This, it is obvious, is far from being constant, as it must necessarily vary with the amount of solid matters present, and which depend upon the health, vigour, age and nourishment of the animal, as well as on the time that has elapsed since parturition, and other causes.

" Under the microscope, myriads of extremely minute globules are seen floating in milk; these, on account of their extreme minuteness, appear black at their edges, and with a magnifying power of 100, the largest of them does not exceed in diameter, according to Raspail, ·00039 inches. On the addition of a drop of solution of potass, the globules are seen to vanish and a limpid fluid is left.

" As the opacity of milk depends on its holding in diffusion myriads of opaque globules, Sir A. Cooper has by straining it repeatedly through a filter sufficiently fine, separated the opaque particles. On submitting this to the test of experiment, I have also found it to succeed most perfectly, a nearly limpid fluid resulting after the milk had been repeatedly filtered.

" The simplest mode of regarding milk is that of an emulsion, formed by the intimate mixture of a fatty matter termed *butter*, with an albuminous constituent, called in chemical language, *casein*. The intimacy of the mixture is doubtless increased by the presence of sugar of milk, as saccharine substances are well known to possess the property of forming imperfect emulsions with oils.

" Cow's milk contains on an average about 10 or 11 per cent. of solid matter, made up of organic and saline constituents.

" When milk is permitted to repose for a few hours, a large proportion of its oily constituents, mixed with some of its caseous matter, slowly separates from the mass of fluid, and being of lower specific gravity than the latter, rises and forms an opaque layer on its surface. This lighter portion is termed *cream*, and the milk from which it is thus separated is popularly termed *skimmed milk*, because the cream is skimmed off, for the purpose of being converted into butter. The specific gravity of the cream is on an average 1·0244, and that of skimmed milk 1·0348, the greater gravity of the latter affording a sufficient explanation of the phenomenon of the cream floating on its surface.

" If the milk from which the cream has been thus separated, be left to itself, it sooner or later undergoes a spon-

taneous change, some free lactic acid becoming developed, and the albuminous constituent, *casein*, separates in large white coagula. The developement of lactic acid, in all probability, arising from the reaction of caseous matter on the saccholactin, or sugar of milk, as lately pointed out by M. Fremy. This always takes place with greater rapidity in warm than in cold weather, and is hastened during an electric state of the atmosphere, as during a tempest. The addition of a small quantity of any free acid, or of the well-known *rennet*, greatly facilitates this change and consequent coagulation of the caseous matter. The serous fluid from which the *casein* or *curd* has been thus separated, is popularly termed *whey*.

" When whey is submitted to evaporation so as to free it from a large proportion of water, it on cooling crystallizes in small brownish grains; constituting sugar of milk. In Switzerland a very large quantity of this sugar is procured from the whey left after separating the curd in the process of cheese-making, and is used by the peasants for all the purposes to which cane-sugar is applied in this country.

" Sugar of milk consists of,

Carbon	45·94
Hydrogen	6·00
Oxygen	48·06
	100·00

" It is generally stated to be incapable of undergoing the vinous fermentation, although an alcoholic fluid termed *koumiss*, has been long prepared by the Tartars from mare's milk. It is now, however, placed by the researches of Hess, (POGGENDORFF. *Annalen.* 21., 194,) beyond a doubt, that sugar of milk is capable of being converted into alcohol by fermentation, although not with so much readiness as cane or grape-sugar.

" A layer of cream formed on the surface of milk by repose, is by no means homogeneous, for on carefully examining it, two distinct portions, not, however, separated by any very evident line of demarcation, may be made out; of these the uppermost is richest in butter, and the lowest n caseous matter. The average proportion of cream separated from milk by repose, is about one-eighth, but this varies considerably.

" When cream is submitted to mechanical agitation, as in a churn, it separates into two portions, the one being a soft fatty substance of an agreeable odour, constituting the well-known butter, the other is a more serous fluid holding some casein, sugar, and saline matters in solution, and termed butter-milk, the petit-lait of the French. Butter generally contains about one-sixth of its weight of caseous and other matters mechanically mixed with it; these by

careful fusion become separated, and then the butter may be kept for a longer space of time without becoming rancid.

" After butter has been carefully fused, filtered through paper whilst melted, and well washed with water, it is nearly pure; in this state, 100 parts of hot alcohol dissolve 3·46 parts of it. Butter thus purified, contains, like all other fats, *oleine* and *stearine*, with the addition of a third fatty ingredient peculiar to butter, and hence named *butyrine*.

" Anything like a quantitative analysis of milk can, it is obvious, be considered in no other light than that of affording an approximation to the average proportion of its principal ingredients. The following are the results of the analysis of Berzelius.

1000 parts of *skimmed milk*, of specific gravity 1·033, contained

Water	928·75
Caseous matter with traces of butter	28·00
Sugar of milk (saccholactin)	35·00
Lactic (acetic) acid, acetate of potass, and traces of a salt of iron	6·00
Hydrochlorate and phosphate of potass	1·95
Phosphate of iron	0·05

1000 parts of *cream*, of specific gravity 1·024, consisted of

Butter	45
Caseous matter	35
Sugar of milk and saline ingredients	44
Water (*butter-milk?*)	876

" By incineration, caseous matter leaves above 6·5 per cent. of ashes, consisting chiefly of phosphate of lime.

"The caseous matter, or casein, of milk, constitutes the basis of cheese: it may be considered as bearing the same relation to milk, that the albumen does to blood. It is, indeed, more than probable, that casein is but a modification of ordinary albumen, and hence may, in a physiological sense, be considered as the albuminous principle of milk. Casein is precipitated from its solutions, as in milk, by the addition of acids, which indeed appear to combine with it, for by separating them by a very simple chemical process from the coagula, the casein once more becomes soluble in water. A familiar example of the coagulation of casein by an acid is met with, in the vomiting of curdled milk by suckling infants; the coagulating agent in these cases, is probably hydrochloric acid, which, from the researches of Dr. Prout and Leopold Gmelin, appears to be constantly present in the stomach. The rationale of the disappearance of this disagreeable symptom, on the administration of a few grains of chalk or magnesia, is hence sufficiently obvious.

"Casein, when rendered as pure as possible, consists, according to the analyses of Gay-Lussac and Thenard, and Berard, of—

	Carbon.	Oxygen.	Hydrogen.	Nitrogen.
Gay-Lussac and Thenard . .	59·78	11·41	7·43	21·38
Berard	60·07	11·41	6·99	21·51

"Damp casein, when set aside in a warm place, rapidly

undergoes putrefactive fermentation, and a complex mass results, consisting, according to Prout, of two substances, termed caseic acid and caseous oxide, or, according to Braconnot, chiefly of a matter termed aposepodine.

"Milk drawn shortly after parturition, differs in its physical and chemical character from milk drawn at a more distant period. This variety is termed *colostrum;* that of the cow is yellow, mucilaginous, and occasionally mixed with blood; it contains but mere traces of butter or other fat, and appears to contain albumen as one of its ingredients, as by exposure to heat, it completely solidifies, like so much serum of blood. The specific gravity of the *colostrum* of the cow is about 1·072. This secretion does not turn sour like milk, but readily putrefies; and in three or four days after the birth of the calf, is replaced by the ordinary lacteal secretion.

"The colostrum of the cow, ass, and goat, has been submitted to examination very lately by MM. Chevallier and Henry. They state the property possessed by this secretion of undergoing coagulation by heat, although they have not mentioned albumen among its ingredients. It is probable that it was confounded with the mucous matter, stated by these gentlemen to be present in the fluid. The following is the result of their analysis of the colostrum of the cow:—

Casein . . .	15·07
Mucous matter . .	2·00
Saccholactin, or sugar of milk	?
Butter . . .	2·60
Water . . .	80·33
	100·00

"On taking a retrospective glance at the above remarks on the composition of cow's milk, which I have taken as a standard or type of this class of secretions, we cannot help being struck with the peculiar manner in which the different component parts appear to be arranged, for the more ready nourishment of the new-born animal. Milk may be physiologically regarded as made up of three classes of ingredients; the first containing those which resemble vegetable secretions in the absence of nitrogen; the second including those which contain abundance of nitrogen, and consequently afford a proper pabulum for the growth of the young animal; the third class containing those ingredients which, in the present state of chemical physiology we have no safe grounds for supposing are *digested*, or their elements re-arranged by vital chemistry, and hence differ from the first two classes in being rather *appropriated* by the vital influence of the infant animal, than assimilated to form such combinations.

A. *Ingredients of milk in which nitrogen is absent.* Sugar of milk, fatty matters.

B. *Ingredients of milk in which nitrogen is present.* Caseous matter.

C. *Inorganic, or saline ingredients.* Salts of potass, soda, lime, and iron.

"The latter class contains those earthy salts which constitute the chief ingredients in osseous structures; and all being dissolved in, or diffused through, abundance of water, become fitted to pass or drain through the minutest vascular tissues."

The lacteal secretions of other Mammalia, so far as they have been examined, appear to differ from the milk of the cow rather in the quantity and proportion of their respective constituents, than the super-addition or subtraction of any particular ingredient. Occasionally, the fatty matters present, are found to differ slightly in the products of their saponification with alkalies, and in the character of the acids produced: thus the fat of the milk of the cow, goat, and porpoise, yield respectively butyric, hircic, and phocenic acids.

The following is a comparative view of the composition of the milk of the cow, ass, goat, sheep, and mare, from the analyses of Henry, Chevallier, Luiscius, and Bondt.

	Cow.	*Goat.*	*Ass.*	*Sheep.*	*Mare.*
Casein . . .	4·48	4·02	1·82	4·50	1·62
Butter . .	3·13	3·32	0·11	4·20	traces
Sugar of milk .	4·77	5·28	6·08	5·00	8·75
Saline matters .	0·60	0·58	0·34	0.68	} 89·63
Water . . .	87·02	86·80	91.65	85.62	