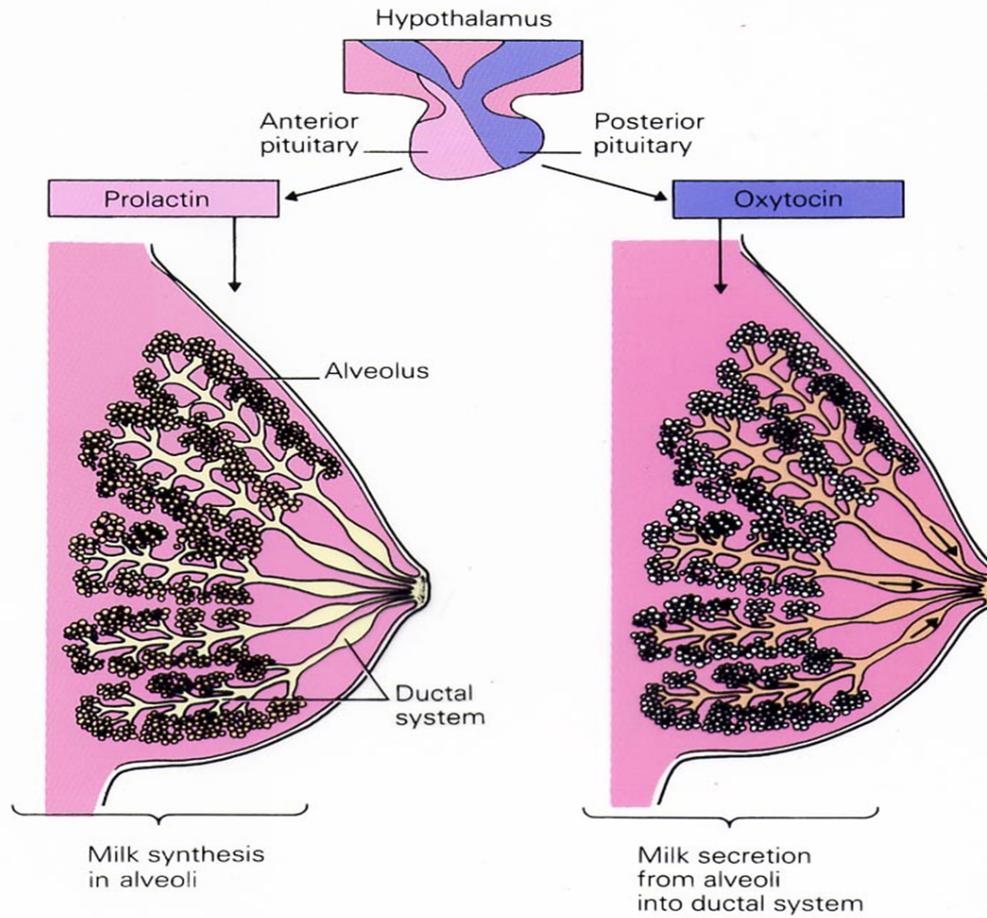


LACTATION AND HUMAN MILK

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Growth of Mammary Glands

Embryology

- 6th week of gestation: Mammary glands begin to develop as solid growths of epidermis called mammary ridges
- Under the influence of estrogen from placenta, mammary ridges canalize to form ducts
- At birth, mammary glands of males and females are identical, composed of ~15-20 rudimentary lactiferous ducts

Development of Breasts:

Puberty

- Under the influence of estrogen from developing follicle & corpus luteum each month)
- Enlargement occurs due to deposition of fat & connective tissue
- Nipple becomes enlarged and pigmented
- Further growth & branching of lactiferous ducts

Development of Breasts: Pregnancy

- More intense growth and branching of lactiferous ducts (under high levels of estrogen from corpus luteum & placenta)
- GH, glucocorticoids, prolactin, insulin all influence growth
- Final development of mammary glands occurs under the influence of progesterone, which (in concert with hormones mentioned above) cause alveoli to bud from the ends of the lactiferous ducts
- Each alveolus is lined by milk secreting cells

Milk Production (during pregnancy)

- Prolactin, secreted by anterior pituitary gland, stimulates milk production
- During pregnancy, prolactin levels increase 20 fold but action of prolactin inhibited by high estrogen & progesterone levels
- Human chorionic somatomammotropin (i.e. placental lactogen) plays role in lactogenesis
- Towards end of pregnancy, breasts are fully developed but milk production is suppressed except for small amount of colostrum (same concentration of proteins and lactose as regular milk but hardly any fat)

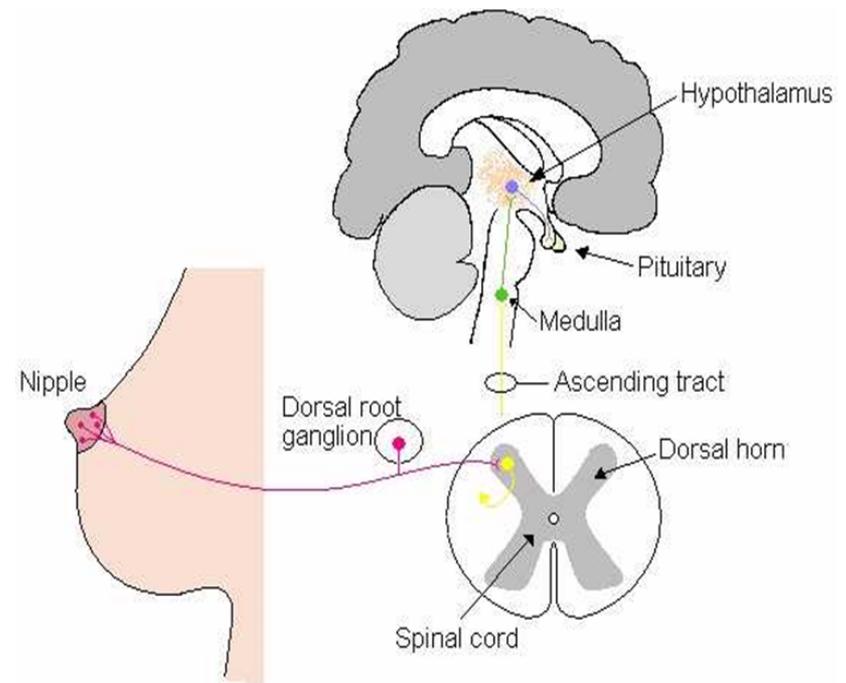
Milk Production

(after birth)

- After birth, estrogen and progesterone levels drop and milk is produced in 1-7 days
- Milk production requires: secretion of hormones involved in protein, glucose & calcium regulation (GH, cortisol, insulin, PTH)
- PRL levels return to normal within a few weeks. Each time an infant feeds, neurohumoral reflex leads to burst of prolactin secretion

Milk Ejection

- Alveolar milk accumulates in the lactiferous sinuses (enlargements of ducts near opening of nipple)
- Suckling ↑ hypothalamus release of oxytocin from post. pituitary.
- Oxytocin ↑ contraction of myoepithelial cells around the ducts.
- Negative maternal emotions (frustration, anger, anxiety) can inhibit oxytocin secretion & suppress milk ejection reflex



Contraindications

- HTLV-1 and HTLV-2
- HSV with lesion on the breast
- Active tuberculosis
- Medications that contraindicate breastfeeding
- Newborn with galactosemia
- Maternal HIV
 - ▣ US: not recommended
 - ▣ UNICEF: When replacement feeding is acceptable, feasible, affordable, sustainable and safe, avoidance of all breastfeeding is recommended; otherwise, exclusive breastfeeding is recommended during the first months of life.

Colostrum

- It is the first stage of breast milk that is produced after birth and lasts for several days
- It has a yellowish to cream colored thick appearance
- It is high in protein (antibodies), vitamins (especially fat soluble vitamins), minerals
- Major protein is whey (80:20 whey:casein)
- Very low in fat compared to mature breast milk

Mature Milk

- Contains higher levels of fat, lactose, and vitamins (more water-soluble vitamins)
- Larger percentage is water
- More protein is casein (55:45 whey:casein)
- Multiple carbohydrates including lactose and human milk oligosaccharides
- Two types milk: foremilk and hindmilk
 - ▣ Foremilk has more lactose and less fat

Preterm breast milk

- Contains more protein, sodium, chloride
- Protein amount still below amount supplied by placenta
- Less lactose

Immunologic Components

- Immunoglobulins - Human milk contains all of the different antibodies (M, A, D, G, E), but secretory immunoglobulin A (sIgA) is the most abundant
- Lactoferrin - which binds to iron, thus making it unavailable to pathogenic bacteria
- Lysozyme - which enhances sIgA bactericidal activity against gram-negative organisms
- Mucins - adhere to bacteria and viruses and help eliminate them from the body
- Leukocytes - with the transition from colostrum to mature milk, the percentage of macrophages increases from 40-60% of the cells to 80-90%

Donor Milk

- Milk from 3-5 donor mothers is thawed, transferred to glass flasks, and mixed
- Milk samples are cultured during the pasteurization process then frozen at -4°F and stored
- Culture-positive milk is discarded
- Milk is shipped frozen overnight to hospitals and individuals



Donor Milk

- Pasteurization impacts immunological properties
- Lymphocytes, alkaline phosphatase, cytokines, some growth factors, lipoprotein and some lipases are destroyed
- Decreased lactoferrin and lysozyme
- Some immunoglobulins are preserved such as IgA and IgG but IgM mostly destroyed

Nutritional Composition

Nutrient (Unit)	Minimum Level Recommended ¹	Mature Human Milk	Typical Commercial Formula	Cow's Milk (Mean)
Protein (g)	1.8 (See note 2.)	1.3–1.6	2.3	5.1
Fat (g)	3.3 (See note 3.)	5	5.3	5.7
Carbohydrate (g)	...	10.3	10.8	7.3
Linoleic acid (mg)	300	560	2300	125
Vitamin A (IU)	250	250	300	216
Vitamin D (IU)	40	3	63	3
Vitamin E (IU)	0.3 FT 0.7 LBW	0.3	2	0.1
	1 g linoleic			
Vitamin K (μg)	4	2	9	5
Vitamin C (mg)	8	7.8	8.1	2.3
Thiamine (μg)	40	25	80	59
Riboflavin (μg)	60	60	100	252
Niacin (μg)	250	250	1200	131
Vitamin B ₆ (μg)	15 μg/g protein	15	63	66
Folic acid (μg)	4	4	10	8
Pantothenic acid (μg)	300	300	450	489
Vitamin B ₁₂ (μg)	0.15	0.15	0.25	0.56
Biotin (μg)	1.5	1	2.5	3.1
Inositol (mg)	4	20	5.5	20
Choline (mg)	7	13	10	23
Calcium (mg)	5	50	75	186
Phosphorus (mg)	25	25	65	145
Magnesium (mg)	6	6	8	20
Iron (mg)	1	0.1	1.5 in fortified	0.08
Iodine (μg)	5	4–9	10	7
Copper (μg)	60	25–60	80	20
Zinc (mg)	0.5	0.1–0.5	0.65	0.6
Manganese (μg)	5	1.5	5–160	3
Sodium (meq)	0.9	1	1.7	3.3
Potassium (meq)	2.1	2.1	2.7	6
Chloride (meq)	1.6	1.6	2.3	4.6
Osmolarity (mosm)	...	11.3	16–18.4	40

¹Committee on Nutrition, American Academy of Pediatrics.

²Protein of nutritional quality equal to casein.

³Includes 300 mg essential fatty acids.

- Human milk has more long chain fatty acid
- DHA added to formula