Postpartum Nutrient Provision
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- Support young until they can obtain their own food
- Maximizes survival
- Speeds postpartum development
- Critical in migratory species
Crop Milk

- Some birds – pigeons
- Crop sac/gland
  - produce crop milk under stimulation of prolactin
  - prolactin released due to brood patch tactile stimulation
  - prolactin stimulates crop and inhibits ovulation
Mammary Glands

• Milk production by process called lactation
• Mammary gland evolved from sweat glands
Hypothesis

• Mammal-like reptiles (therapsids)
  - incubated eggs with brood patch or pouch.
  - Moist patch conducive to optimal growth and survival.

• Secretions of salt, proteins and fat
  - serve as a nutrient source
  - maximize growth and survival.

• Localized sweat glands would enlarge for increased synthesis.
Monotremes

- Numerous small milk-secreting glands
  - open onto two ventrolateral areas of bare skin
  - MILK FIELDS or AREOLAE

- Platypus
  - female lies on back - milk is released onto skin
  - sucked up by young using mammary hairs

- Echidna
  - milk fields in fold of skin - marsupium
  - mechanism similar to that in platypus
Mammary Organization

echidna  marsupial  human

ungulate  cow
Metatherians

• The ducts of a group of milk secreting glands open at single point - a teat
  - teats are scattered around marsupium or ventral abdomen
• At birth, young marsupial has developed forelimbs, jaw and mouth -
  - crawl into marsupium and attach to teat
• Teat swells-
  - enable a semi-permanent connection
  - milk is ejected without need for suckling
Eutherians

• Mammary gland opens to the outside by one or more ducts at the nipple
• Can also open into cavities or cisterns with a hollow projecting teat (e.g., utter of cow)
• Usually paired with one or multiple pairs
• Located along a ventrolateral line - mammary ridge
Human Mammary Glands

• Paired organs
  - (but others can be present)

• Variation in size / shape due to fat deposition
  - no major differences in milk synthetic or secretion ability

• Each breast has 15-20 lobes of glandular tissue
  - separated by fat and ligamentous tissue (suspensory ligaments of Cooper)

One of the most referred cases of accessory breast tissue from 1827 that involves Therese Ventre of Marseilles. Veititre had an accessory breast on the lateral aspect of her left thigh that enlarged during puberty and produced milk when she became pregnant. Loukas et al Am Surgeon 73 (2007)
Pregnancy and Lactation

• Late adolescence
  - breast mitotically dormant and undifferentiated

• Mid pregnancy
  - breast matures under stimulation of estrogens and progesterone
  - tip of ducts differentiate into alveolar milk-secreting cells
Each lobe contains grape-like clusters of glandular cells - mammary alveoli
Mid-pregnancy

• At mid-pregnancy
  - mammary glands cells have little rER and Golgi
  - casein granules few
  - casein major proteins of milk

• Under stimulation from
  - placental lactogens and glucocorticoids
  - the alveolar cells increase rER and Golgi
    • allowing casein synthesis
  - (chorionic somatomammotropin in humans)
Milk is synthesized /secreted from each lobe into secondary mammary tubules
At birth

- **Prolactin** secretion increases
- **Prolactin** causes
  - casein gene to be transcribed
  - stabilizes the message
- **During lactation in mouse**
  - can produce 10% body wt in milk/day
  - 80% of proteins in milk caseins
    - $\beta$-casein most abundant
Conception

Pregnancy

Progesterone

Oestrogens

Birth

Lactation

Oestradiol levels remain basal until cycles begin

Weaning

Prolactin

200 ng/ml

hPL

Mature milk

Transitional milk

Colostrum

Milk secretion

Weeks postpartum

1 2 3
Hormonal Control of Milk Release

- With drop in estrogens and progesterone,
  - **prolactin** can stimulate alveolar synthesis of milk
- **Suckling**
  - inhibits FSH and LH release
  - but stimulates PRL release
    - (levels rise 2-20 fold in 30 mins)
- **First milk** *colostrum*
- 'Real' milk appearing in 2-3 days
Milk Ejection Reflex

Oxytocin

Prolactin
Colostrum

- Secreted during first week
- **Contains:**
  - Higher minerals, fat soluble vitamins (A,D,E,K), and immunoglobulins (IgGs)
- **Transitional milk** - lower protein and IgGs
- **Mature milk** - increase in lactose, fat, and total calories
Can nursing be contraceptive?

- No - high failure rate
- Nursing blocks ovulation 6-9 mo
- Non-nursing women ovulate 1 - 4 mo after birth
- After 6-9 months regular menstrual cycle begins whether nursing or not
- First post-partum ovulation occurs BEFORE menstruation!
!Kung hunter-gathers

• Very long birth interval - 44.1 months
• Women nurse and have coitus frequently
  - use no contraceptives
• BUT - they nurse briefly but frequently
  - every 13 mins during day for 1 min or so
• Frequent nursing and weaning at 3.5 years
  - blocks FSH/LH due to high prolactin levels
Bioamplification of fat soluble chemicals

Dramatic increase in levels of fire retardants in Swedish women's bodies, 1972 to 1997