



**OKLAHOMA
BREASTFEEDING
RESOURCE CENTER**

Our Team



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Disclosure

- This class will not refer to products, drugs, or devices of a commercial company with which we have a significant relationship.
- We have not accepted a fee from a commercial company for this class.
- Supported with funding from the Oklahoma State Department of Health.
- Mannel serves as Executive Director of the Oklahoma Mothers' Milk Bank, a statewide nonprofit.

How Does It Work?

Milk Production and Expression

- How the breast makes milk
- Indications for expression of milk
- Mechanics of expression
- Milk collection and storage
- Troubleshooting common problems



How the Breast Makes Milk



US Breastfeeding Committee



With permission, Gannaway

Mammogenesis

- Breast development begins during first weeks of fetal gestation
- Next major development during puberty

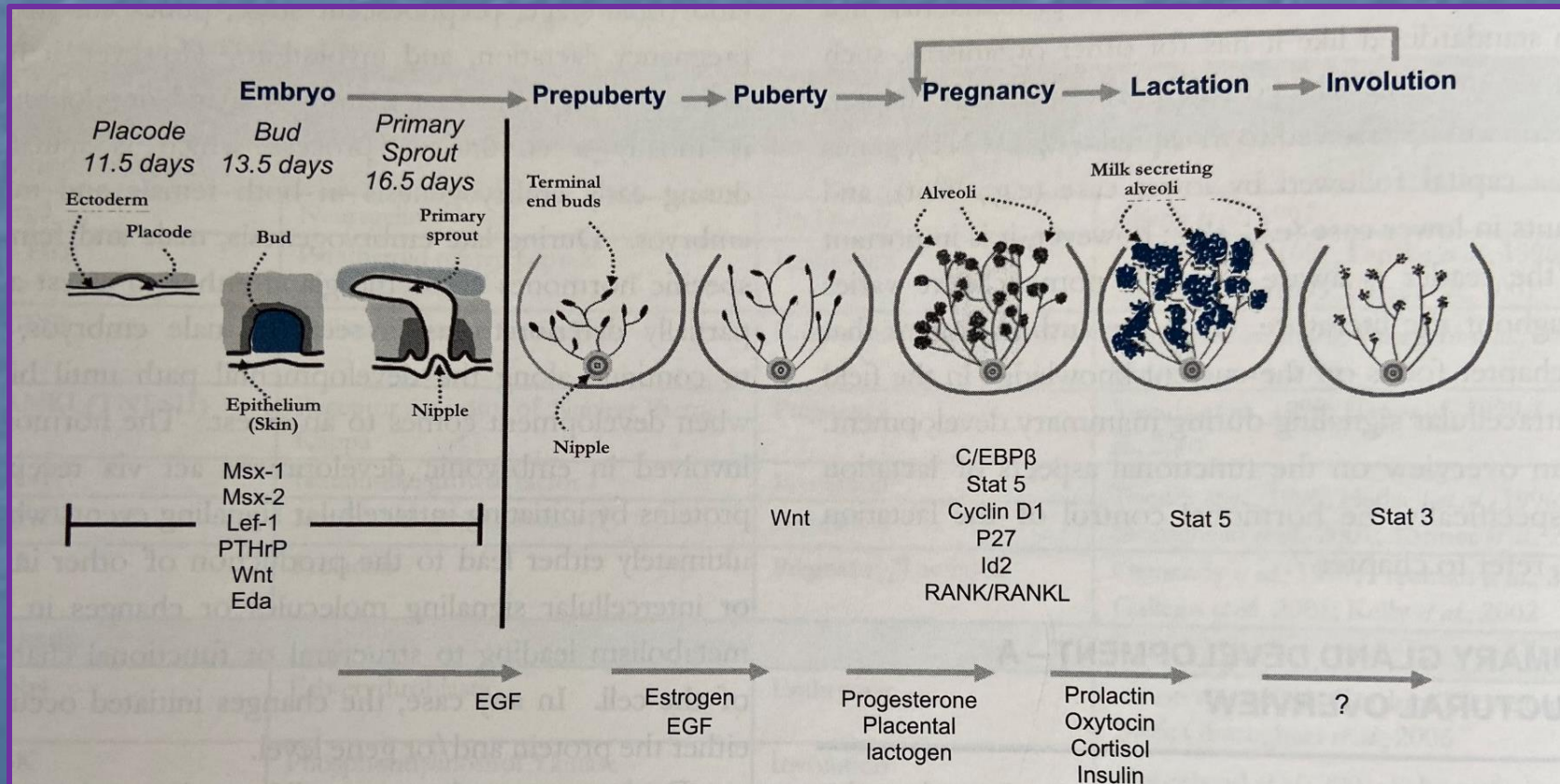
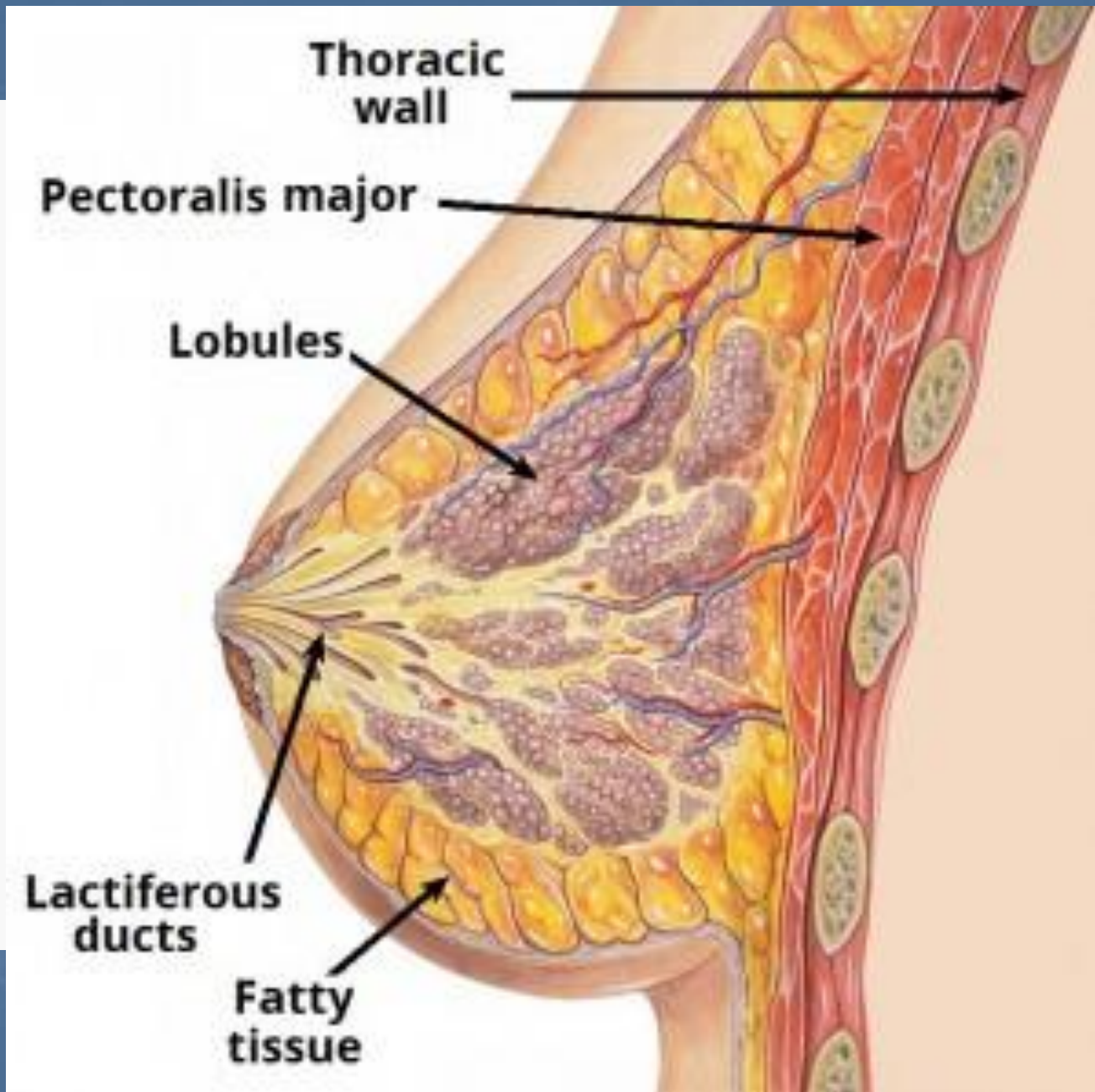
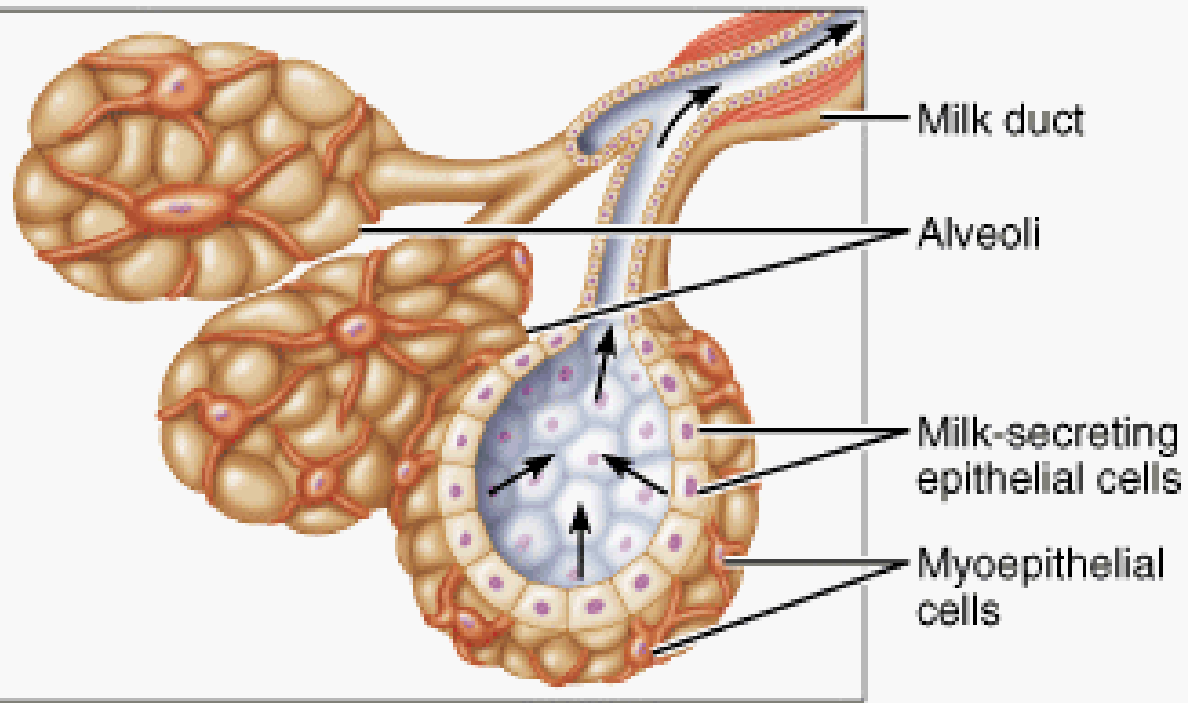


Figure from Hale & Hartmann, 2007

Mammogenesis in Early Pregnancy

- Estrogen – ductal system
- Progesterone – lobes and alveoli
- Prolactin – nipple growth
- Placental lactogen – areolar growth

Transition of breast from non-secreting organ to secreting organ



Lactogenesis I

- Lactogenesis I = capacity of mammary gland to secrete milk from mid-pregnancy to late pregnancy
- Lactation occurs after 16 weeks of pregnancy
- Lactogenesis I continues until 2-3 days after birth

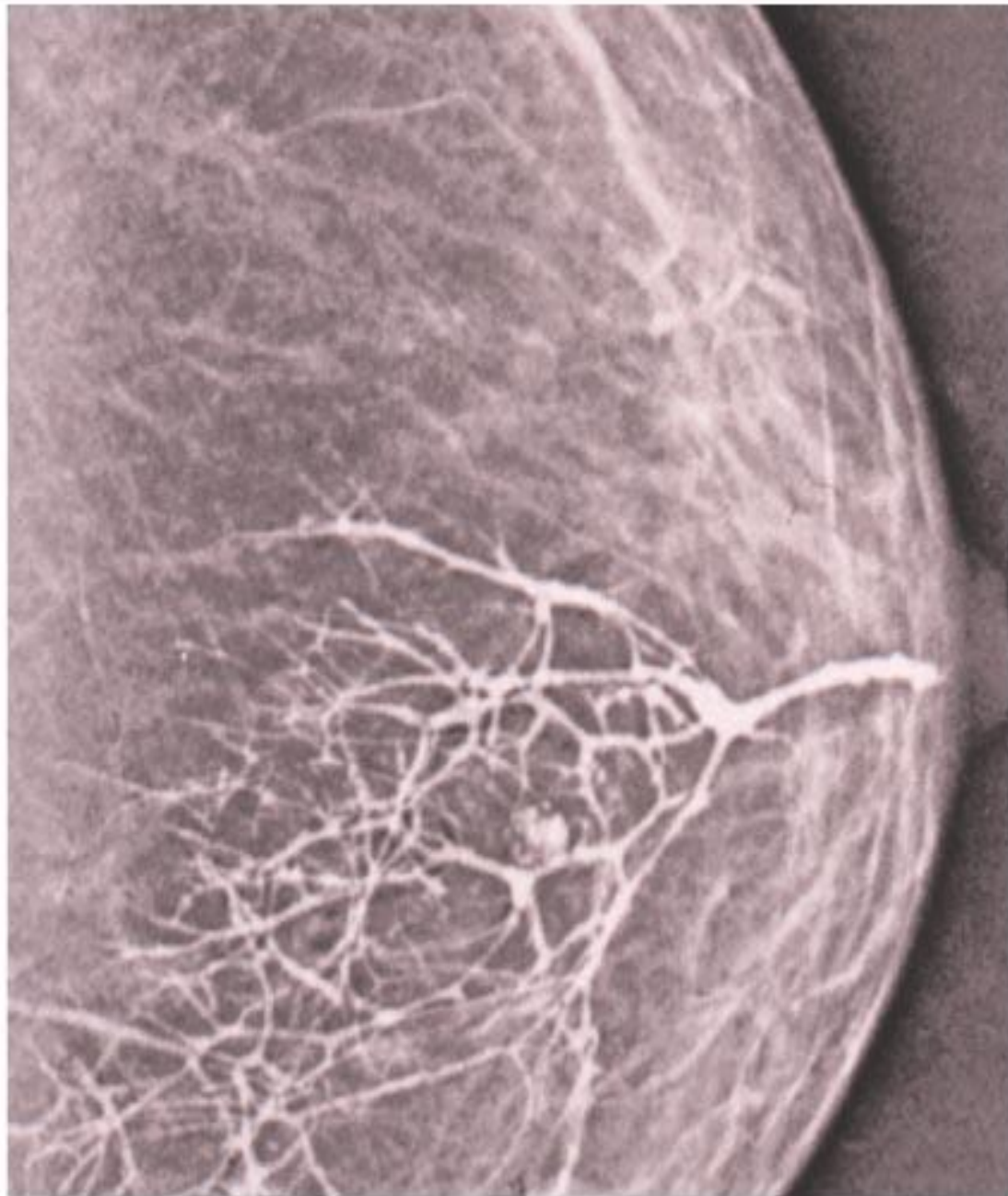
Colostrum

- Increased protein
 - Higher concentration of immunoglobulins
 - Overall dose to baby = 1 g/day
- Decreased fat
- Decreased lactose
- Low water/fluid volume



Milk ducts and
ductules

Figure A.01



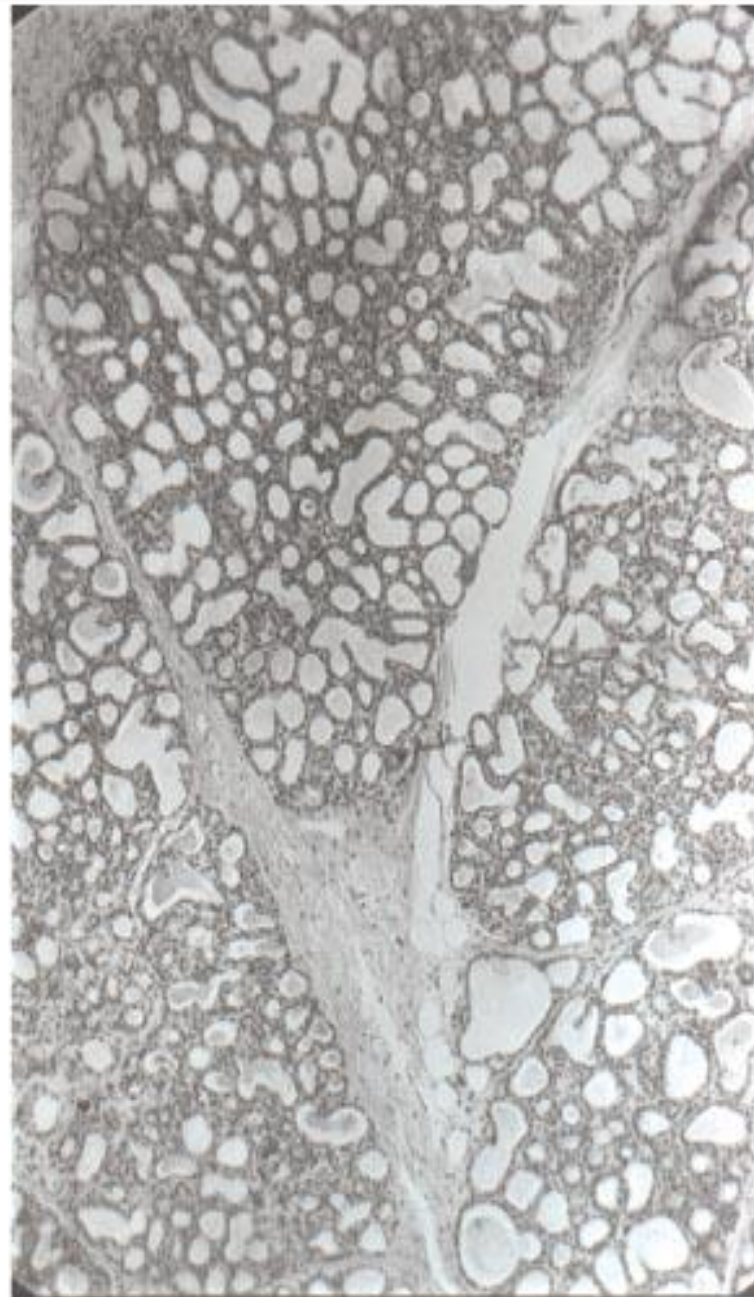
Lactogenesis II

- Onset of copious milk secretion after birth
- Milk volume increases rapidly, then abruptly levels off
- Triggered by a rapid drop of progesterone after delivery of placenta
- Occurs 2-3 days after birth

Secretory activation with delivery of placenta

Milk droplets

Figure A.07



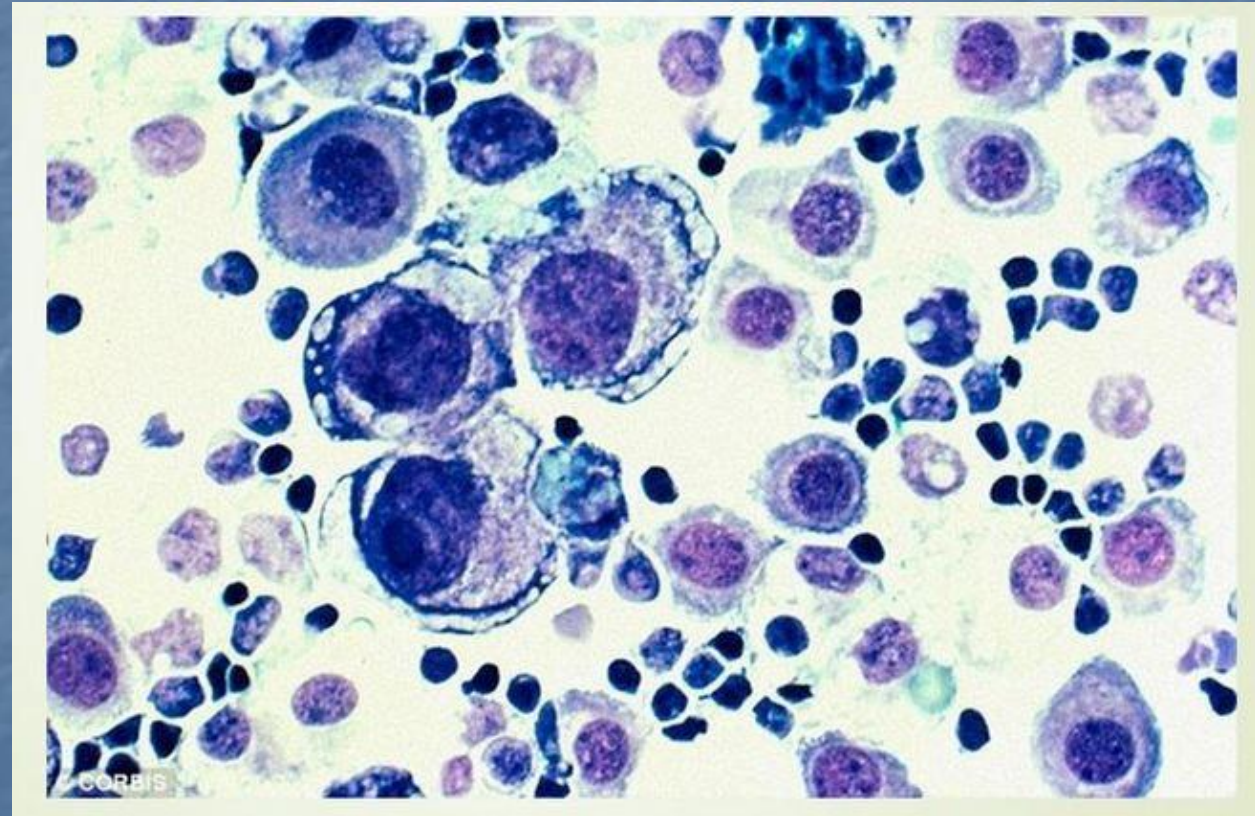
Transitional-Mature Milk

- Lower protein concentration
 - Overall dose to baby = 1 g/day
- Higher fat
 - Most recently made milk (end of feeding)
- Higher lactose
 - Less recently made milk (start of feeding)
- Higher water concentration (>85%)



Milk is a Bioactive Substance

- Immunoglobulins
 - Secretory IgA, IgG, IgM, IgD, IgE
- White blood cells
 - T & B cells, neuts, lymphs, macrophages
- Enzymes - lactase
- Lactoferrin
- Oligosaccharides
- Hormones



DID YOU EVER WONDER WHAT'S IN... ?

BREASTMILK

WATER

CARBOHYDRATES (energy source)

Lactose
Oligosaccharides (see below)

CARBOXYLIC ACID

Alpha hydroxy acid
Lactic acid

PROTEINS

(building muscles and bones)

Whey protein
Alpha-lactalbumin
HAMELET (Human Alpha-lactalbumin Made Lethal to Tumour cells)
Lactoferrin
Many antimicrobial factors (see below)
Casein
Serum albumin

NON-PROTEIN NITROGENS

Creatine
Creatinine
Urea
Uric acid
Peptides (see below)
Amino Acids (the building blocks of proteins)
Alanine
Arginine
Aspartate
Cysteine
Cystine
Glutamate
Histidine
Isoleucine
Leucine
Lycine
Methionine
Phenylalanine
Proline
Serine
Taurine
Threonine
Tryptophan
Tyrosine
Valine
Carnitine (amino acid compound necessary to make use of fatty acids as an energy source)
Nucleotides (chemical compounds that are the structural units of RNA and DNA)
5'-Adenosine monophosphate (5'-AMP)
3'-5'-Cyclic adenosine monophosphate (3'-5'-cyclic AMP)
5'-Cytidine monophosphate (5'-CMP)
Cytidine diphosphate choline (CDP choline)
Guanosine diphosphate (UDP)
Guanosine diphosphate - mannose
3'- Uridine monophosphate (3'-UMP)
5'-Uridine monophosphate (5'-UMP)
Uridine diphosphate (UDP)
Uridine diphosphate hexose (UDPH)
Uridine diphosphate-N-acetyl-hexosamine (UDPAH)
Uridine diphosphogluconic acid (UDPGA)
Several more novel nucleotides of the UDP type

FATS

Triglycerides
Long-chain polyunsaturated fatty acids
Docosahexaenoic acid (DHA) (important for brain development)
Arachidonic acid (AHA) (important for brain development)
Linoleic acid
Alpha-linolenic acid (ALA)
Eicosapentaenoic acid (EPA)
Conjugated linoleic acid (Rumenic acid)
Free Fatty Acids
Monounsaturated fatty acids
Oleic acid
Palmitoleic acid
Heptadecenoic acid
Saturated fatty acids
Stearic
Palmitic acid
Lauric acid
Myristic acid

Phospholipids

Phosphatidylcholine
Phosphatidylethanolamine
Phosphatidylinositol
Lysophosphatidylcholine
Lysophosphatidylethanolamine
Plasmalogens

Sphingolipids

Sphingomyelin
Gangliosides
GM1
GM2
GM3
Glucosylceramide
Glycosphingolipids
Galactosylceramide
Lactosylceramide
Glyboetraosylceramide (GB3)
Glybooside (GB4)

Sterols

Squalene
Lanosterol
Dimethylsterol
Methosterol
Lathosterol
Desmosterol
Triacylglycerol
Cholesterol
7-dehydrocholesterol
Stigma-and campesterol
7-ketocholesterol
Sitosterol
B-lathosterol
Vitamin D metabolites
Steroid hormones

VITAMINS

Vitamin A
Beta. carotene
Vitamin B6
Vitamin B8 (Inositol)
Vitamin B12
Vitamin C
Vitamin D
Vitamin E
a-Tocopherol
Vitamin K
Thiamine
Riboflavin
Niacin
Folic acid
Pantothenic acid
Biotin

MINERALS

Calcium
Sodium
Potassium
Iron
Zinc
Chloride
Phosphorus
Magnesium
Copper
Manganese
Iodine
Selenium
Choline
Sulphur
Chromium
Cobalt
Fluorine
Nickel

METAL

Molybdenum (essential element in many enzymes)

GROWTH FACTORS (aid in the maturation of the intestinal lining)

Cytokines
interleukin-1β (IL-1β)
IL-2
IL-4
IL-6
IL-8
IL-10
Granulocyte-colony stimulating factor (G-CSF)
Macrophage-colony stimulating factor (M-CSF)
Platelet derived growth factors (PDGF)
Vascular endothelial growth factor (VEGF)
Hepatocyte growth factor-α (HGF-α)
HGF-β
Tumor necrosis factor-α
Interferon-γ
Epithelial growth factor (EGF)
Transforming growth factor-α (TGF-α)
TGF-β1
TGF-β2
Insulin-like growth factor-I (IGF-I) (also known as somatomedin C)

Insulin-like growth factor-II
Nerve growth factor (NGF)
Erythropoietin

PEPTIDES

(combinations of amino acids)

HMGF I (Human growth factor)
HMGF II
HMGF III
Cholecystokinin (CCK)
β-endorphins
Parathyroid hormone (PTH)
Parathyroid hormone-related peptide (PTHrP)
β-defensin-1
Calcitonin
Motilin
Bombesin (gastric releasing peptide, also known as neuromedin B)
Neurotensin
Somatostatin

HORMONES

(chemical messengers that carry signals from one cell, or group of cells, to another via the blood)

Cortisol
Triiodothyronine (T3)
Thyroxine (T4)
Thyroid stimulating hormone (TSH) (also known as thyrotropin)
Thyroid releasing hormone (TRH)
Prolactin
Oxytocin
Insulin
Corticosterone
Thrombopoietin
Gonadotropin-releasing hormone (GnRH)
GRH
Leptin (aids in regulation of food intake)
Ghrelin (aids in regulation of food intake)
Adiponectin
Feedback inhibitor of lactation (FIL)
Eicosanoids
Prostaglandins (enzymatically derived from fatty acids)
PG-E1
PG-E2
PG-F2
Leukotrienes
Thromboxanes
Prostacyclins

ENZYMES

(catalysts that support chemical reactions in the body)

Amylase
Arylsulfatase
Catalase
Histaminase
Lipase
Lysozyme
PAF-acetylhydrolase
Phosphatase
Xanthine oxidase

ANTIPROTEASES

(thought to bind themselves to macromolecules such as enzymes and as a result prevent allergic and anaphylactic reactions)

a-1-antitrypsin
a-1-antichymotrypsin

ANTIMICROBIAL FACTORS

(are used by the immune system to identify and neutralize foreign objects, such as bacteria and viruses.)

Leukocytes (white blood cells)
Phagocytes
Basophils
Neutrophils
Eosinophils
Macrophages
Lymphocytes
B lymphocytes (also known as B cells)
T lymphocytes (also known as T cells)
stgA (Secretory immunoglobulin A) (the most important anti-infective factor)
IgA2
IgG
IgD
IgM
IgE

Complement C1
Complement C2
Complement C3
Complement C4
Complement C5
Complement C6
Complement C7
Complement C8
Complement C9
Glycoproteins
Mucins (attaches to bacteria and viruses to prevent them from clinging to mucosal tissues)
Lactadherin
Alpha-lactoglobulin
Alpha-2 macroglobulin
Lewis antigens
Ribonuclease
Haemagglutinin inhibitors
Bifidus Factor (increases growth of Lactobacillus bifidus - which is a good bacteria)
Lactoferrin (binds to iron which prevents harmful bacteria from using the iron to grow)
Lactoperoxidase
B12 binding protein (depletes microorganisms of vitamin B12)
Fibronectin (makes phagocytes more aggressive, minimizes inflammation, and repairs damage caused by inflammation)
Oligosaccharides (More Than 200 Different Kinds)

FORMULA

WATER

CARBOHYDRATES

Lactose
Corn maltodextrin

PROTEIN

Partially hydrolyzed reduced minerals whey protein concentrate (from cow's milk)

FATS

Palm olein
Soybean oil
Coconut oil
High oleic safflower oil (or sunflower oil)
M. alpina oil (Fungal DHA)
C.ohnii oil (Algal ARA)

MINERALS

Potassium citrate
Potassium phosphate
Calcium chloride
Tricalcium phosphate
Sodium citrate
Magnesium chloride
Ferrous sulphate
Zinc sulphate
Sodium chloride
Copper sulphate
Potassium iodide
Manganese sulphate
Sodium selenate

VITAMINS

Sodium ascorbate
Inositol
Choline bitartrate
Alpha-Tocopheryl acetate
Niacinamide
Calcium pantothenate
Riboflavin
Vitamin A acetate
Pyridoxine hydrochloride
Thiamine mononitrate
Folic acid
Phylloquinone
Biotin
Vitamin D3
Vitamin B12

ENZYME

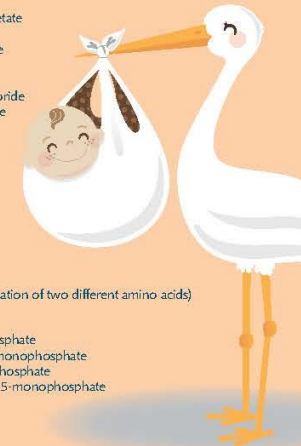
Trypsin

AMINO ACID

Taurine
L-Carnitine (a combination of two different amino acids)

NUCLEOTIDES

Cytidine 5-monophosphate
Disodium uridine 5-monophosphate
Adenosine 5-monophosphate
Disodium guanosine 5-monophosphate
Soy Lecithin



Developed as a student project for the Breastfeeding Course for Health Care Providers, Douglas College, New Westminster, BC, Canada - © 2007 by Cecily Heslett, Sherri Hedberg and Haley Rumble.

Lactogenesis II

- Continued milk production
- What is it dependent on??
 - MILK REMOVAL
- Reflects infant's appetite rather than mom's ability to make milk
 - "supply and demand"



Delayed or Impaired Lactogenesis

- Cesarean birth
- Diabetes, type I
- Obesity
- Polycystic Ovary Syndrome (PCOS)
- Hypertension
- Stress
- Retained Placenta
- Postpartum Hemorrhage

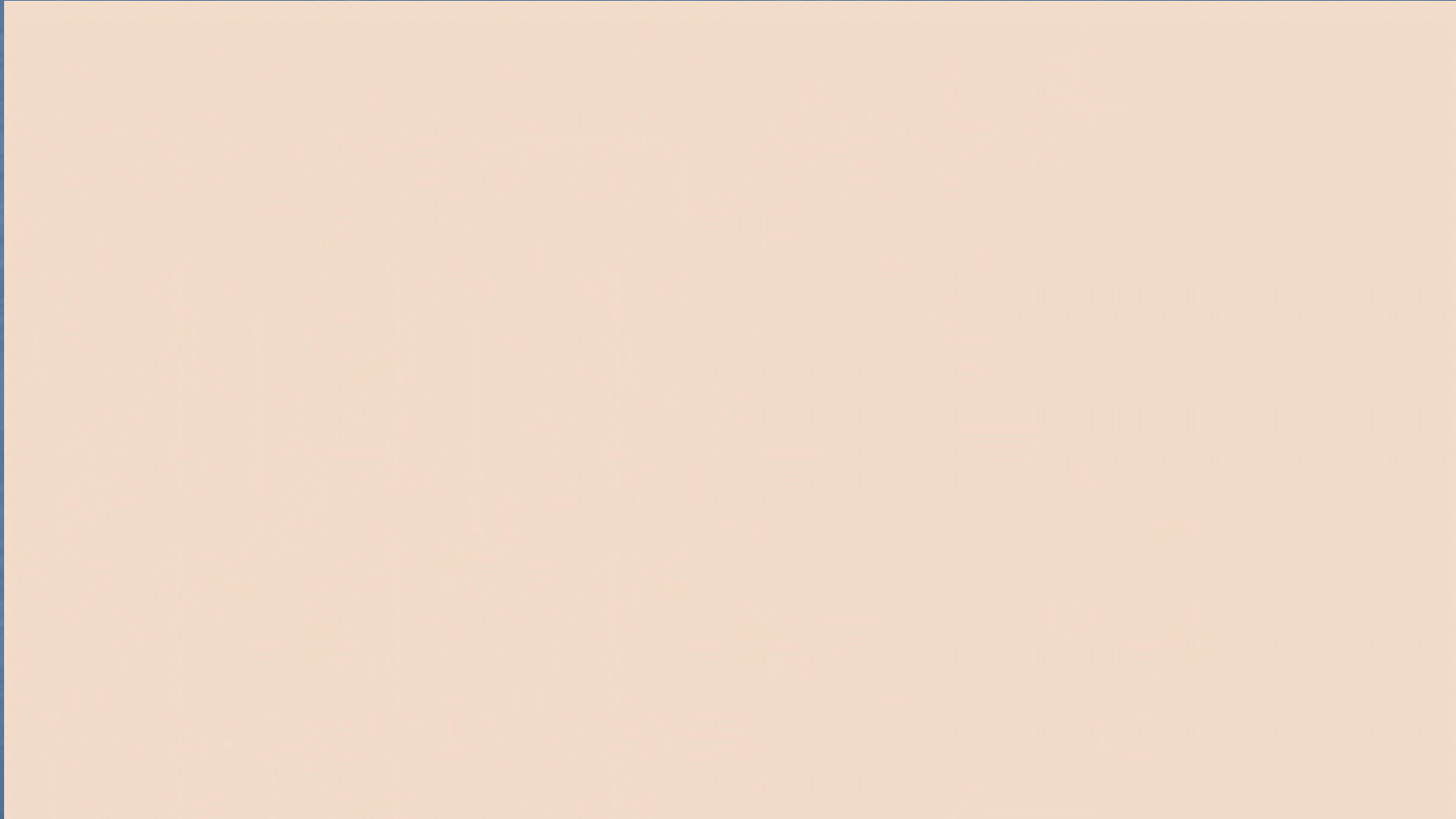
Indications for Expression of Milk

Indications for Expression of Milk

- Delayed initiation of breastfeeding
- Interruption of breastfeeding
- Decreased milk supply
- Relief of engorgement
- Donating to a milk bank



EXPRESSING MILK FOR your premature baby



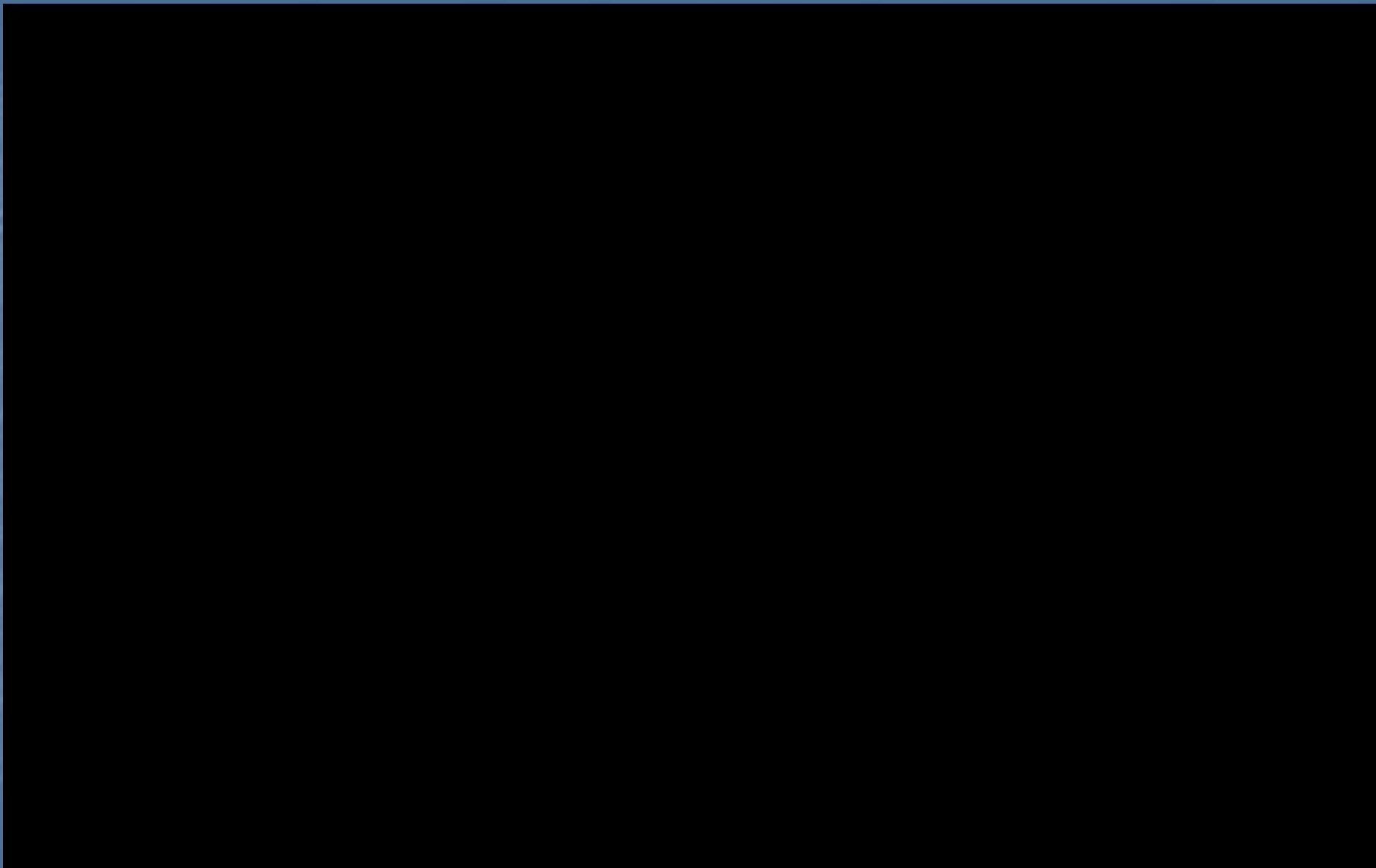
Hand Expression



Hand Expression

- Most common form of milk expression
- Is more effective for expressing colostrum
- When mechanical breast pump not available
- Useful for stimulating milk ejection reflex (MER) before using mechanical pump
- When used after pumping, more effectively drains the breast: “hands-on pumping”

Early Hand Expression Increases Later Milk Production



Pumping with hand
pump

Figure 1.13



Automatic Electric Pumps

- Double-pumping → ↑ milk collection
- Best for mothers working full-time
- Best for sustaining milk production (NICU moms)
- Faster pumping
- Less chance of injury



Milk Collection

Initiating and sustaining milk production for a preterm/sick infant:

- Initiate pumping w/in 6 hours of delivery
 - Consider starting with hand expression
- Double-pump with a hospital grade breast pump
- Stimulate MER (breast massage, heat,...)
- Hands-on pumping!
- Pump 8-10 times/day for 10-15 min each
- Practice kangaroo care daily

Pumping FAQs from moms

- ***When do I count the start of a pumping session?***

Pumping time starts from beginning of last session to beginning of next session

- ***How often do I need to clean/sanitize my pump parts?***

Sanitize pump once per day, rinse well after each use during the day

- ***Should I take some type of herbal supplement to increase my milk supply?***

There is no evidence to support, some will exclude you as a milk donor

Rusty pipe syndrome

Figure A.08





Internet



BfMed,2020



Internet

Average Milk Volumes

PP Dy 1: 40 - 120 ml

PP Dy 2: 100 - 200 ml

PP Dy 3: 200 - 400 ml

PP Dy 5 – 10: 500 ml (~ 1oz/brst q 3 hrs)

By 1 month postpartum, most mothers are producing 700-800 ml/day.

- ABM Protocol #3: Supplementary Feedings in the Healthy Term Breastfed Neonate 2017

Average Infant Intake

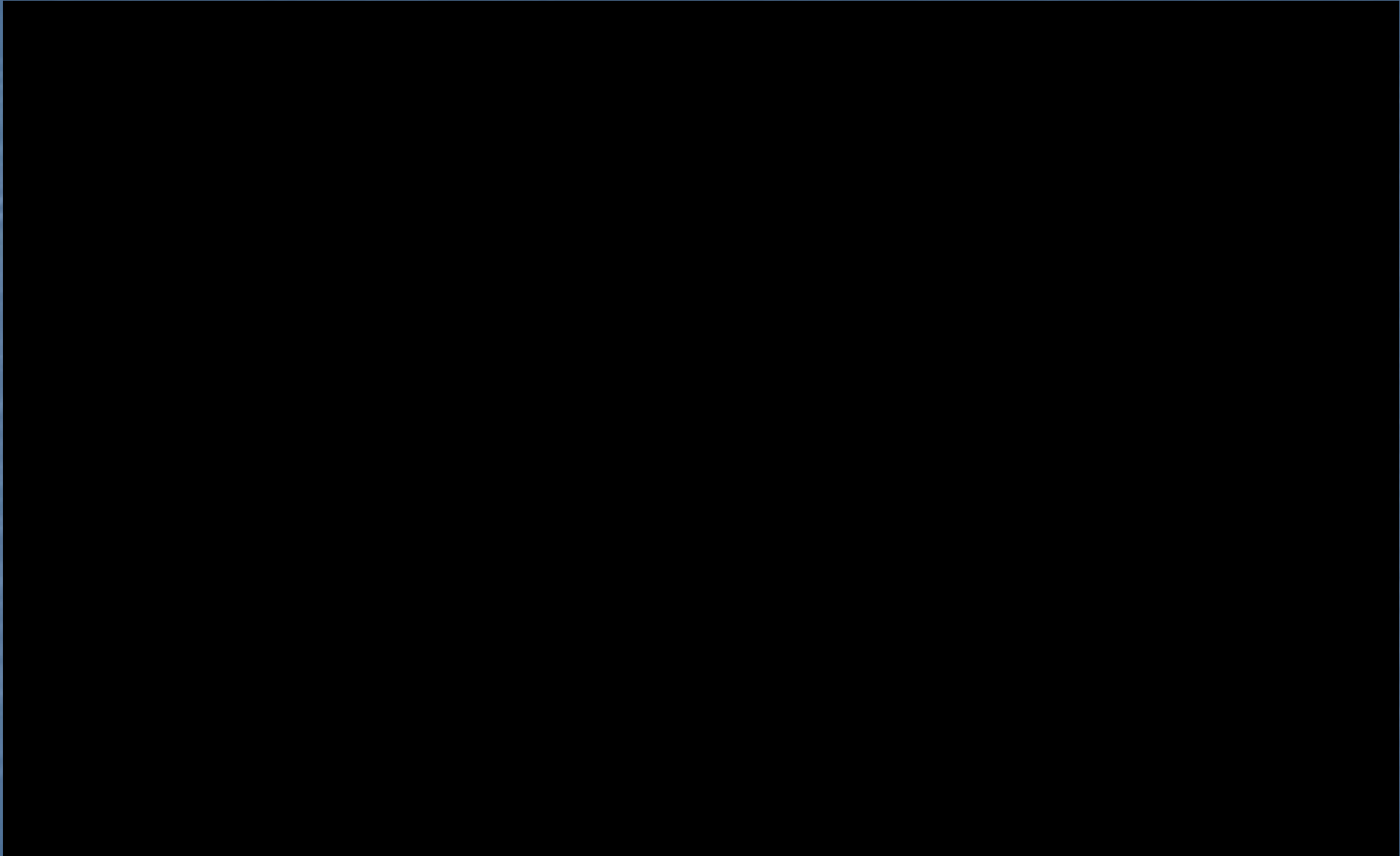
- Day 1: 2-10 ml/fdg
 - Day 2: 5-15 ml/fdg
 - Day 3: 15-30 ml/fdg
 - Day 5: 30-60 ml/fdg
-
- ABM Protocol #3: Supplementary Feedings in the Healthy Term Breastfed Neonate 2017

Low or Decreasing Milk Production

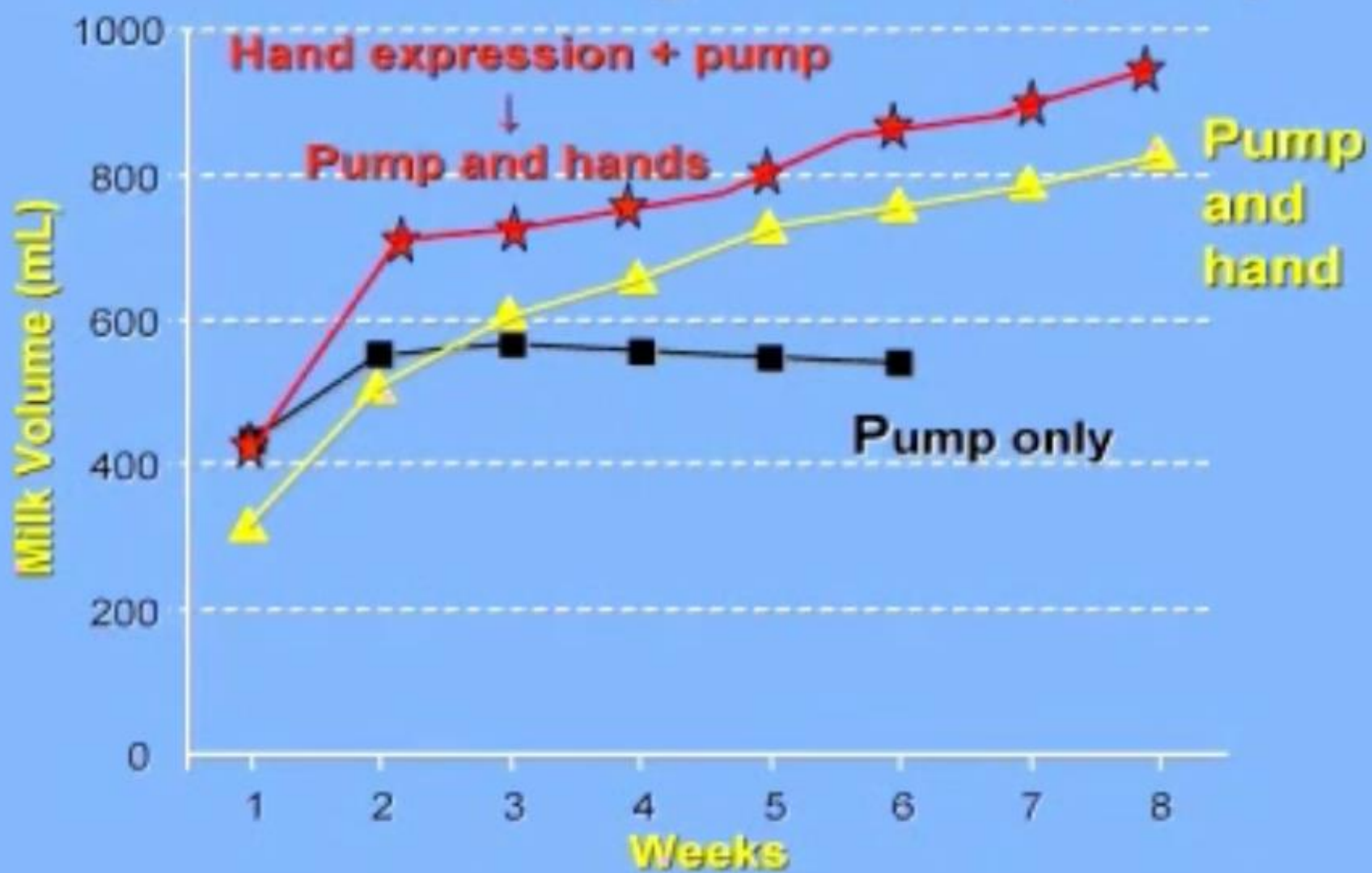
- Insure frequent pumping (8-10x/day)
- Tips to elicit milk release
 - Relaxation tips
 - Breast massage, heat
 - Kangaroo care w/ baby
- Fatigue, stress, pain, anxiety/depression
- Rule out maternal medications
- Insure effective type of pump
- Hands-on pumping!



Maximizing Milk Production with Hands On Pumping



More milk using hands + pump









Pain with Pumping

- Insure proper flange fit
- Decrease length of pumping sessions
- Decrease vacuum
- Insure vacuum is released or interrupted during pumping sessions
- Rule out infection





OBRC



OBRC







OKLAHOMA
mothers' milk bank



www.okmilkbank.org

Our New Home!
940 NE 13th, Garrison Tower, Ste 1220
Oklahoma City
405-297-LOVE



DONOR MOTHERS





OKLAHOMA
mothers' milk bank



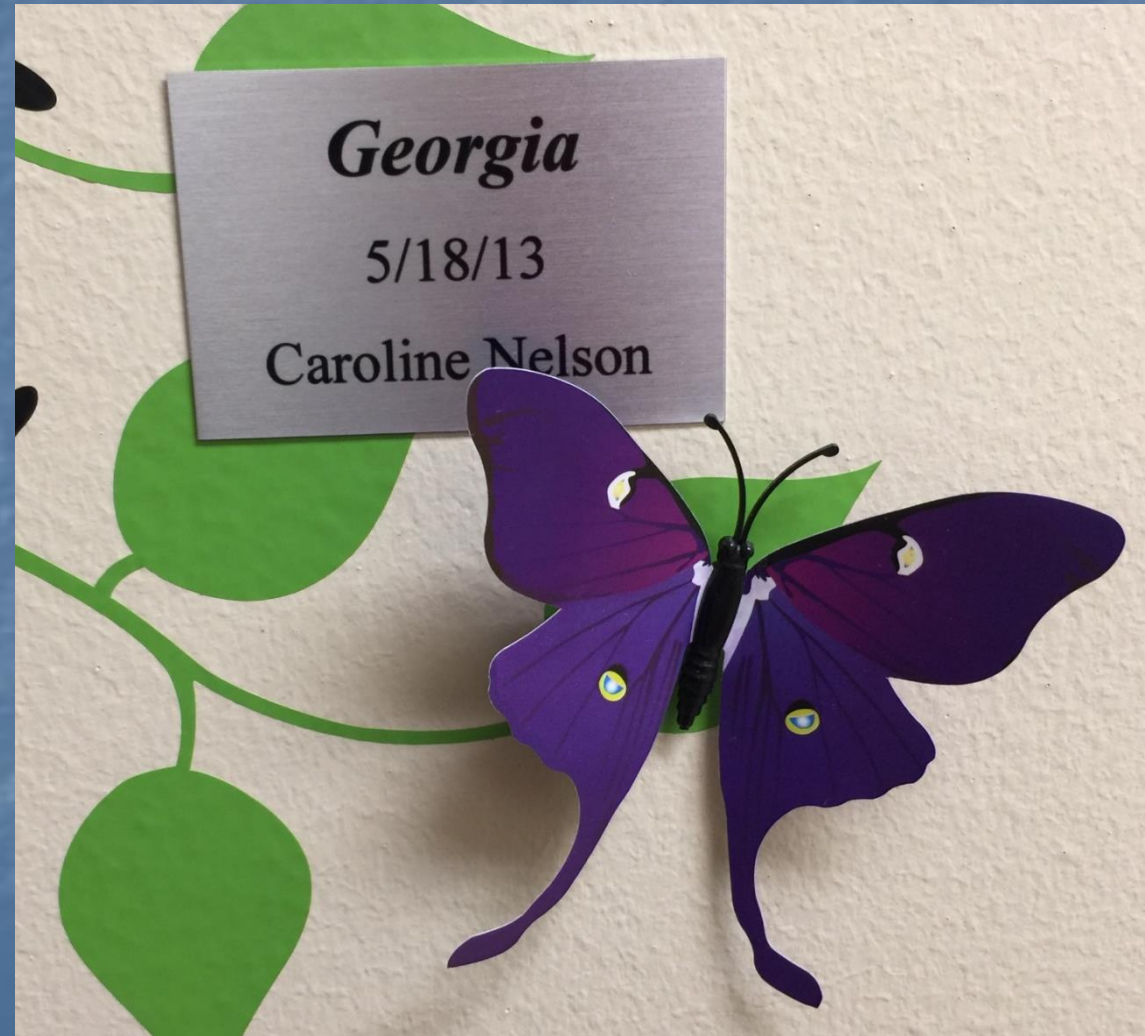
Silas Murphy Memorial Wall



Oklahoma Mothers' Milk Bank



Unexpected Death In Utero



Why donate milk after a perinatal or infant loss?

To be able to donate milk in honor and in memory of her, it's her legacy

"This process has been so healing in my grief journey. I'm thankful you guys exist!" Londyn, mother of Wolfgang

It felt good... like I'm still a mom

One way my loss can help other babies... one thing that I feel like I can do that's positive

"I didn't want to let go of that physical connection to her. I wanted to do something in her honor to help other families." Brandy, mother of Melody



Thank you to City of Tulsa's ARPA Grant!