

## BREAST ANATOMY & HISTOLOGY

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### Objectives

- Locate the major structures of the breast
- Discuss the innervation and blood supply of the breast.
- Describe the histology of the human breast

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### PLAN

- Introduction
- External view
- Internal view ('new' anatomy)
- Supply to the breast
- Histology

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### Breast...

- Medical name: 'mammary gland'
- Comes from Latin word for breast '*mamma*' (probably due to infant's hunger cry 'mamma')

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### ... a So Special Organ

- Primary biological function: to make milk
- Symbol of female gender, beauty, sex appeal.... Differing among cultures and ages
- Symbol of death (breast cancer)
- The only organ not fully developed at birth
- Changing appearance during a woman's life:
  - Before, during and after puberty
  - During the menstrual cycle
  - During pregnancy and breastfeeding
  - During menopause

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### A solid foundation for IBCLCs...

- 'A thorough understanding of the anatomy, histology and physiology of the breast provides a solid foundation upon which to investigate and treat women and infants experiencing breastfeeding difficulties' (Geddes D., 2007).

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## General anatomy: Location

- Superficial to the pectoralis major muscle




Image from [image.slidesharecdn.com/breastanatomy](http://image.slidesharecdn.com/breastanatomy)

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## Location (cont.)

- Vertically: between 2<sup>nd</sup> and 6<sup>th</sup> rib in the midclavicular line.
- Horizontally: from lateral border of sternum to the mid axillary line along the 4<sup>th</sup> rib.

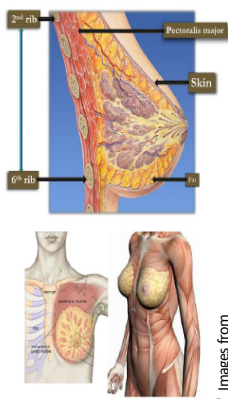


Image from [image.slidesharecdn.com/breastanatomy](http://image.slidesharecdn.com/breastanatomy)

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## PLAN

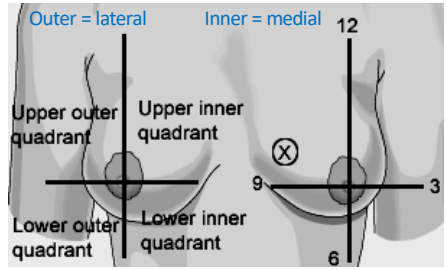
- Introduction
- External view
  - Description tool
  - Size
  - Skin
  - Areola
  - Nipple
- Internal view ('new' anatomy)
- Supply to the breast
- Histology

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## Description: two methods

- Quadrants: UOQ, UIQ, LOQ, LIQ
- Face of a clock: 'at 10 o'clock position'



Outer = lateral Inner = medial

Upper outer quadrant Upper inner quadrant

Lower outer quadrant Lower inner quadrant

12 9 3 6

http://www.wdv.com/Cancer/Breast/CBE/

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## Size and milk production

- No direct relation between **breast size** and **milk production**: what is important is the amount of **glandular tissue**.  
E.g. large fatty breasts could make less milk than small breasts full of glandular tissue..
- Breast size is more or less related to **milk storage capacity**, which is different than milk production capacity (*see session on physiology*).

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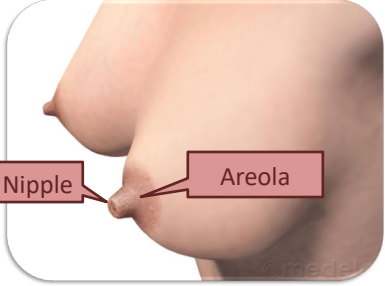
## During pregnancy

- Most common: gradual growth throughout entire pregnancy.
- Greatest rate of breast growth: first 5 months.
- Increase in breast volume can range between 12 - 227 ml.
- Some women experience minimal breast enlargement ( less than 1 cup size).
- No direct relationship between growth in pregnancy and milk production at 1 month

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## External appearance - Skin



Nipple  
Areola

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## Skin of the breast

- It includes the nipple, areola and general skin.
- Thin, flexible, elastic cover of the breast, adherent to the fat-laden subcutaneous tissue.
- It contains hair, sebaceous glands and sweat glands.
- The nipple and areola are extremely elastic and can stretch 2-3 times resting length.



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## Areola

- Circular pigmented area which surrounds the nipple
- Constructed of smooth muscle, elastic connective tissue fibers in radial & circular arrangement.
- Contains numerous nerve endings.
- Surrounded by hair follicles (not on it).
- Contains Montgomery's tubercles, also called 'areola glands'.



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## Areolar Glands = Montgomery's tubercles

- Within the areola
- Contain openings for sebaceous, lactiferous and sweat glands.
- Enlarge during pregnancy, become prominent.
- Secrete a substance that lubricates and protects the nipples and small amount of milk.



The Breastfeeding Atlas: Fig. 2.19

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## Areola Glands (AGs)




Figure 19a. Milk-white discharge and palpable mass associated with Montgomery gland blockage.

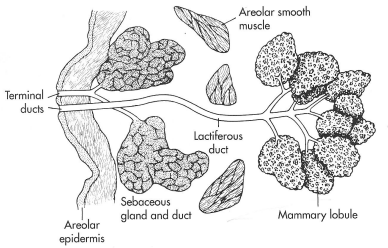
Nicholson B T et al. Radiographics. 2009;29:509-523

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## Areolar glands: mammary milk glands AND sebaceous glands



Terminal ducts  
Areolar smooth muscle  
Lactiferous duct  
Mammary lobule  
Sebaceous gland and duct  
Areolar epidermis

Tubercle of Montgomery and underlying structures. Lactiferous duct may join sebaceous gland ducts and terminate at common opening in areola epidermis.

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Lawrence 2-9

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## Nipple

- Conical elevation located in the center of the areola.
- Average diameter is 1.6 cm, length 0.7 cm.
- Nipples vary in size and shape, some variations carry the potential for a difficult latch.
- Diameter increases during pregnancy (by 9.5 to 11.5 mm) *(and at each pregnancy)*.

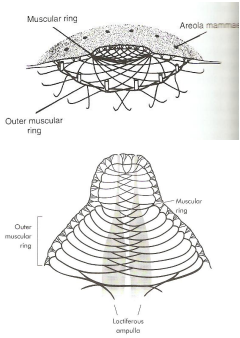
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The Breastfeeding Atlas

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## Nipple (cont.)

- Smooth muscle fibers function as a closure mechanism to keep milk from leaking.
- Longitudinal inner muscles and outer circular muscles make the **nipple erect when stimulated**.



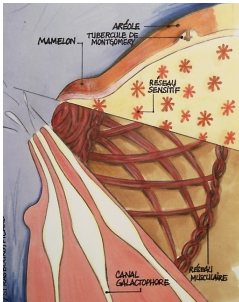
Lawrence 2-10  
Lawrence 2-11

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## Summing-up

- Very rich muscular and nervous structure of the nipple & areola complex
- Role of the areolar glands
- Let's enter through a nipple pore...



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## PLAN

- Introduction
- External view
- Internal view ('new' anatomy)
  - Historical perspective
  - New research methodology
  - New findings
  - Clinical implications
- Supply to the breast
- Histology

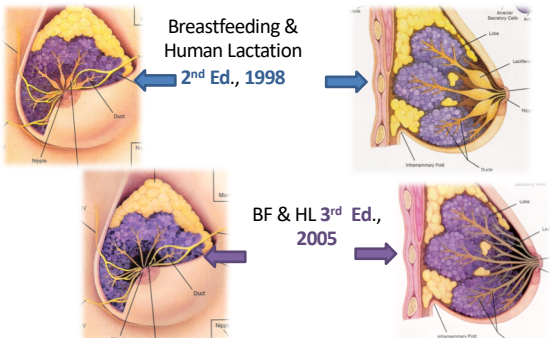
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## Between two editions (1998-2005)

Breastfeeding & Human Lactation  
2<sup>nd</sup> Ed., 1998

BF & HL 3<sup>rd</sup> Ed., 2005



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## Historical perspective

- All previous diagrams based on drawings published by Cooper in 1840 ("On the anatomy of the breast") from dissections done on cadavers.
- Hot wax was injected into the nipple pores.
- The wax casts of milk ducts, 'intertwined like roots of a tree', had been laid out in an orderly manner for the artist to draw.

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### Historical perspective (cont.)



Wax cast of lactating human breast (Cooper, 1840):

- Dilatation after nipple pore (lactiferous sinuses)
- Milk ducts disposed in a radial or symmetrical pattern

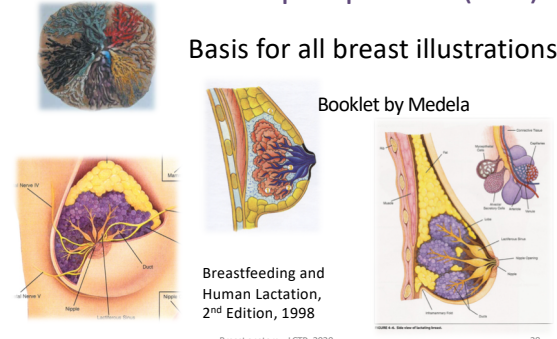
**Fig. 1 Artist's impression of the lobes of the breast. The ducts were injected with coloured wax prior to dissection (from Cooper, 1840).**

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### Historical perspective (end)

Basis for all breast illustrations



Booklet by Medela

Breastfeeding and Human Lactation, 2<sup>nd</sup> Edition, 1998

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### PLAN

- Introduction
- External view
- Internal view ('new' anatomy)
  - Historical perspective
  - New research methodology
  - New findings
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THE UNIVERSITY OF WESTERN AUSTRALIA

### New research

- Ramsay DT, Kent JC, Hartmann RA and Hartmann PE. **Anatomy of the lactating human breast redefined with ultrasound imaging.** *Journal of Anatomy* 2005 206:525-534.
- Geddes DT. **The use of ultrasound to identify milk ejection in women – tips and pitfalls.** *International Breastfeeding Journal* 2009 4:5

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### New research: Material and method

- 21 mothers (exclusive BF 1- 6 months old babies)
- High resolution ultra-sound scanning
- For both breasts

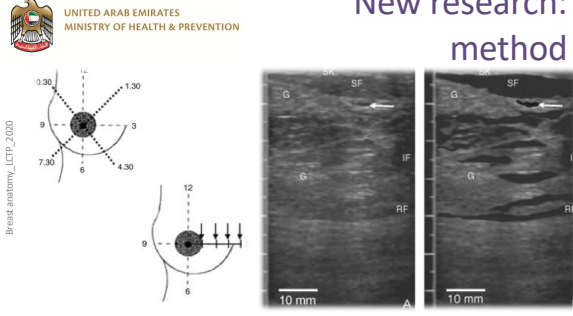


The University of Western Australia

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### New research: method



**Fig. 5 (A) Ultrasound image of tissues of the lactating breast. (B) The skin (SK) is shown as an echogenic (bright) line at the top of the image. The subcutaneous fat (SF) is less echogenic and situated below the skin. The intraglandular fat (IF) is of similar echogenicity to the subcutaneous fat. The glandular tissue is echogenic (G) while the milk duct (arrow) appears as a hypoechoic (low echo) tubular structure. The retromammary fat (RF) is a thin hypoechoic band along the chest wall.**

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**PLAN**

- Introduction
- External view
- Internal view ('new' anatomy)
  - Historical perspective
  - New research methodology
  - New findings: parenchyma and supportive framework
  - Clinical implications
- Supply to the breast
- Histology

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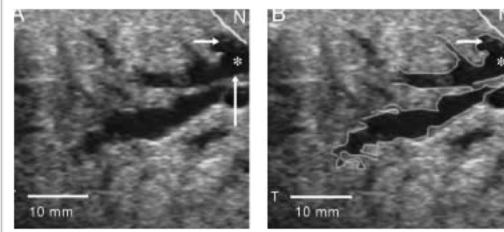
**FUNCTIONAL PART OF THE BREAST (PARENCHYMA)**

- Ducts (from secretory units to nipple pores)
- Glandular tissue (milk production units)

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**Ultrasound appearance of milk ducts**

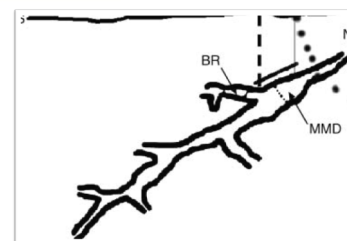


**Fig. 2** (A) Ultrasound image of milk duct in the lactating breast. The duct appears as branching hypoechoic structure within echogenic glandular tissue. (B) The ducts focused on in this scan are outlined in white. The duct is traced from the nipple (N) to the periphery of the breast. The walls are echogenic ( ) and the lumen hypoechoic (asterisk). The first branch of this duct ( ) is imaged almost directly under the nipple.

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**Measurements done on milk ducts**

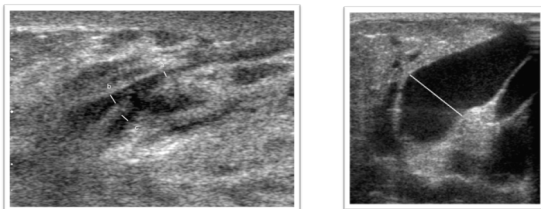


**Fig. 3** Diagram of the milk duct coursing deep into the breast from the nipple (N). Measurements were made of the depth (thin solid line) and diameter (dotted line) of the main milk duct (MMD) and the distance of the first branch (BR, thick solid line) from the base of the nipple. The diameter (double line) and depth from the skin (dashed line) of the first branch (BR) of the duct were also measured.

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**Milk ducts diameter vary between women**



Main milk duct: 0.4 mm (a).  
Merging milk ducts: 0.8 mm (b) and 0.75 mm (c).

Geddes *International Breastfeeding Journal* 2009 4:5 doi:10.1186/1746-4358-4-5

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**Detection of milk ejection by ultrasound**



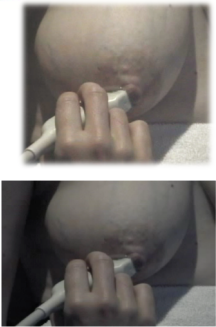
**Ultrasound scanning position for detection of milk ejection in the lactating breast.** The breast that is not suckled/expressed is monitored using a high frequency linear array ultrasound transducer. The milk duct monitored is in the lateral portion of the breast near the base of the nipple. Minimal pressure must be used to avoid compression of the duct.

Geddes *International Breastfeeding Journal* 2009 4:5 doi:10.1186/1746-4358-4-5

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### Detection of milk ejection by ultrasound (cont.)



**Photograph of the right areola of a lactating woman prior to milk ejection.**  
The milk ducts directly superior to the nipple are very superficial and can be seen as bulging under the skin.

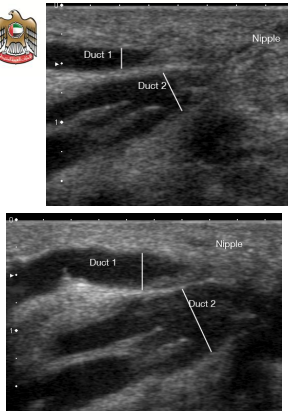
**Photograph of the right areola of a lactating woman at milk ejection.**  
Note the increased swelling of the areola. This is due to the superficial ducts expanding at milk ejection.

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Geddes International Breastfeeding Journal 2009 4:5 doi:10.1186/1746-4358-4-5<sup>9</sup>

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### Detection of milk ejection (cont.)



**Ultrasound image of milk ducts in the human lactating breast prior to milk ejection.**  
Two main milk ducts are displayed on ultrasound. Duct 1 is more superficial (1.95 mm) than Duct 2 (3.72 mm).

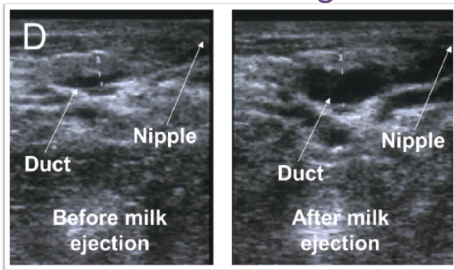
**Ultrasound image of milk ducts [...] at milk ejection.**  
Duct 1 has increased from 1.95 mm to 3.44 mm in diameter. Duct 2 has increased from 3.72 mm to 6.24 mm.

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Geddes International Breastfeeding Journal 2009 4:5 doi:10.1186/1746-4358-4-5<sup>10</sup>

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### “Lactiferous sinuses” exist only during the MER

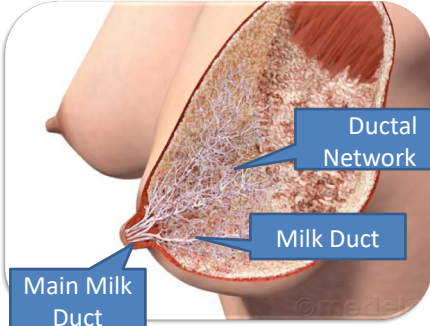


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Geddes International Breastfeeding Journal 2009 4:5 doi:10.1186/1746-4358-4-5

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### Milk ducts



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### Milk ducts (cont.)

- Ductal network: **complex** ; ducts not always arranged in a radial or symmetrical manner.
- Ductal anatomy: **similar for each breast** but can vary greatly between women.
- Main **function of ducts**: **transport**, not storage of milk.
- Resting duct diameter (prior to milk ejection) can differ greatly between women (range: from 1 mm to 4.4 mm).

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### Milk ducts (cont.)


- At milk ejection the ducts expand in diameter (average 58%).
- The **main milk ducts** near the nipple are:
  - approximately 2 mm in diameter,
  - superficial,
  - branching close to the nipple,
  - easily compressed and occluded.
- The conventionally described ‘**lactiferous sinuses**’ **behind the nipple do not exist**.
- The number of milk ducts that exit the nipple ranges **from 4 to 18 (average 9)**.

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### Milk ducts (end)



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### Glandular Tissue

- Grouped by **lobes** (4 to 18)
- Each lobe contains 20 to 40 **lobules**



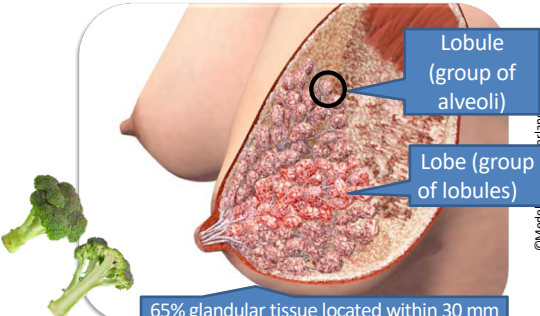
- Each lobule contains 10 to 100 **alveoli**
- Breastmilk synthesized by mammary secretory epithelial cells (**lactocytes**) which line the alveoli. *[see histology]*

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### Glandular Tissue (cont.)



Lobule (group of alveoli)

Lobe (group of lobules)

65% glandular tissue located within 30 mm from base of the nipple


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### Glandular tissue (end)



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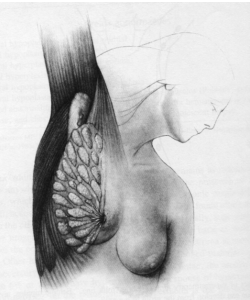
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### Axillary tail, or tail of Spence

- In 95% of women, the ducts ascend into the axilla, partly under the lateral border of the pectoralis majora.
- Occasionally the extension reaches until the apex of the axilla.



Lawrence 2-6


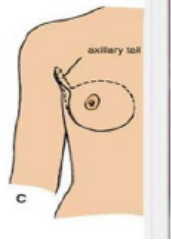
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### Tail of Spence (end)

- Prolongation of upper outer quadrant in axillary direction

BF Atlas 2<sup>nd</sup> ed. 1002 h: engorgement of Tail of Spence

Image from [image.slidesharecdn.com/breast](http://image.slidesharecdn.com/breast)

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## STRUCTURAL PART OF THE BREAST

- Fatty tissues
- Ligaments

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## Fatty tissues

- Approximately 37% of the breast is fatty tissue.
- The amount of fatty tissue present is similar for each breast but can vary greatly between women.
- Fatty tissue is found in three areas: **subcutaneous**, **intraglandular** and **retromammary**.
- The intraglandular fat intermingles with the glandular tissue and is difficult to separate.

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## Fatty tissues (cont.)

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## Cooper's ligaments

- Named after Sir Astley Paston Cooper
- Also known as the suspensory ligaments
- Provide a loose framework of connective tissue
- Radiate from the fibrous stroma of the breast to the skin, providing support for the fatty and glandular tissues.

Midanterior chest wall  
Right side  
Lawrence 2-13

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## Cooper's Ligaments (cont.)

Connection with skin  
Cooper's Ligaments

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Summing-up of the 'new' anatomy

retromammary fat  
intraglandular fat  
subcutaneous fat  
areola  
main milk duct  
milk duct  
glandular tissue  
cooper's ligaments

**Fig. 7** Drawing of the gross anatomy of the lactating breast based on ultrasound observations made of the milk duct system and distribution of different tissues within the breast.

The University of Western Australia, 2006. ©Medella AG, Switzerland, 2006.

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## PLAN

- Introduction
- External view
- **Internal view ('new' anatomy)**
  - Historical perspective
  - New research methodology
  - New findings
  - Clinical implications
- Supply to the breast
- Histology

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## Comparison Old/ New Anatomy

**OLD**

**NEW**

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## Comparison Old / New

<ul style="list-style-type: none"> <li>• No branching of ducts until deep in the breast</li> <li>• Lactiferous sinuses</li> <li>• Glandular tissue starts deep in the breast</li> <li>• Undifferentiated fatty tissue</li> <li>• Even ratio of glandular to fatty tissue</li> <li>• Even distribution of glandular tissue</li> <li>• Ductal network depicted as radial and symmetrical</li> <li>• 15 to 20 ducts at the nipple</li> </ul>	<ul style="list-style-type: none"> <li>• Branching of ducts close to the nipple</li> <li>• No lactiferous sinuses</li> <li>• Glandular tissue starts close to the nipple</li> <li>• Subcutaneous, intraglandular, retromammary fat</li> <li>• Ratio of glandular to fatty tissue is 2:1</li> <li>• 65% within 30mm of nipple</li> <li>• Ductal network not always radial or symmetrical</li> <li>• 4 to 18 ducts exiting at the nipple (average 9)</li> </ul>
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## Clinical implications

- Number of milk ducts lower than previously believed → loss of only a few ducts has more consequences.
- The intermingling of fat and glandular tissue may make breast surgery more complex in order to preserve a woman's future potential to breastfeed.
- Milk removal: larger milk duct diameters associated with longer milk ejection episodes.
- Ducts superficial and compressible → well fitted breastshield (flange) needed during breast expression.

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## Future use of ultrasound scanning

- Detection of blockage of duct (not easily compressed, like DVT)
- Assessment of amount of glandular tissue (for low milk supply, breast asymmetry...)
- Further research on milk ejection reflex, role of position of the nipple in the mouth in relation with suck/swallow/breath cycle...

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## Spreading of the new anatomy

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### PLAN

- Introduction
- External view
- Internal view ('new' anatomy)
- **Supply to the breast**
  - Blood supply
  - Lymphatic drainage
  - Innervation
- Histology

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### Blood supply

Breast: highly vascular. Blood flow doubles by 24 weeks.

30%: lateral thoracic artery

60% blood supply: internal mammary artery

Venous supply: parallel to arterial supply.

Lawrence 2-14 64

### Lymphatic drainage

Mainly to the axillary lymph nodes

Lawrence 2-15

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### Innervation

Mainly branches IV, V, VI of intercostal nerves

Cross section of nerve supply

Figure 12-6 Innervation of the mammary gland

Lawrence 2-17 66

### Innervation (End)

Areola: branch IV of intercostal nerves

If scar at 7-8 o'clock: → loss of sensation nipple and areola

Figure 12-6 Innervation of the mammary gland

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### PLAN


- Introduction
- External view
- Internal view ('new' anatomy)
- Supply to the breast
- **Histology**

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## Histology of the lactating breast: not studied in depth

- Due to ethical considerations
- And difficulties to acquire tissue from lactating breasts (compared to non-lactating breasts or to animal models).

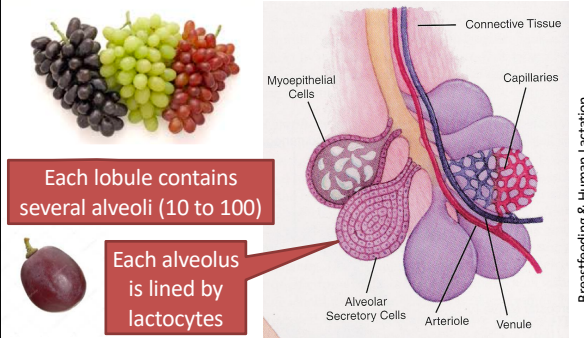


<https://www.ncbi.nlm.nih.gov/microscopie-clipart-24895/>

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## Overview of a Lobule



Each lobule contains several alveoli (10 to 100)

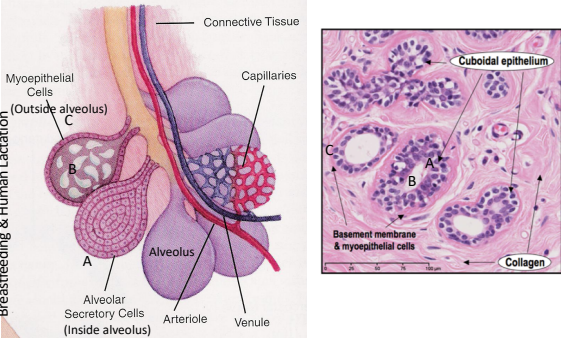
Each alveolus is lined by lactocytes

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## Overview




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## Alveolus

- Alveolus consists of a continuous **single layer of lactocytes**.
- Delineated at the outside by the **basal lamina**.
- Lactocytes: **cuboidal/ columnar** in shape.
- Coupled with **specialized cell junctions**, which are **tight** during established lactation, and **leaky** during pregnancy.



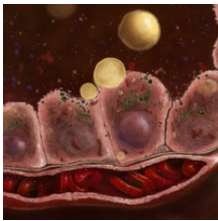
<https://www.ncbi.nlm.nih.gov/microscopie-clipart-24895/>

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## Lactocyte

- Portion of the lactocyte directed towards the lumen is termed **“apical”** and the outer portion **“basal”**.
- Microvilli project from the apical surface of the cell into the lumen.
- Milk secretion occurs at the apical surface of the lactocyte.
- **! Increased intra-alveolar pressure** → flattens lactocytes and decreases/stops milk secretion.



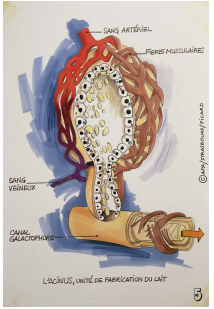
See reference previous slide

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## Myoepithelial cells

- Surround the alveolus (‘outer layer’) and extend onto the milk ducts.
- Smooth muscle filaments, appearance differs depending on location:
  - Cells that surround the **alveoli** are **stellate** shaped.
  - Cells associated with **ducts** are **spindle** shaped, aligned longitudinally.



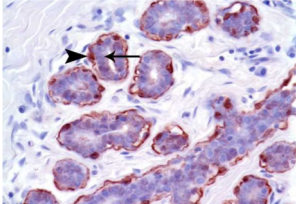
Action pour l’Allaitement, France

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## Myoepithelial cells (cont.)

- Devoid of innervation
- Contraction effected by hormone oxytocin by binding to a receptor on the myoepithelial cell.
- Lactating breast highly sensitive to oxytocin (minute amount required)



(NORMAL BREAST HISTOLOGY) This immunohistochemical stain for S-100 protein shows a complete outer layer of myoepithelial cells (arrowhead) but the inner cuboidal to columnar epithelial cells are not reactive for this antigen.

<https://www.nathoedia.com/education/eatlas/histology/breast/images.aspx>

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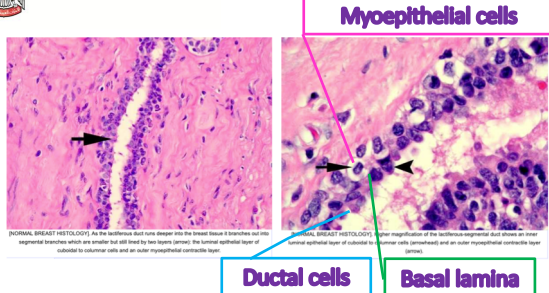
## Milk ducts

- Form the pathway for milk to be transported to the nipple.
- Do not actively participate in either the secretion or modification of milk.
- Consist of an **inner layer of epithelium, stratified squamous** type in the nipple, **cuboidal** within the gland.

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## Milk ducts (cont.)



(NORMAL BREAST HISTOLOGY) As the lactiferous ducts cross deeper into the breast tissue & branches out into terminal lobular branches which are smaller but still lined by two layers (arrow) the luminal epithelial layer of cuboidal to columnar cells and an outer myoepithelial contractile layer.

(NORMAL BREAST HISTOLOGY) Higher magnification of the lactiferous terminal duct shows an inner cuboidal epithelial layer (arrowhead) and an outer myoepithelial contractile layer (arrow).

- Myoepithelial cells apposed to the basal lamina.
- Ductal cells form a single cell layer on the inner side of the basal lamina.

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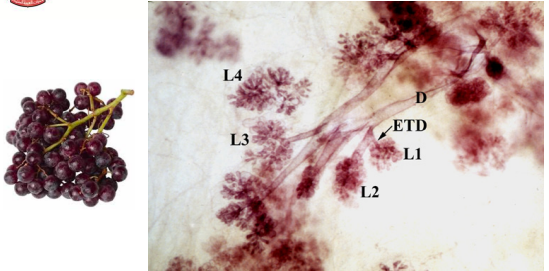
## Milk ducts (cont.)

- Terminal duct lobular unit (TDLU): lobular architecture and intralobular connective tissue (hormonally responsive, fibroblasts, macrophages, lymphocytes, vessels).
- Continuous basement membrane follows contour of the ducts and ductules.
- Main ducts are supported by fibrous connective tissue.
- Shape of duct varies according to amount of milk (more irregular when less milk).

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## Terminal Duct Lobular Unit



Slice of human mammary tissue , the TDLU  
D : duct , ETD: extra lobular terminal duct  
L1-4: Lobules. L1 = 1mm in diameter

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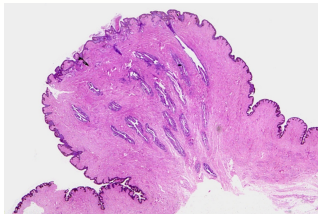
## Nipple

- Contains numerous **sebaceous glands** independent of hair follicles, dense fibrous stroma containing **erectile smooth muscle tissue**, stratified **squamous epithelium** resembling skin but with increased **melanin** pigment.
- Stratified squamous epithelium extends into duct lumens for a short distance.
- Nipple is unpigmented before menarche, pigmentation increases after first menstrual cycle

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## Nipple (end)



<https://www.memoriana.com/files/headers/137371-Anatomy-and-Histology-of-the-Breast/>

This histological section shows the nipple and some areola. Epithelium stains blue and stroma stains red. Note lactiferous duct at the surface of the nipple. It is plugged with keratin. This mechanical barrier prevents bacteria from entering the duct in non-lactating women.

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# BREAST ANATOMY & HISTOLOGY

Thank you!

People love to get worked up about breastfeeding in public!  
But now we have the perfect solution to please both the lovers and the haters

<http://fbcdn-sphotos-e-a.akamaihd.net/photos-ak-ic3/11...>

## THE BOOB BEANIE