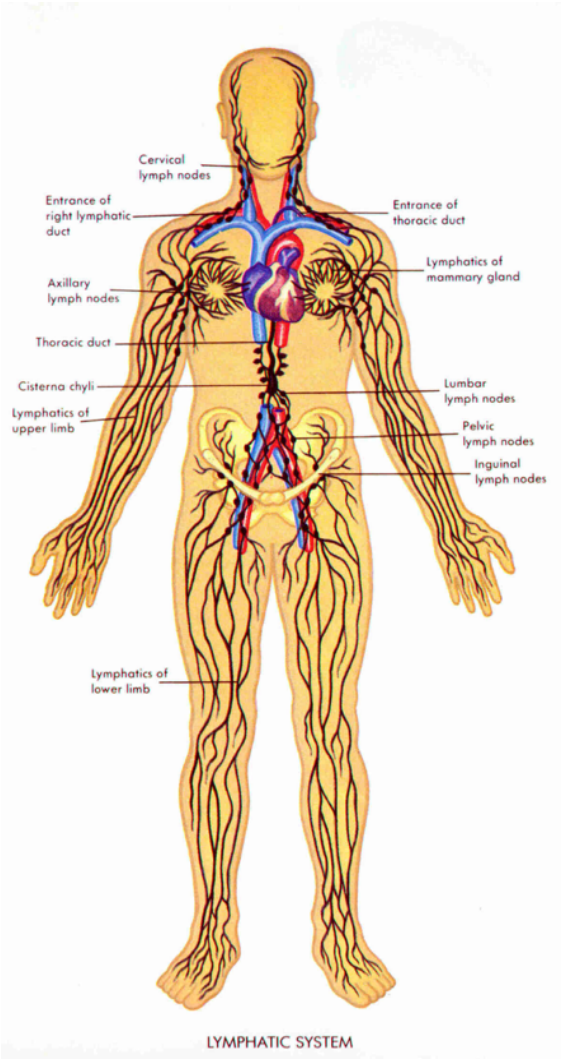
Understanding the Lymphatic System

Introduction

The treatment of lymphedema is based on an understanding of how the lymphatic system works. Therapists must understand this system in depth. Patients, and others involved in self-care steps, need to have at least a basic understanding of these functions. It is this basic level of understanding that is presented here.

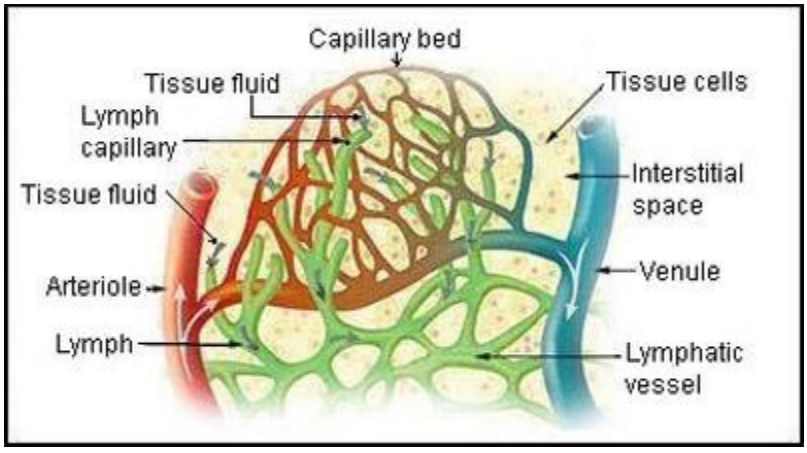
The functioning of the lymphatic system is closely related to that of the circulatory system. To understand more about how these systems differ, see The Circulatory and Lymphatic Systems Compared, (later section).



The Origin of Lymph

Lymph originates as blood plasma. The plasma of arterial blood is rich in "groceries" for the cells. In the capillary beds throughout the body the flow of blood is slowed so that plasma can leave and become tissue fluid. Tissue fluid is also known as intercellular fluid or interstitial fluid.

- *Tissue fluid delivers the nutrients, oxygen, and hormones required by the cells.*
- *Tissue fluid collects and carries away some cellular waste products.*
- *90 percent of the tissue fluid returns to the capillary bed. Here it again becomes plasma and continues its journey throughout the body as part of the venous circulation.*
- *Lymph is the 10 percent of the tissue fluid that is left behind.* Normally the amount of lymph circulating in the body is one to two quarts and it makes up one to three percent of the body weight.



The Role of Lymph

The role of tissue fluid is to deliver the *groceries* to the cells. The role of lymph is to *take out the trash* that is left behind and to dispose of it.

As lymph continues to circulate between the cells it collects waste products that were left behind including dead blood cells, pathogens, and cancer cells. This clear fluid also becomes protein-rich as it absorbs dissolved protein from between the cells.

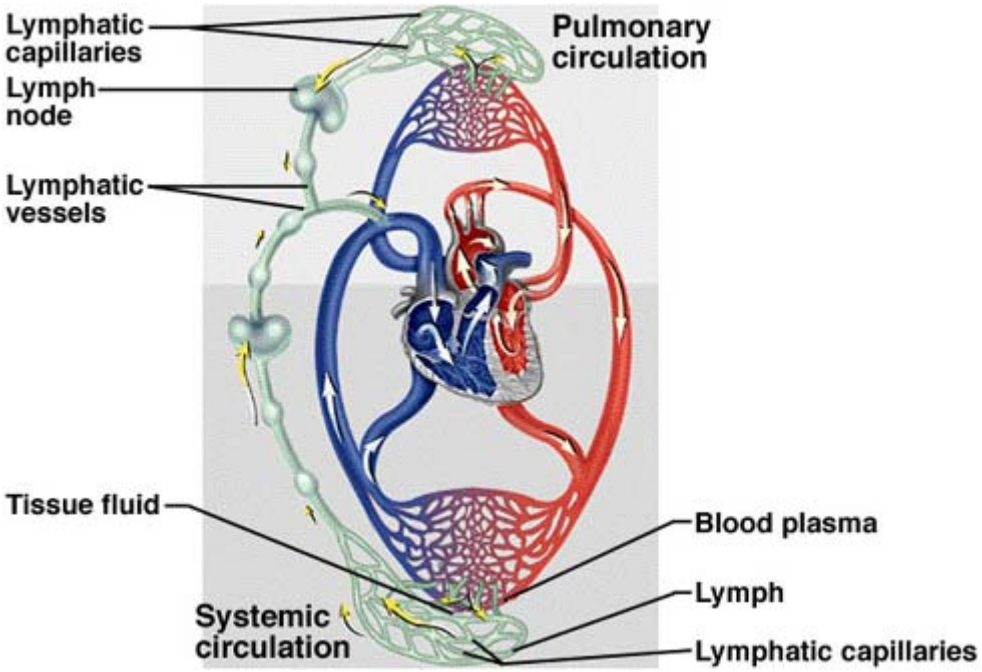
Lymphatic Capillaries

The lymphatic capillaries form a mesh-like network of tiny tubes that are distributed throughout the tissue spaces and are located just under the skin. These capillaries branch and interconnect freely so that they extend into almost all tissues.

Lymph capillaries are blind-ended tubes with no opening to allow the lymph easy access. The end of the capillary is only one-cell in thickness and these cells are arranged in a slightly overlapping pattern – like the shingles on a roof.

Pressure from the fluid surrounding the capillary forces these cells to separate for a moment. This allows fluid to enter, but not to leave, the capillary.

There are one-way valves within the lymphatic capillaries. These valves ensure the continued flow of the lymph away from the tissues. ↓



Lymphatic Vessels

Deeper within the body the lymphatic vessels become progressively larger and are located near the veins. Like veins, the lymphatic vessels have valves to prevent any backward flow. Angions are the segments created by the space between two sets of valves. Smooth muscles in the walls of the lymphatic vessels cause the angions to contract sequentially to aid the flow of lymph toward the thoracic region.

Lymph Nodes

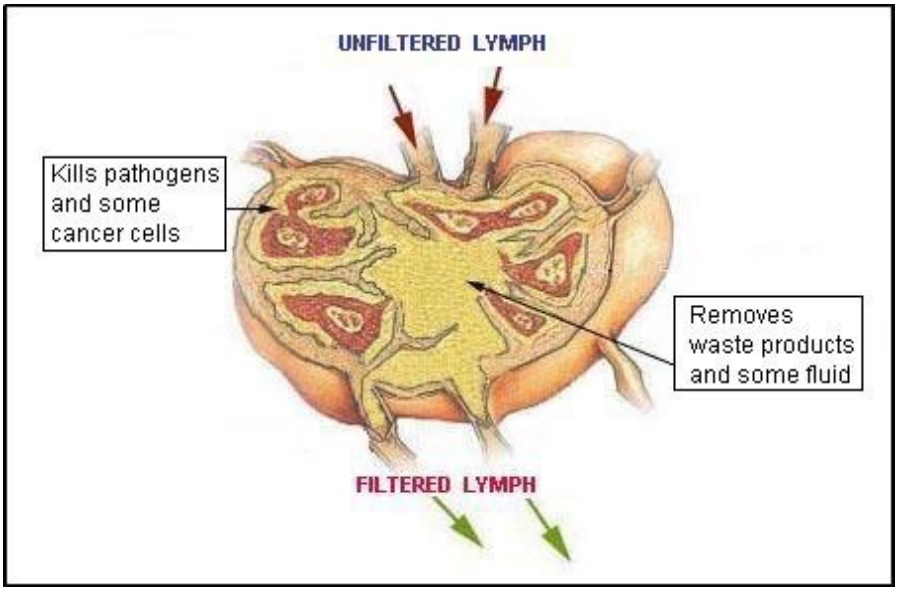
At birth there are between 600-700 lymph nodes present in the average human. Although these nodes can increase or decrease in size throughout life, any nodes that have been damaged or destroyed, do not regenerate.

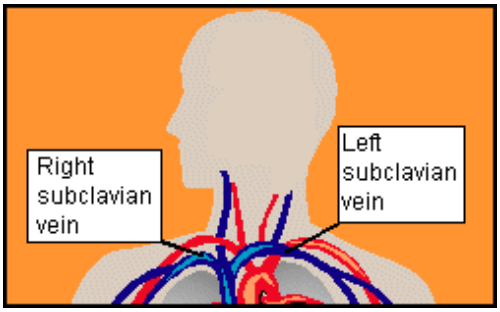
Afferent lymphatic vessels carry lymph into the nodes where waste products and some of the fluid are filtered out.

Lymphocytes, which are specialized white blood cells located within the lymph node, kill pathogens that may be present. Lymph nodes also trap cancer cells and slow the spread of the cancer until they are overwhelmed by it.

Efferent lymphatic vessels carry lymph out of the node to continue its return to the circulatory system.

Cancer cells that have left their original site travel first to nearby lymph nodes. For this reason lymph nodes play an important role in the detection and treatment of cancer.



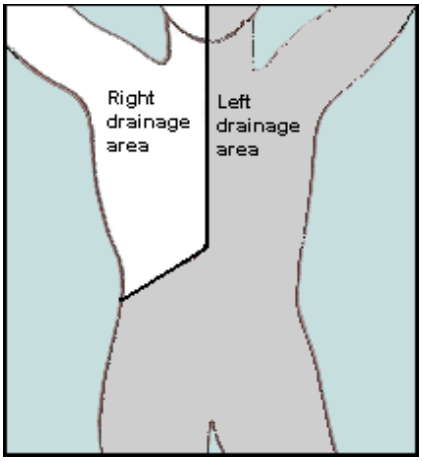


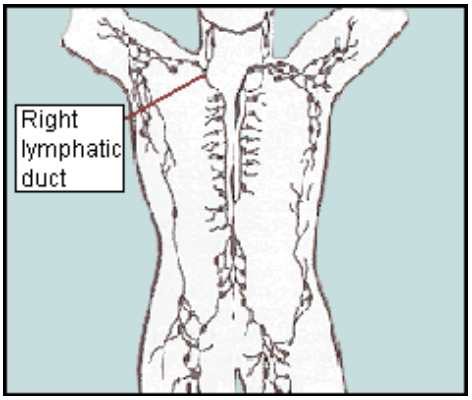
The *terminus* is the area at the base of the neck where the lymphatic ducts return the lymph to the circulatory system.

Here the *subclavian veins*, which are located just under the collar bones, receive the lymph and it once again circulates throughout the body as plasma.

Drainage Areas

Lymphatic drainage is organization into two separate and very unequal drainage areas. These are the right and left drainage areas and normally lymph does not drain across the invisible lines that separate these areas. Structures within each area carry lymph to its destination, which is to return to the circulatory system.





The Right Drainage Area removes lymph from the:

- Right side of the head and neck
- Right arm
- Upper right quadrant of the body.

Lymph from this area flows into the right lymphatic duct. This duct returns the lymph to the circulatory system by draining into the right subclavian vein.

The Left Drainage Area removes lymph from the:

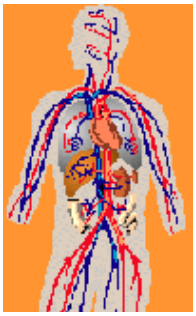
- Left side of the head and neck
- Left arm and the left upper quadrant
- Lower trunk
- Both legs

The cisterna chyli temporarily stores lymph as it moves upward from the lower areas of the body. The thoracic duct carries lymph upward to the left lymphatic duct. The left lymphatic duct returns the lymph to the circulatory system by draining into the left subclavian vein.

Why This is so Important

- *Damage disturbs the flow.* When lymphatic tissues or lymph nodes have been damaged, destroyed or removed, lymph cannot drain normally from the affected area. When this happens excess lymph accumulates and results in the swelling that is characteristic of lymphedema.
- *Drainage areas.* The treatment of lymphedema is based on the natural structures and the flow of lymph. The affected drainage area determines the pattern of the manual lymph drainage (MLD) and for self-massage. Although lymph does not normally cross from one area to another, MLD stimulates the flow from one area to another. It also encourages the formation of new lymph drainage pathways.
- *MLD treatment and self-massage* begin by stimulating the area near the terminus and the larger lymphatic vessels. This stimulates the flow of lymph that is already in the system and frees space for the flow of the lymph that is going to enter the capillaries during the treatment. See Lymphedema Treatment Methods (later section).
- *MLD treatment* continues as a gentle massage technique to stimulate the movement of the excess lymph in affected tissues. The rhythmic, light strokes of MLD provide just the right pressure to encourage this excess lymph to flow into the lymph capillaries.
- The *compression garments, aids, and/or bandages* that are worn between treatments help control swelling by providing pressure that is needed to encourage the flow of lymph into the capillaries. See Compression Methods (later section).
- *Exercise* is important in the treatment of lymphedema because the movements of the muscles stimulate the flow of the lymph into the capillaries. Wearing a compression garment during exercise also provides resistance to further stimulate this flow.
- *Self-massage*, as prescribed by your therapist, is another way in which lymph is encouraged to flow into the capillaries. Each self-massage session begins with steps to stimulate the flow of lymph that is already in the system. This is followed by gentle strokes are used to encourage the flow of lymph into the capillaries.

The Circulatory and Lymphatic Systems Compared



Circulatory system

The human body has two circulatory systems! These are the *cardiovascular system* and the *lymphatic system*. The differences between these two systems are compared in the table below. To simplify the explanation, in this chart they are referred to simply as blood and lymph. To learn more about the lymphatic system, see Understanding the Lymphatic System.

Being aware of the differences between these two systems makes it easier to understand the special difficulties encountered by the lymphatic system when any part of that system is not functioning properly.

Comparison of the Cardiovascular and Lymphatic Systems	
Cardiovascular System (Blood)	**Lymphatic System (Lymph)**
Blood is responsible for collecting and distributing oxygen, nutrients and hormones to the tissues of entire body.	*Lymph* is responsible for collecting and removing waste products left behind in the tissues.
Blood flows in a closed continuous loop throughout the body via the arteries, capillaries, and veins.	*Lymph flows* in an open circuit from the tissues into lymphatic vessels. Once within these vessels, lymph flows in only one direction.
Blood is pumped. The heart pumps blood into the arteries that carry it to all of the body. Veins return blood from all parts of the body to the heart.	*Lymph is not pumped.* It passively flows from the tissues into the lymph capillaries. Flow within the lymphatic vessels is aided by other body movements such as deep breathing and the action of nearby muscles and blood vessels.

Blood consists of the liquid plasma that transports the red and white blood cells and platelets.	*Lymph* that has been filtered and is ready to return to the cardiovascular system is a clear or milky white fluid.
Blood is visible and damage to blood vessels causes obvious signs such as bleeding or bruising.	*Lymph is invisible* and damage to the lymphatic system is difficult to detect until swelling occurs.
Blood is filtered by the kidneys. All blood flows through the kidneys where waste products and excess fluids are removed. Necessary fluids are returned to the cardiovascular circulation.	*Lymph is filtered* by lymph nodes located throughout the body. These nodes remove some fluid and debris. They also kill pathogens and some cancer cells.
Blood vessel damage or insufficiency produces swelling that containing low-protein fluid.	*Lymphatic vessel damage or insufficiency* produces swelling containing protein-rich fluid.

Lymphedema Treatment Methods

Introduction

The primary goals of the lymphedema treatment are to:

- *Move stagnant lymph out of the tissues.*
- *Assist in the reduction of swelling.*
- *Help control swelling.*
- *Soften fibrotic tissue.*
- *Improve the patient's general health.*

These goals are achieved through the use of treatment is known as *Complete Decongestive Therapy* (CDT), *Complex Decongestive Therapy,* or *Complete Decongestive Physiotherapy (CDP).* Although the names vary slightly, and therapist training programs teach slight variations on these components, however most lymphedema treatment plans include these major elements.

The three primary components of this treatment are *manual lymph drainage*, the use of *compression techniques*, and teaching the patient *self-management procedures* that are to be performed at home between professional visits.

Manual Lymph Drainage

Manual Lymph Drainage, which is referred to as M-L-D, is based on a technique that is said to be, *"as gentle as a butterfly kiss."* This is the reason that a butterfly is often used as a symbol of lymphedema and its treatment.

This gentle massage technique is performed by a qualified lymphedema therapist. To learn more about MLD, read the article Manual Lymph Drainage.

Compression Methods

The use of compression, at all times, is an important factor in maximizing gains between professional visits. The goals of compression are to:

- *Retain the progress made in reducing swelling during the MLD treatment.*
- *Prevent, or minimize, additional swelling.*
- *Support natural draining of lymph from the tissues.*

Different compression techniques are used to be most effective during the day while the patient is active, to provide compression while the patient sleeps or is less active, or to provide maximum support and flexibility.

Self-Management Techniques

Learning self-bandaging
is an important skill.

After initial treatment, the number of professional visits is greatly reduced—yet lymphedema is present 24 hours a day. Therefore it is important that the patient, or care-giver be able to follow through on a self-management program at home.

Self-massage is a form of MLD that is performed daily at home.

Compression needs vary depending on the stage of the lymphedema and its treatment. The patient must learn how to manage this at home.

Skin care is to maintain the health of the skin to prevent deterioration and to prevent infections.

Daily exercise is essential to maintain the flow of lymph, increase mobility, control weight, and improve the patient's general health and sense of well-being.

Compression Methods

Introduction

The use of ongoing compression is an essential element in the treatment of lymphedema. The overall goal of the use of compression is:

- Retain the progress made in reducing swelling during the MLD treatment.
- Prevent, or minimize, additional swelling.
- Support natural draining of lymph from the tissues.
- Provide resistance during muscle movement.
- Aid in softening fibrotic tissues.

Compression Methods Compared

The types of compression and their specialized features are compared in the table below.

Bandages

Bandages are effective and flexible form of compression, particularly in the early stages of treatment.

Bandages provide proper compression when the patient is active or when the patient is resting.

They can also be easily adjusted to fit the changing limb size and compression needs.

Compression Garments

A medi compression garment is a knit two-way stretch sleeve or stocking that is worn to assist in controlling swelling and to aid in moving lymph from the affected area. These garments are only worn while the patient is awake and active.

Compression Aids

Compression aids are custom-fitted sleeves, stockings, or pads made of a fabric covering a layer of foam. They help to control swelling, enhance the flow of lymph, and assist in softening fibrotic tissues.

These garments are usually worn in the evening or during sleep when the patient is not as active. Bandages can be placed over compression aids to increase the resistance and amount of compression.