

Sutures and Ligatures



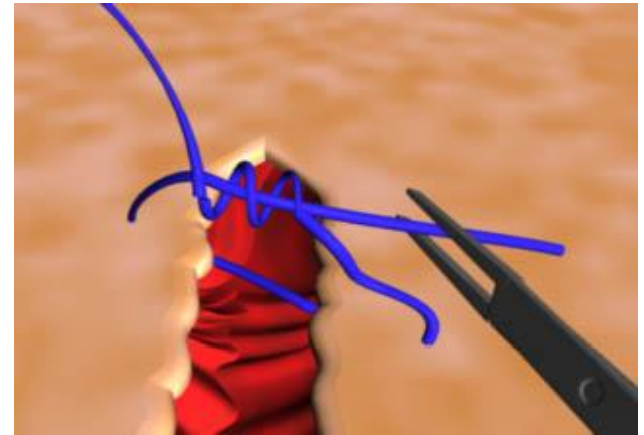
Introduction

- ➡ A surgical suture (stitches) is a strand or fiber used to hold wound edges in position during healing
- ➡ The process of applying such strand is called *suturing*
- ➡ When such material, without a needle is used to stop bleeding by **tying off** severed blood vessels, the strand is called a *ligature*, and the process is known as *ligating*
- ➡ Suture closure permits **primary** wound healing
- ➡ Tissues are held in proximity until enough healing occurs to withstand stress without mechanical support

Suture Qualities

□ The ***ideal*** suture has the following characteristics:

- Sterile
- All-purpose
- Causes minimal tissue reaction
- Easy to handle
- Holds securely when knotted (i.e., no fraying or cutting)
- High tensile strength
- Favorable absorption profile
- Resistant to infection



Suture Selection

❑ It depends on:-

- ✓ Surgeons familiarity with the suture
- ✓ Physical and biological characteristics of the suture
- ✓ Healing characteristics of the tissue in which it is placed
- ✓ Presence of infection etc

Suture Material

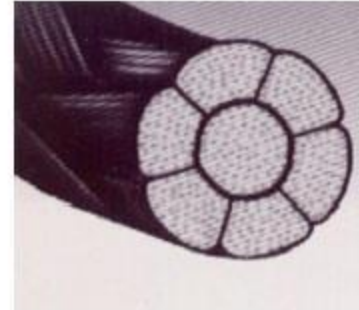
- Three ways of classifying suture material:
 - Natural or Synthetic
 - Absorbable or Non-Absorbable
 - Monofilament or multifilament (Braided/Twisted)

Suture Material...

☐ Natural

E.g., Silk, linen, catgut

SILK



CATGUT



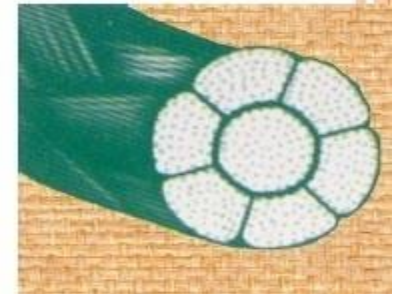
☐ Synthetic polymer

E.g., Polypropylene, polyester, polyamide

Polypropylene



Polyester



Suture Material...

❑ Absorbable

- *catgut, polydioxanone, polyglycolic acid*
- Used for ***deep tissues*** (internal), membranes, & rarely on the skin

❑ Non-Absorbable

- *polyester, nylon, stainless steel*
- Used for skin (removed) & some deep structures (tendons, vessels – not removed)

Suture Material...

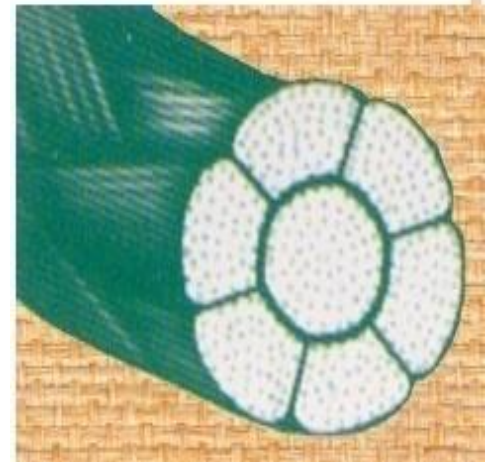
❑ Monofilament

- Polypropylene
- Polydioxanone
- Nylon



❑ Multifilament

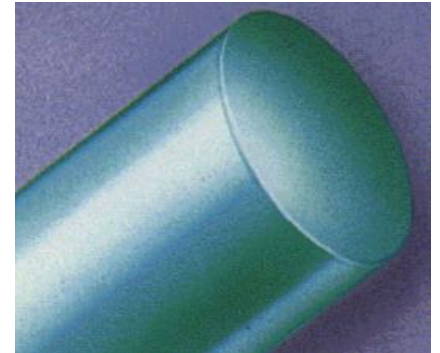
- Catgut (twisted)
- Polyester (braided)
- Silk (braided)



Monofilament Vs Multifilament

Monofilament suture

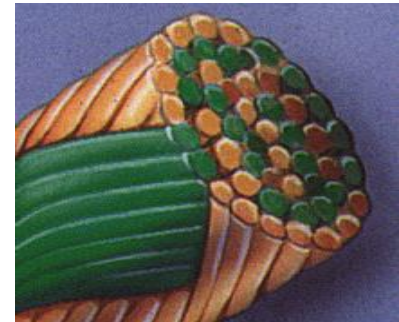
- Made of a single strand
- Less resistance as they pass through tissue
- More resistant to harboring microorganisms
- No capillary action
- Well-suited to vascular surgery
- Extreme care must be taken when handling and tying these sutures



Monofilament Vs Multifilament ...

Multifilament suture

- Several filaments, or strands, twisted or braided
- Affords greater tensile strength, and flexibility
- High capillarity, increased infection risk
- Impairs passage through tissue but results in considerably better **knot holding security**
- Generally coated (smoothes out the irregular surface and thus facilitates passage through tissue)



Absorbable Vs Non-absorbable

- ❑ Based on their degradation properties

Absorbable suture

- Absorbed or digested by the body cells and tissue fluids in which they are embedded during & after healing processes
- Prepared either from the **collagen** of healthy mammals or from **synthetic** polymers
- Some are absorbed rapidly, while others are **treated** or chemically structured to **lengthen** absorption **time**

Absorbable suture

- ***Natural*** absorbable sutures are digested by body enzymes which attack and break down the suture strand
- ***Synthetic*** absorbable sutures are hydrolyzed causing the breakdown of the suture's polymer chain

1. Surgical gut (Catgut)

- ✓ Most commonly used absorbable suture material
- ✓ Derived from the small intestine of healthy sheep
- ✓ Uniformly fine-grained and possesses great tensile strength and elasticity

Absorbable suture...

- ❑ Two types, according to USP
 - **Type A** which are plain or untreated & are digested faster by enzymes
 - Used as ligature for superficial small vessels, suture for a subcutaneous stitch
 - *Plain* – lasts 3-5 days (tensile strength)
 - **Type C** (Chromicized surgical gut): undergo medium treatment with chromium salts and has **slower** digestion rate by enzymes.
 - Used as ligature for blood vessels, suture for the mucosa of the GIT, UT, respiratory tract, muscle
 - lasts 10-15 days (tensile strength)



Absorbable suture...

2. Dexon (polyglycolic acid)

- ✓ Widespread absorbable suture material of a **synthetic, braided** polymer
- ✓ Stronger than gut
- ✓ Has **low** rate of **reactivity** and infection rate, and excellent **knot security** and tensile **strength**
- ✓ A drawback of Dexon is its high **friction** that binds and snags when **wet**

Absorbable suture...

3. Vicryl (Polyglactin 910)

- ✓ Braided, synthetic, absorbable
- ✓ Stronger than gut: retains strength up to 3 weeks
- ✓ Broken down by hydrolysis
- ✓ Components that inhibit bacterial growth

4. Poliglecaprone 25 (MONOCRYL suture), Polyglyconate, Polydioxanone (PDS* II suture)

Non-absorbable Sutures

- ❑ Are not digested by body enzymes nor hydrolyzed in body tissue
- ❑ Made from a variety of **non-biodegradable** materials and are ultimately **encapsulated** by the body's fibroblasts
- ❑ Manufactured from various materials such as: **polyester, nylon, or polypropylene**
- ❑ Only used when **long term support** is required
- ❑ Ordinarily remain where they are buried
- ❑ May be removed by a surgeon when used for skin closure

Non-absorbable Sutures...

- Used frequently for cardiovascular, ophthalmic, and neurological procedures
- Tissue reaction generally low (except silk)

Applications:

- Exterior skin closure
- Within the body cavity, where they will remain permanently encapsulated in tissue
- Patient history of reaction to absorbable sutures
- Prosthesis attachment (i.e., pacemakers)

Non-absorbable Sutures...

Silk surgical suture

- Consist chiefly of protein fibroin as extruded by the silk worm
- Problem of acute inflammatory reaction that may lead to encapsulation by fibrous connective tissue
 - E.g. braided silk



Dermal silk

- Natural twisted silk encased in an insoluble coating of tanned **gelatin** or other protein
- Coating withstand autoclaving without stripping, and purpose is to prevent **in-growth** of tissue cells, which would interfere with its removal after use as a skin or dermal suture

Non-absorbable Sutures...

Nylon (e.g. ETHILON*)

- The first modern synthetic fiber
- Available as **monofilaments** in the useful range of sizes, as well as in the form of **multifilament** fibers braided into strands of comparable diameter
- **Poor knot security** → at least 4-5 "throws" (knots) are required

Non-absorbable Sutures...

Polyester Fiber

- Melt-extruding polyethylene terephthalate into fine filaments that then are braided into various sizes
- Do not lose strength significantly when in contact with water or body fluids
- When there is a critical need for permanent reinforcement as E.g., in the installation of artificial heart valves
- **Excellent knot-holding** characteristics

Non-absorbable Sutures...

Stainless Steel

- ✓ Available as both twisted and monofilament strands
- ✓ Strongest
- ✓ Great knot security
- ✓ Difficult handling
- ✓ Can cut through tissues
- ✓ Very little tissue reaction, won't harbor bacteria
- ✓ Orthopedics and thoracic surgery



Suture Sizes

- Suture materials are also classified according to their size
- Currently, two standards are used to describe the size of suture materials; USP and EP
- In the USP standard the size is represented by a combination of two Arabic numerals
- A 0 and any number other than 0, like 2-0 (or 2/0)
- USP standard is more commonly used

Suture Sizes...

- ❑ The higher the first number, the smaller the suture material
- ❑ Sizes greater than 0 are denoted by 1, 2, 3 etc.
- ❑ This standard size also varies with the type of suture material

11/0, 10/0, 9/0, 8/0, 7/0, 6/0, 5/0, 4/0, 3/0, 2/0, 0, 1, 2, 3, 4, 5
Thinnest ←————→ Thickest

- ❑ *Modern sutures range from **#5** (heavy braided suture for orthopedics) to **#11/0** (fine monofilament suture for ophthalmic)*

Suture Sizes...

USP and EP size codes:

USP Size codes		EP Size codes	Suture Diameter (MM)	
Non synthetic absorbable materials	Non absorbable and synthetic absorbable materials	Absorbable and Non absorbable materials	Min	Max
	11/0	0.1	0.01	0.019
	10/0	0.2	0.02	0.029
	9/0	0.3	0.03	0.039
	8/0	0.4	0.04	0.049
8/0	7/0	0.5	0.05	0.069
7/0	6/0	0.7	0.07	0.099
6/0	5/0	1	0.10	0.14
5/0	4/0	1.5	0.15	0.19
4/0	3/0	2	0.20	0.24
3/0	2/0	2.5	0.25	0.29
2/0	0	3	0.30	0.39
0	1	4	0.40	0.49
1	2	5	0.50	0.59
2	3	6	0.60	0.69
3	4	7	0.70	0.79
4	5	8	0.80	0.89
5	6	9	0.90	0.90
6	7	10	1.00	1.09

Suture indications by location

- Much of the process regarding suture selection depend on surgeon training and preference
 - **Mucosal lacerations (mouth, Tongue or genitalia)**
 - Absorbable Suture 3-0 or 4-0
 - **Scalp, Torso (chest, back, abdomen), Extremities**
 - Superficial: Non absorbable Suture 4-0 or 5-0
 - Deep: Absorbable Suture 3-0 or 4-0
 - **Face, Eyebrow, Nose, Lip**
 - Superficial: Non absorbable Suture 6-0
 - Deep: Absorbable Suture 5-0

Suture indications...

– **Ear, Eyelid**

- Superficial: Non absorbable Suture 6-0

– **Hand**

- Superficial: Non absorbable Suture 5-0
- Deep: Absorbable Suture 5-0

– **Foot or sole**

- Superficial: Non absorbable Suture 3-0 or 4-0
- Deep: Absorbable Suture 4-0

Surgical Needles

- ❑ Necessary for the placement of sutures in tissue
- ❑ They should be:
 - **Sharp** enough to penetrate tissue with minimal resistance
 - **Rigid** enough to resist bending, yet flexible enough to bend before breaking
 - **Sterile** and **corrosion-resistant**

Best qualities of surgical needles

- Made of high quality stainless steel
- As slim as possible without compromising strength
- Stable in the grasp of a needle-holder
- Able to carry suture material through tissue with minimal trauma

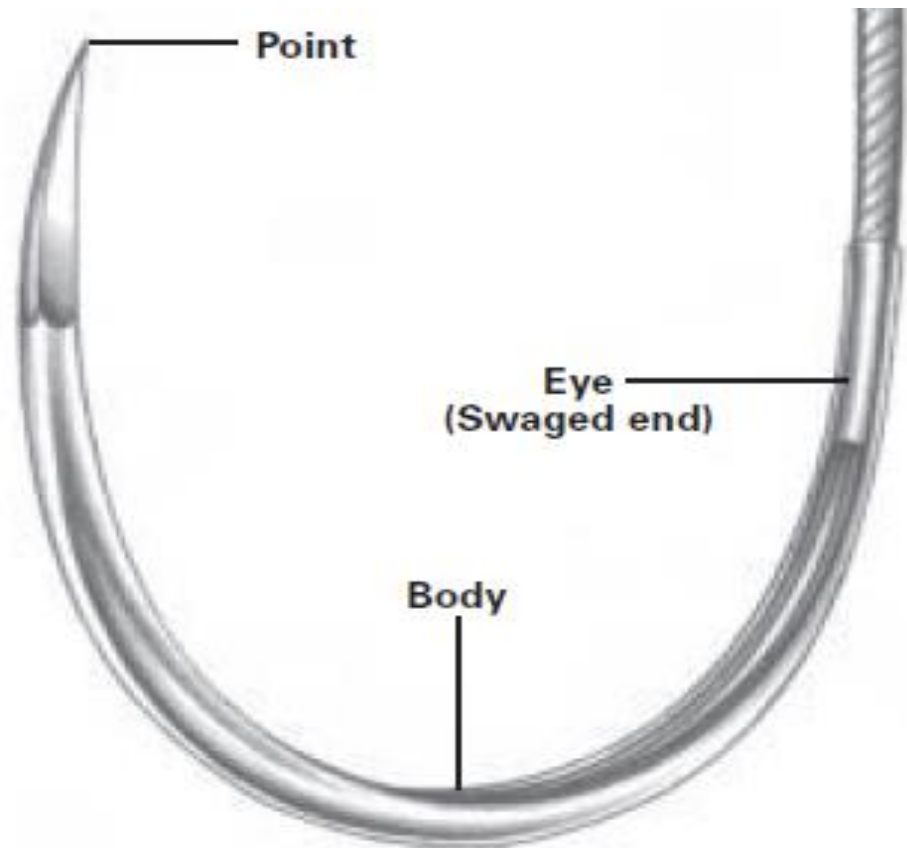
Parts of the Needle

❑ The eye

- Closed eye, French (split or spring) eye, or swaged (eyeless)

❑ The body

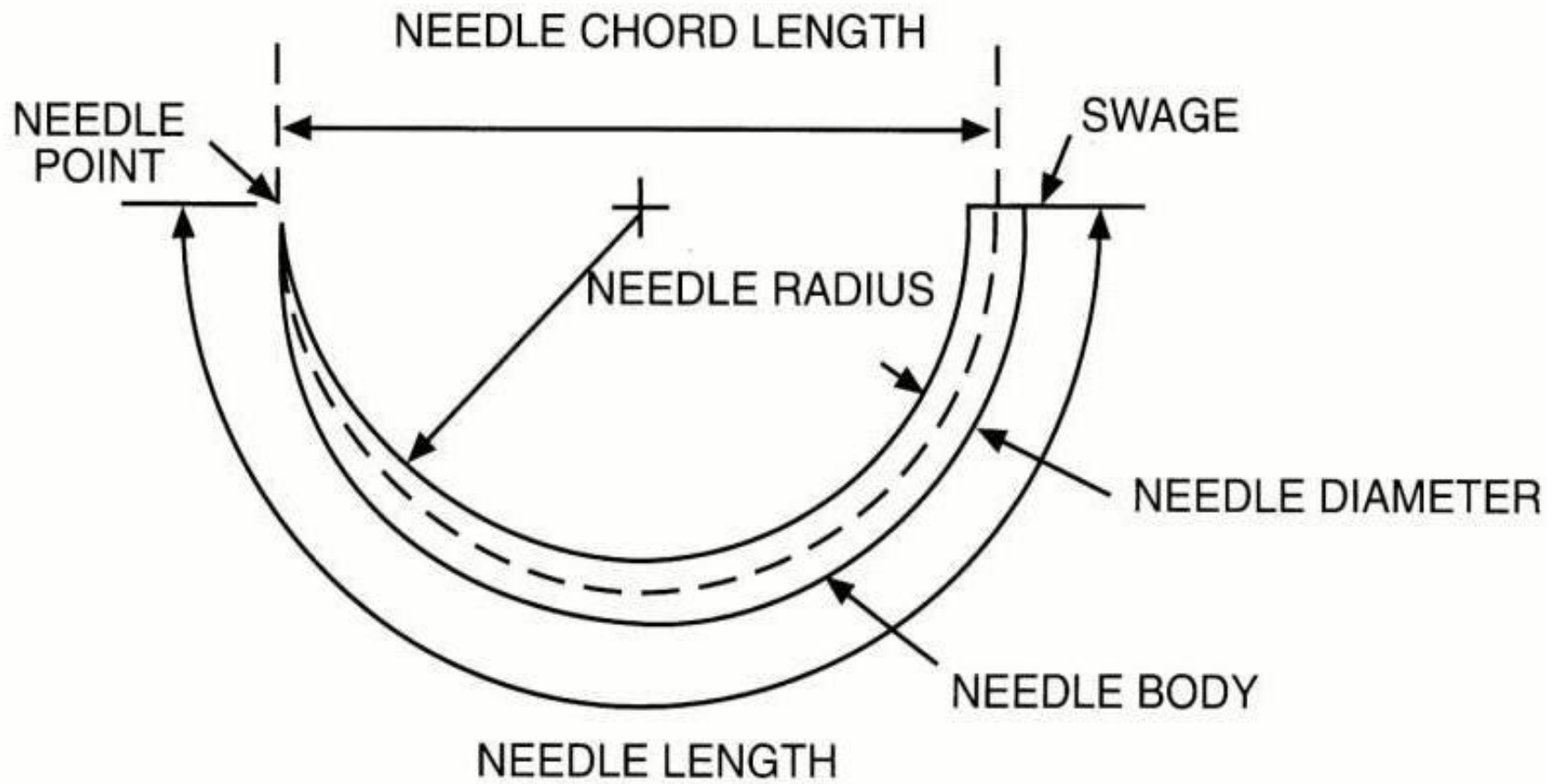
❑ The point



Needle measurements

- ***Chord length:*** linear distance from the point of the curved needle to the swage
- ***Needle length:*** distance measured along the needle from the point to the swage. It is the measurement supplied on suture packages
- ***Radius:*** the distance from the body of the needle to the center of the circle along which the needle curves
- ***Diameter:*** the gauge or thickness of the needle wire is considered the diameter

Anatomy of a Surgical Needle



Needle Point Types

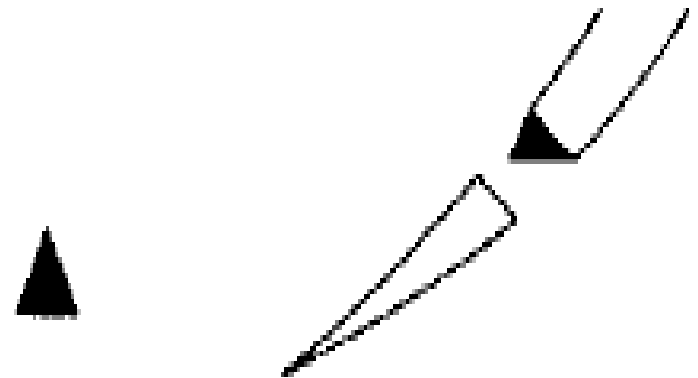
1. Cutting Needles

- ✓ have at least two opposing cutting edges
- ✓ sharpened to cut through tough, difficult-to-penetrate tissue
- ✓ ideal for skin sutures
- ✓ care must be taken in some tissues to avoid cutting through more tissue than desired

Needle Point Types...

❑ Conventional cutting

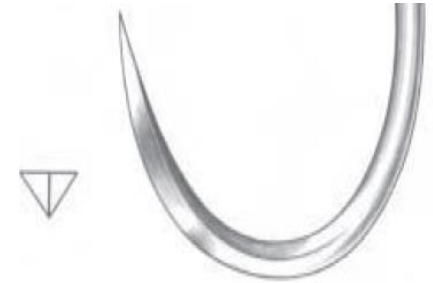
- ✓ has 3 cutting edges (triangular cross-section)
- ✓ The third cutting edge is on the inner, **concave** curvature (surface-seeking)
- ✓ Very sharp
- ✓ Cuts rather than dilates



Needle Point Types...

❑ Reverse cutting

- ✓ The third cutting edge is on the outer **convex** curvature of the needle (depth-seeking)



- ✓ designed for tissue that is tough to penetrate (E.g., skin, tendon sheaths, oral mucosa, nasal cavity, ligament)
- ✓ Very sharp, cuts rather than dilates



Needle Point Types...

❑ Side-cutting (spatula)

- needles are flat on the top and bottom surfaces to reduce tissue injury
- allow maximum ease of penetration and control as they pass between and through tissue layers



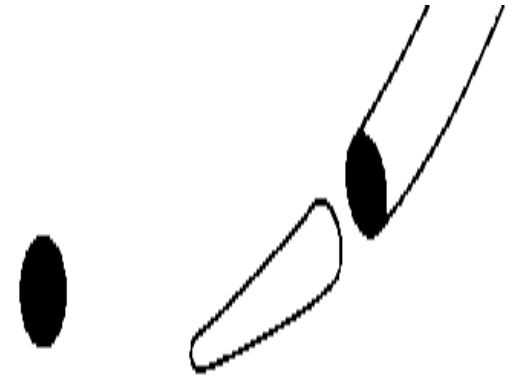
Needle Point Types...

2. Tapered needles

- ✓ No cutting edge

❑ **Blunt-point** - known as "*Protect Point*"

- ✓ Dissects friable tissue rather than cuts it
- ✓ The point is rounded and blunt, ideal for suturing the liver and kidneys



Needle Point Types...

❑ Taper-point

- ✓ penetrates and passes through tissues by stretching (dilating) without cutting dissect
- ✓ A sharp tip at the point flattens to an oval/rectangular shape
- ✓ used for easily penetrated (soft) tissues (e.g., subcutaneous layers, peritoneum, myocardium, biliary tract, abdominal viscera)



Needle Body Types

- ❑ The portion which is grasped by the needle holder during the surgical procedure
- ❑ Should be as close as possible to the diameter of the suture
- ❑ Curvature of the needle body may come in a variety of different shapes

Needle Body Types...

□ Straight

- used to suture easily accessible tissue that can be manipulated directly by hand
- also useful in microsurgery for vessel repair



Needle Body Types...

❑ Half-curved or ski

- is rarely used in skin closure because it is difficult to handle
- straight portion of the body does not follow the curved point
- resulting in an enlarged curved point, which makes the needle difficult to handle



Needle Body Types...

❑ Curved

- predictable path through tissue and requires less space for maneuvering than a straight needle
- necessitates manipulation with a needle holder
 - 1/4 circle – eye, microsurgery
 - 3/8 circle – used for the most body structures, skin closure
 - 1/2 circle – used for the most body structures
 - 5/8 circle – urinary and reproductive system

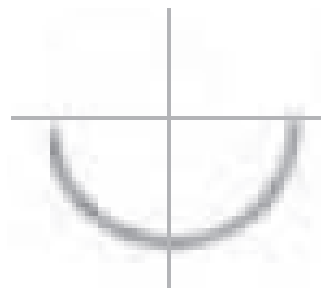
1/4 circle



3/8 circle



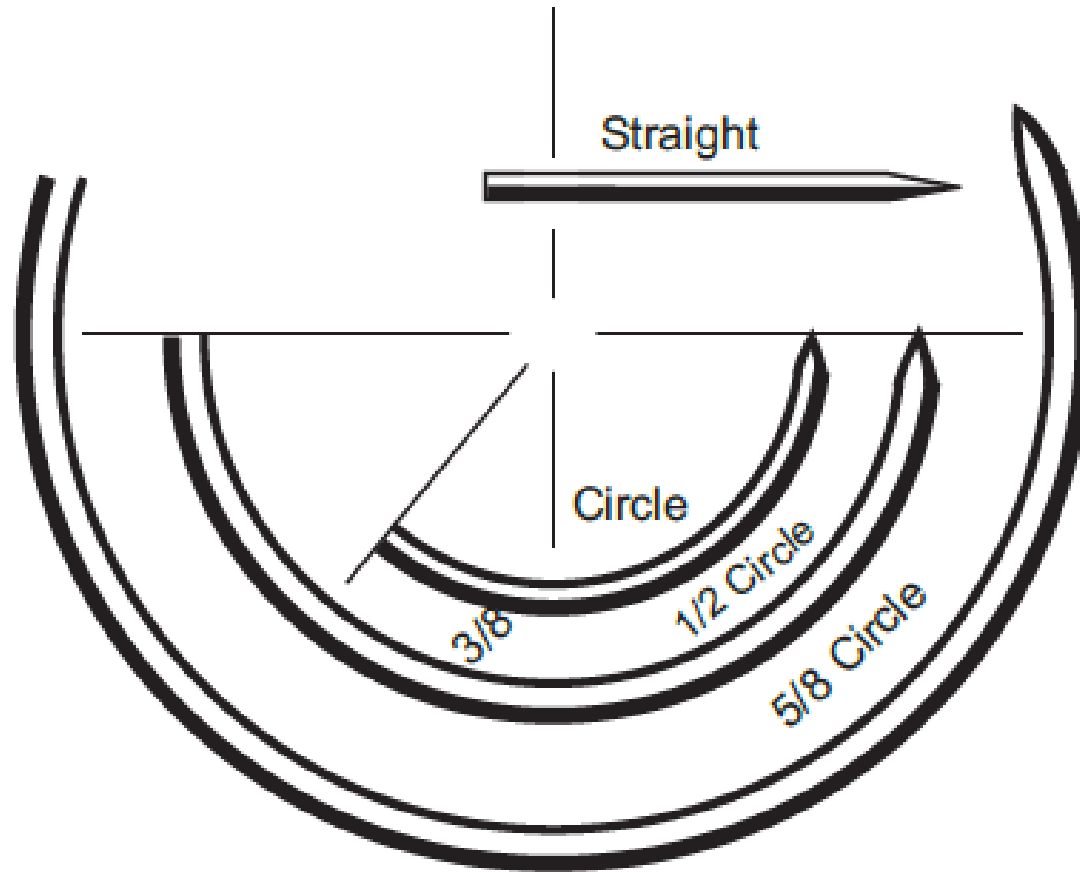
1/2 circle



5/8 circle



Needle Body Types...



The eye of Needle

➡ Traumatic needles Vs Atraumatic needles

➡ **Traumatic needles –**

- needles with holes or eyes which are supplied to the hospital separate from their suture thread
- the thread comes out of the needle's hole on both sides

Traumatic needles...

- When passing through the tissues, this type of suture rips the tissue to a certain extent, thus the name *traumatic*



Closed Eye



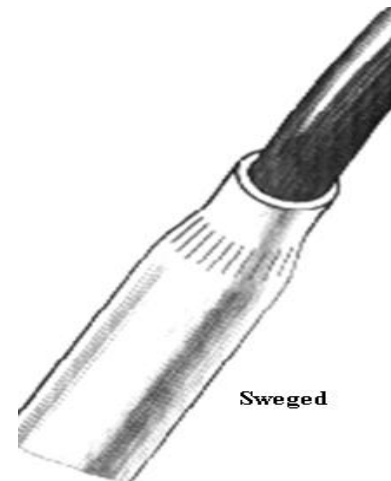
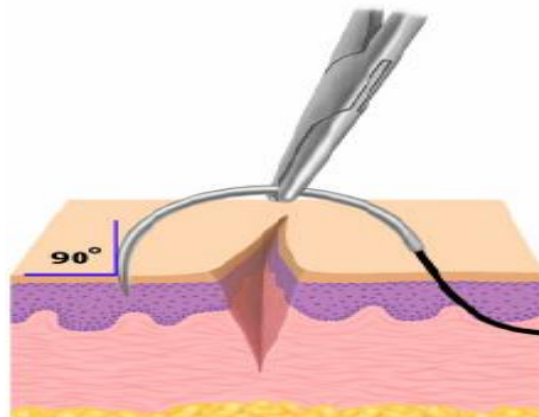
French Eye



The eye of Needle, Cont'd

➡ Atraumatic needles (with sutures)

- comprise an eyeless needle attached to a specific length of suture thread
- the suture end of a *swaged* needle is smaller than the needle body

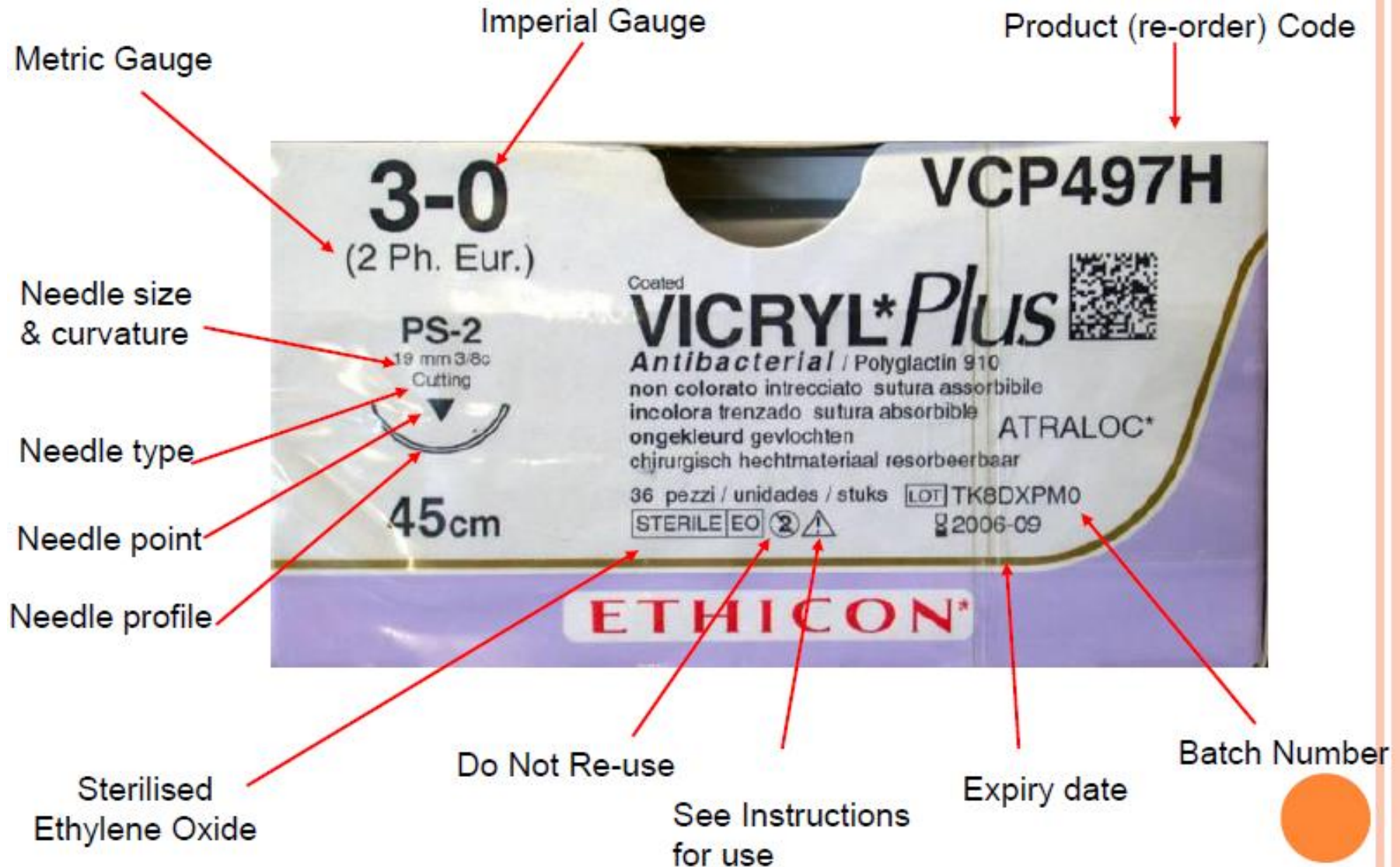


Suture Label

❑ The label must state:

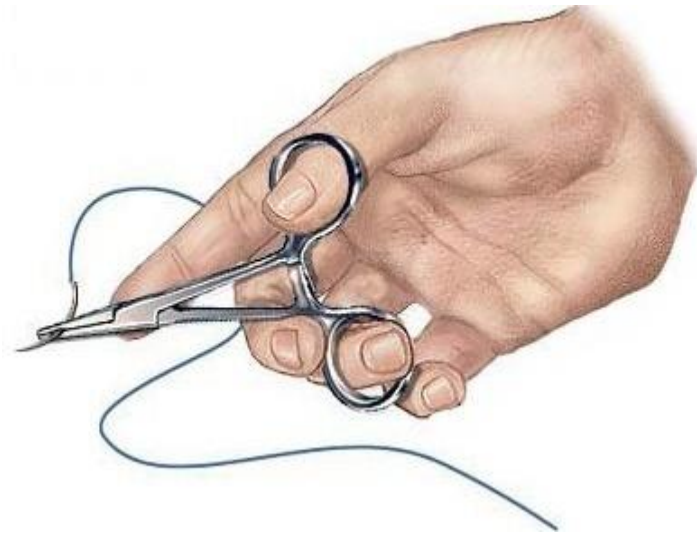
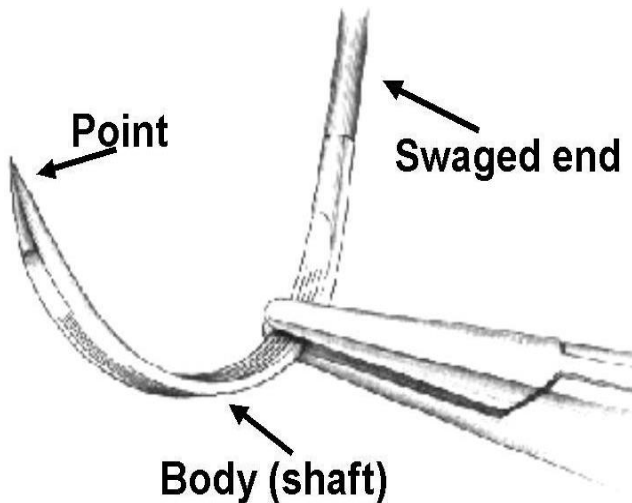
1. The length of the strand in centimeters or in meters;
2. The gauge number;
3. For single use only;
4. Where applicable, the Needle length, curvature and profile;
5. Lot number
6. Manufacture date;
7. Expiry date
8. Sterilization method;
9. Storage instructions;
10. Manufacturer's Name & Address

Suture Label...



Needle Holders

- **Using needle holder**
- Grasp needle about $\frac{2}{3}$ rd of the way back from point



Disposable Scalpel

- Used to cut the skin, sometimes called a surgical knife.



Surgical Blades

- Most common sizes are #10,#11,#15



Medical Gloves

- are disposable gloves
- used during medical procedures
- prevent contamination between care-givers and patients
- prevent contact with certain *chemotherapy* drugs
- Include: examination gloves, surgical gloves, and chemotherapy gloves
- meet performance criteria such as *leak resistance*, *tear resistance*, etc

Medical Gloves...

Surgical gloves

- sold as sterile products

Examination gloves

- not usually sold as sterile products
- packaged in pairs or boxes of single gloves

Chemotherapy gloves

- sold as sterile or non-sterile products
- usually packaged in boxes of single gloves or fitted pairs
- properties to protect the wearer from chemotherapy drugs



Medical Gloves...

- **surgical gloves** to protect a surgical wound from contamination
- **examination gloves** to prevent contamination or infection when examining or treating a patient
- **chemotherapy gloves** when working with chemotherapy drugs

Non-medical gloves: such as those used for household cleaning or for fire or injury protection, are not regulated by FDA. They do not meet FDA requirements for use in patient care

Before using medical gloves:

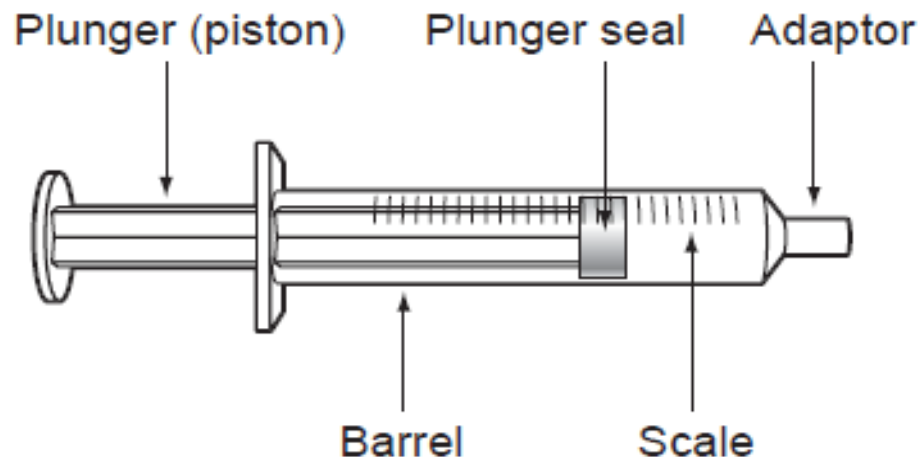
- Wash hands before putting on sterile gloves
- Make sure gloves fit properly
- Check allergy of natural rubber latex gloves (PVC, polyurethane)
- Be aware that sharp objects can puncture medical gloves
- Change your gloves if they rip or tear
- After removing gloves, wash your hands thoroughly with soap and water or alcohol-based hand rub
- Never reuse medical gloves
- Never wash or disinfect medical gloves
- Never share medical gloves with other users

Syringes

- Instruments intended for instillation of liquids into the body or its cavities, **OR** to withdraw body fluids from
- categories based on principle of action:

Plunger Syringes

- Have three parts: *plunger*, *barrel* with ml calibration and *tip*
- Hypodermic Syringes are best examples



Hypodermic Syringes

- are used to administer medication subcutaneously, or intradermally, intravenously, or intramuscularly
- hypodermic indicates-administered by injection beneath the skin
- Plunger movement (pull & push) inside the barrel allows the syringe to take in and expel a liquid.

Hypodermic Syringes...

- The open end of the syringe may be fitted with:
 - a hypodermic needle
 - a nozzle
 - **Tubing** to help direct the flow into and out of the barrel.
- The barrel of a syringe is made of plastic or glass

Hypodermic Syringes ...

- Usually graduated in units of volume (ml)
- Nearly always transparent
- **Glass** syringes may be sterilized in an autoclave
- **most modern medical syringes are plastic** with a rubber piston because:
 - **Seals much better** between piston and barrel
 - **Cheap** enough to **dispose off** after used only once
 - Reduce risk of spreading blood-borne diseases (no reuse)

Hypodermic Syringes ...

- Re-use
 - ✓ Spreads HIV, Hepatitis....
 - ✓ Safe for insulin injection at home, if used only by one person.
- Medical syringes are sometimes used without a needle for:
 - ✓ Oral administration of liquid medicines to young children or animals, or
 - ✓ Oral feeding of milk to small young animals

Hypodermic Syringes...

Pre-filled syringes:

- Supplied as a standard dosage **container**
- Each carry a single dose of sterile medication

Graduation:

- Syringes are usually graduated in ml
- Common size ranges from 2 ml to 50 ml
- Up to 200 mL available for veterinary use & transfusion
- ≤ 1 mL syringes graduated in 0.1- or 0.01-ml
- Also graduated with special units e.g. Insulin U

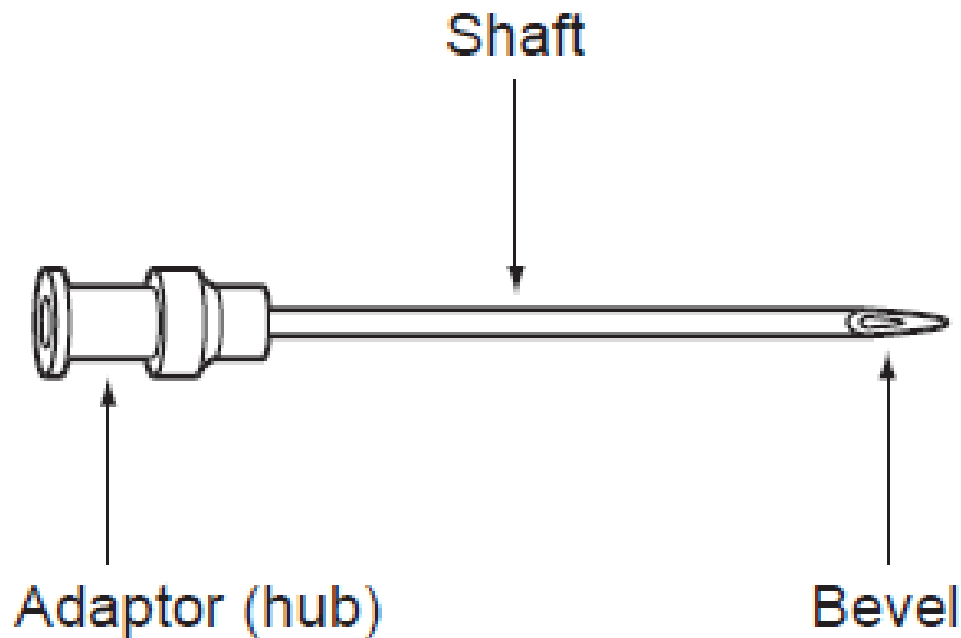


Hypodermic Needles

- hollow needle commonly used with a syringe to inject substances into the body
- also used to take liquid samples from the body
- can be used for IM, or IV, Intraarticular, intradermal, intraspinal
- hypodermic needles used are meant for single use
- needles are embedded in a plastic or aluminum **hub** that attaches to the syringe barrel by means of a *press-fit* or *twist-on* fitting

Hypodermic Needles...

- Needles also are called **cannulas**
- Have been made of stainless steel, chromium, platinum, silver, ...



Hypodermic Needles...

Hypodermic Needles are mainly characterized by:

1. Gauge: outside diameter of the *cannula* (needle shaft)

- The larger the number, the smaller the diameter
- Needles in common medical use range from 11 gauge (the largest) to 32 (the smallest)
- Needle diameter depends on purpose of use
- For injection administration, gauge usually not greater than 16 G (1.65 mm) is used
- 21 gauge needles are most commonly used for drawing blood for testing purposes

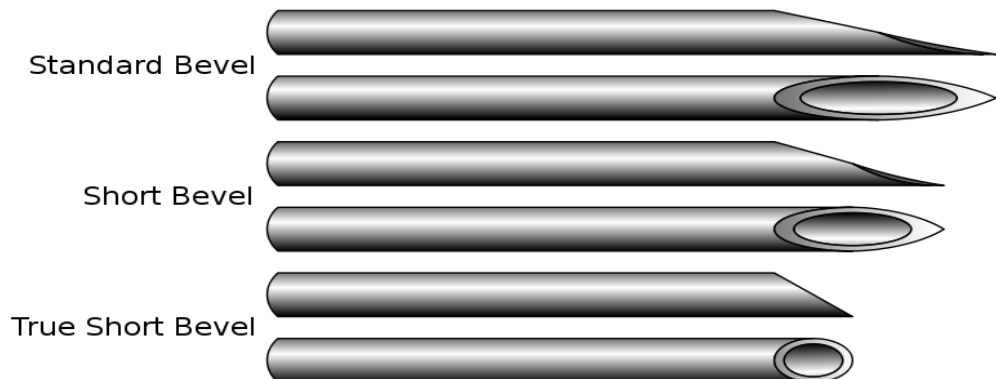
Hypodermic Needles...

2. Needle length:

- Length of needle shaft (starting from where the cannula joins hub)
- Depends on Purpose
- Usually ranges from 0.25 to 6 inches

3. Bevel:

- The slanting cutting edge which has a tapering point/tip.
- Facilitates penetration and injection through tissue or rubber closures



Needles designed for a variety of purposes

- Factors to be considered for selection: safety, rate of flow, comfort of patient, and depth of penetration

Long-bevel needles: for local anesthesia, aspirating, and subcutaneous administration

Short-bevel needles: for iv administration, infusions, and transfusions

Special short-bevel needles: for intradermal and spinal admn.

For local anesthesia: 26 to 20 G, ½ inch to 6 inches

IV, blood transfusion needles – 19-15 G, 1¼ inch to 2½ inch

Insulin syringes



- Have markings to show how much insulin is inside the syringe
- Insulin syringes come in different sizes and lengths to match insulin strength
- Sizes of insulin syringes:
 - 1 cc insulin syringe: For doses of 100 units or less
 - 1/2 cc insulin syringe: For doses of 50 units or less
 - 3/10 cc insulin syringe: For doses of 30 units or less

ASSIGNMENT

- Equipments Used in Surgery, Anesthesia, Orthopedics: **G1**
- Equipments Used in Ophthalmology, Dentistry, ENT: **G2**
- Self-Care Diagnostic Devices and medicinal gases: **G3**
- **Medical Supplies and Equipments used in Veterinary Medicine**
 - Peculiar characteristics of Supplies Used in Veterinary Medicine:
 - Equipments Used for Oral Administration of Drugs: **G4**
 - Equipments Used for Intravenous Administration
 - Materials Used for Administration of Topical Medication: **G5**