Sources of microorganisms in raw milk :

The initial number and types of microorganism in fresh raw milk depend on a number of sources, the primary ones being

1- The udder and teats (The interior and the exterior conditions).
2-The milker and milk handlers .
3-Water supplies.
4-Air.
5-Milking equipment.
6-The subsequent storage and transport conditions may further increase the microbial number if proper cooling (refrigeration) is not practiced.

I - Internal contamination

The initial number of microorganisms in aseptically drawn fresh raw milk is almost high

A-Interior of the udder:

1-The interior of the normal udder:

milk when secreted in the healthy udder is almost sterile but as it passes through ducts and reservoirs of the udder, organisms are carried into it especially from the walls of the teat canal, these bacteria enter through teat opening and spread in the interior of the udder (lactiferous ducts) by their physical movement and multiplication, majority of these bacteria come down in the foremilk.

These microorganisms may range from a few hundred to a few thousands per ml of milk. They are washed out by the first few streams of milk withdrawn from the udder; therefore, fore-milk usually contains the largest counts or number and strippings usually have a lower bacterial count.

Types of microorganisms contributed by this source are the following few genera: -**Micrococci** (**predominate**), **Streptococci**, and **Corynebacterium**.

2-Interior of infected udder (mastitis) :

The mastitis causing bacteria get excreted in milk (most of them in fore-milk fraction)

a-**Subclinical form of mastitis** contributes about 10000 bacteria /ml of milk.

b- **Clinical form of mastitis** contributes over 10 million bacteria/ml (such high numbers are generally excreted in streptococcal and coliform mastitis). In Staphylococcal mastitis the number excreted is not so high. Mastitis may lead to the development of millions of the infectious organisms per ml of milk from diseased quarters.

Types of microorganisms contributed by this source:

The most common microorganisms are:

1-Staphyloccus aureus.
2-Streptococcus agalactiae.
3-Streptococcus dysagalactiae.
4-Streptococcus uberis.
5-Escherichia coli.
6-Corynebacterium pyogenes.

Other infrequent microorganisms are:

-Leptospira, Listeria, Bacillus cereus, Pasteurella multocida, Clostridium perfringens, Actinomycetes, Rickettsia (Coxiella burnetii), and Yeasts (Cryptococcus neoformans).

B-Blood (Diseased animal):

Circulation of microorganisms in the blood of diseased animal as in :

1-Bacteraemia.
2-Viraemia.
3-Rickettisaemia.
4-Toxoplasma.

The infected animals excrete or shed organisms in their milk which sometimes the continues without manifestation of diseases (Asymptomatically).

The causative organisms of these diseases are:

1-Brucella abortus and Brucella melitensis as in (Brucellosis).
2-Mycobacterium tuberculosis as in tuberculosis (TB).
3-Clostridium botulinum as in (Botulism).
4-Coxiella burnetti as in Q-fever.
5-Leptospira as in leptospirosis.
6-Listeria as in Listeriosis.

II- External contamination

The secreted milk is almost sterile and contamination may occur during production, handling, transport and distribution of milk.

A- The exterior of normal udder and teats and animal body (belly, Flanks and Tail):

These surfaces soiled with feed, manure, mud and bedding materials (like sand, straw and saw dusts) such dirts may fall into the milk pail and carrying a considerable number of bacteria into the milk during milking.

The bacterial count in milk obtained from cows with unwashed teats (soiled heavily with manure) might reach approximately 10 cfu/ml, and the bacterial count associated with bedding material increased during winter housing (when teats are more soiled with bedding materials containing counts as high as 100 cfu/ml) than during summer (when cows are sent to pastures and hence lesser exposure to such bedding). The aerobic spore counts on teat surfaces were 102-105/teat depending on environmental conditions. The cows fed on "bad silage" excrete Clostridial spores in their feces which may contaminate teat surfaces and gain entry into milk.

Organisms associated with such dirt are often of the gas-forming group as Coliform and Clostridial spores also Bacillus spores and Micrococci, Staphylococci and faecal Streptococci. Under current milk production procedures, the body of the dairy animal has become a minor source of bacteria in milk.

Flanks and udders are clipped, cows are washed, udders dried and the milk is taken with milking machines.

B-Personnel (Milkers and handlers) unclean or unhealthy:

The number of microorganisms derived from milkers or handlers is more when hand milking is practiced. The milker's hands may be a source of pathogenic bacteria of human origin. Moreover, a disease can be easily being carried from one animal to another on the milker's hands.

Organisms may drop directly into the milk pail from the nose and mouth during sneezing or coughing, wet-hand milking is especially objectionable because the liquid washes dirt and bacteria from teats, udder and hands into milk.

Several diseases caused by bacteria and spread through milk may be 630 transmitted, either directly or indirectly from the milker or handler to the milk, such as:

1-Typhoid fever.
2-Diphtheriae.
3-Scarlet fever.
4-Septic sore throat.

These are sometimes transmitted from a diseased person or carrier through milk to susceptible individuals who consume the contaminated milk.
Therefore, persons suffering from an infectious or contagious disease or a carrier of such, should not allowed to handle milk or its products or have a part in the cleaning or care of utensils used for them.
Filthy habits and wet-hand milking or similar practices are to be condemned. The cloths of the milker should be clean, as must be the milking-stool and the cord that is used to tie the animal or its legs. If

these precautions are not observed, the milker may contaminate his hands every time he touches stool and cord.
Types of microorganisms contributed by this source are mainly Staphylococci (Staphylococcus aureus) and Coliform from unclean personnel.
Also any of the human pathogens may come in the milk from unhealthy milker.

C- Milking utensils:

The term "utensils" is entended to include all containers or equipment in which or by which milk or its products are handled, processed, stored, transported or merchandised.
They include pails, cans, milking machine (teat cup, clusters, buckets or cans, milk pipeline, recorder, jars and pipeline receiver, milk cans or bulk tanks and ancillary equipment namely strainer, filter, a cooler and milk flow indicators and meters).
As soon as the fresh milk comes into contact with the inadequately cleaned and sanitized utensils, the virulent microorganisms will contaminate it.
These include **thermoduric**, **Thermophilic** and **mesophilic** microorganisms. After leaving the udder, milk is mainly contaminated from improperly sanitized milking equipment .The residual milk solids (milk residues / milk stones) on such equipment support the growth of microorganisms and formation of bacterial clusters which contaminate the subsequent supplies.

Types of microorganisms contributed by this source are:

1-Mastitis pathogens:

such as Streptococcus agalactiae and Staphylococcus auresus when hot cleaning / disinfecting solutions are used thermodurics predominate (Asporogenous Gram-positive rods).
In bulk tanks the thermoduric count is lower (<10 cfu/m^3) but the psychrotrophic count is higher due to prevalence of cold temperatures.
In the milk cans which are improperly cleaned and covered with lid while still moist, the bacteria may proliferate and contaminate the incoming milk. Spores of Bacillus cereus and other thermodurics in milk are generally contributed by milk cans.

D- Aerial contamination or Atmosphere:

The feeding of dusty hay and grains just before milking has been shown to contaminate the milk to some extent. Although brushing dairy animals just before milking was also found to increase the bacterial content because of the air borne contamination.
Small numbers may gain entry both during hand milking (by falling in the milk pail) and machine-milking (by getting sucked with air in the machine during its operation).

Types of microorganisms contributed by this source are:

1-Micrococci (more than 50% of the aerial microflora).
2-Bacillus spores.
3-Moulds spores.

E- Farm water supplies:

If polluted untreated water (from wells, lakes, springs and rivers) gains access to milk or is used for washing udders and teats or for rinsing milking equipment and other utensils or is used for washing milker's hands.
Any microorganisms present in the water will contaminate the milk. However multiplication of some of the water-borne bacteria in any residual water in the equipment will result in more serious contamination.
Many farms rely on untreated water supplies from wells, lakes, springs and rivers. Bacterial contamination can be introduced from storage tanks which are not properly protected from Rodents, Birds, Insects and dust. So water used in the process of milk production should be of good bacteriological quality (i.e. chlorinated). Chlorination is frequently recommended for water of unsatisfactory bacteriological quality.

Types of microorganisms contributed by this source are :

1- Fecal types like: Coliform, faecal Streptococci and Clostridia.
2-Saprophytic derived from soil and vegetation
3-Pseudomonas (Psychrotrophic microorganisms) and other gram negative rods.
4-Bacillus spores.

F-Flies and Rodents:

The contamination of milk from flies is very common, as they carry several types of microorganisms on their wings and legs from sewage or infected sputum, uterine discharges and abscesses to utensils, milker's hands and water supplies. In this manner pathogenic organisms of various types may be carried into liquid milk.

The principal organisms transmitted in this way are those causing :

1-Typhoid.
2-Paratyphoid.
3-Tuberculosis.
4-Diphtheria.
5-Anthrax.
Such organisms can exist on flies for long periods.

G- Storage and transport:

The improperly cleaned and sanitized equipment used for storage (milk insulated tankers) of raw milk cans or bulk tank) and transport (cans or might increase the bacterial count depending on their hygienic conditions.
Some increase in the microbial count may also result due to pumping of milk which breaks up the bacterial clumps and chains. Secondly, the improper cooling / refrigeration of raw milk during storage and transport leads to an increase in the bacterial number particularly psychrotrophic count.
Hence, in the stored milk psychrotrophs predominate. The psychrotrophic Bacillus spores are detected but they usually do not germinate and outgrow. The thermoduric flora also remains unchanged in stored milk. Among psychrotrophic genera in stored milk pseudomonas species mainly Pseudomonas fluorescens.

The type of predominant microflora depends on the temperature of storage as follow :

0-5° C e.g. Pseudomonas fluorescens

5-10° C e.g. 1-Pseudomonas fluorescens
2-Proteus vulgaris
3-Micrococcus species
4-Alcaligenes viscolactis
5-Alcaligenes marshallii

10-15° C e.g.1- Streptococcus acidominimus
2-Streptococcus agalactiae
3-Streptococcus cremoris
4-Streptococcus durans
5-Streptococcus dysgalactiae
6-Streptococcus faecalis
7-Streptococcus lactis
8-Streptococcus uberis

15-30° C : All Streptococci especially Streptococcus lactis

30-40° C :1-Enterobacter aerogenes
2-Escherichia coli
3-Lactobacillus brevis
4-Lactobacillus bulgaricus
5-Lactobacillus casei
6-Lactobacillus fermenti
7-Lactobacillus helveticus
8-Lactobacillus lactis
9-Lactobacillus plantarum
10-Lactobacillus leichmanii
11-A few Streptococci

40-50° C :1-Lactobacillus bulgaricus
2-Lactobacillus fermenti
3-Lactobacillus lactis
4-Lactobacillus helveticus
5-Lactobacillus thermophiles
6-Streptococcus faecalis
7-Streptococcus thermophilus