Casting or Ingot Structure :-

Molten metals are poured into molds and permitted to solidify, often the mold produces a ~~simple shape~~ finished shape, or casting.

In other cases, the mold produces a simple shape, called an ingot, that requires extensive plastic deformation or machining before a finished product is created.

In either a casting or an ingot, a microstructure is produced which can consist of as many as three parts (fig 11).

Chill Zone :-

The chill zone is a narrow band of randomly oriented grains at the surface of the casting.

The metal at the mold wall is the first to cool to or below the freezing temp.

The mold wall also provides many surfaces at which heterogeneous nucleation may take place.

Therefore, a large no. of grains begin to nucleate & and grow.

Columnar Zone :-

The columnar zone contains elongated grains oriented in a particular crystallographic direction.

As heat is removed from the casting by the mold material, the grains in the chill zone begin to grow in the direction opposite to the heat flow, or from the coldest towards the hottest areas of the casting.

This usually means that the grains grow perpendicular to the mold wall.

Grains grow faster in certain crystallographic directions. In metals with a cubic crystal structure, grains in the chill zone that have a <100> direction perpendicular to the mold wall grow faster than other less favourable oriented

grains fig (12).

Eventually, the grains in the columnar zone have <100> directions that are parallel to one another, giving the columnar zone anisotropic properties.

The formation of the columnar zone is influenced primarily by growth, rather than nucleation, phenomena.

The grains may be composed of many dendrites if the liquid is originally undercooled. Or solidification may proceed by planar growth of the columnar grains if no undercooling has occured.

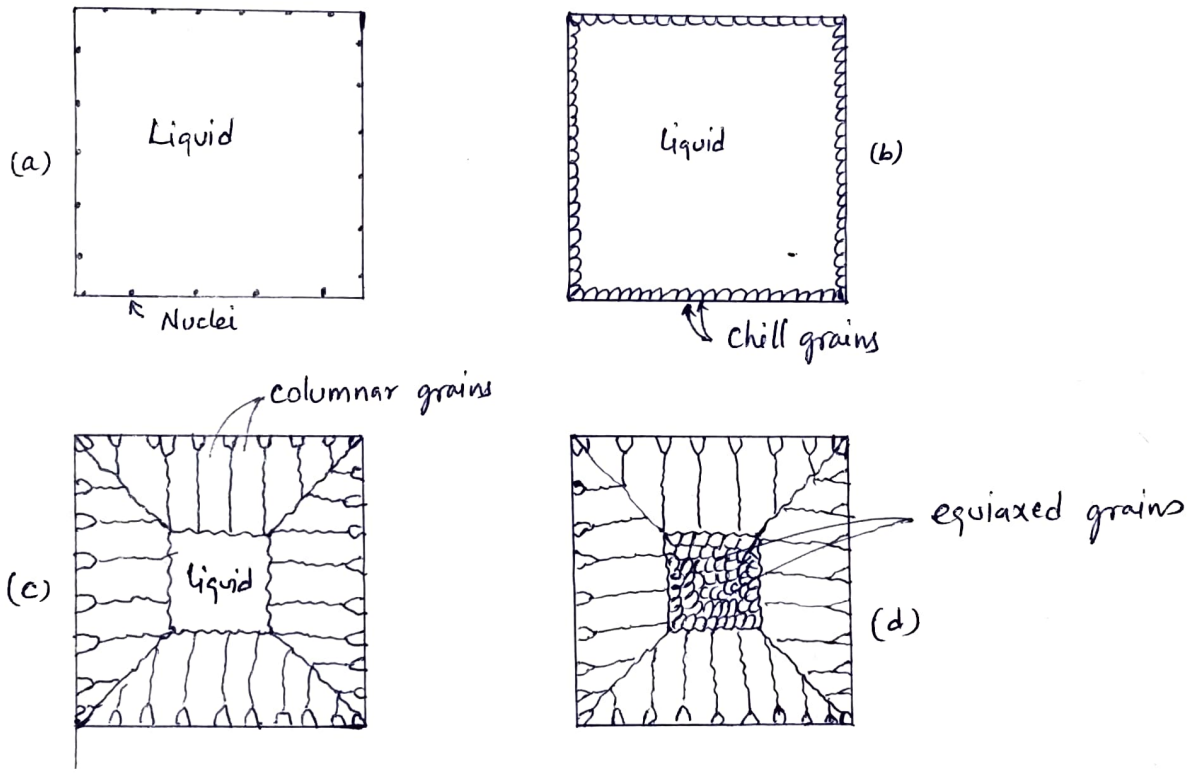

Fig 11. Development of the microstructure of a casting during solidification.
(a) Nucleation begins
(b) The chill zone forms
(c) Prefferred growth produces the columnar zone
(d) Additional nucleation creates the equiaxed zone.

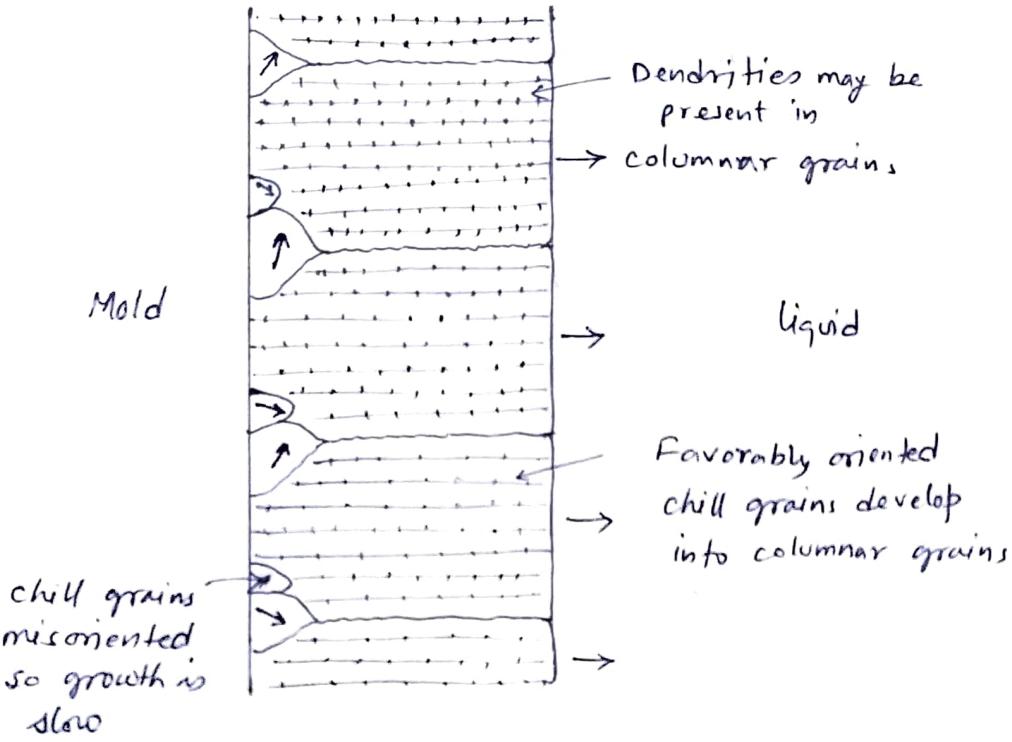

Fig 12: competitive growth of the grains in the chill zone results in only those grains with ~~fab~~ favorable orientations developing into columnar grains.

Equiaxed Zone :-

~~Equiaxed Zone :-~~

In most cases a pure metal continues to grow in a columnar manner until all of the liquid has solidified.

However, in alloys and in special circumstances in pure metals, an equiaxed zone forms in the center of the casting or ingot.

The equiaxed zone contains new, randomly oriented grains, often caused by a low pouring temperature, alloying elements, or grain refining or inoculating agents.

These grains grow as relatively round, or equiaxed, grains with a random orientation and stop the growth of the columnar grains.

The formation of the equiaxed zone is a nucleation - controlled process and causes that portion of the casting to have isotropic behavior.