# HYDROLOGY

# UNIT-I

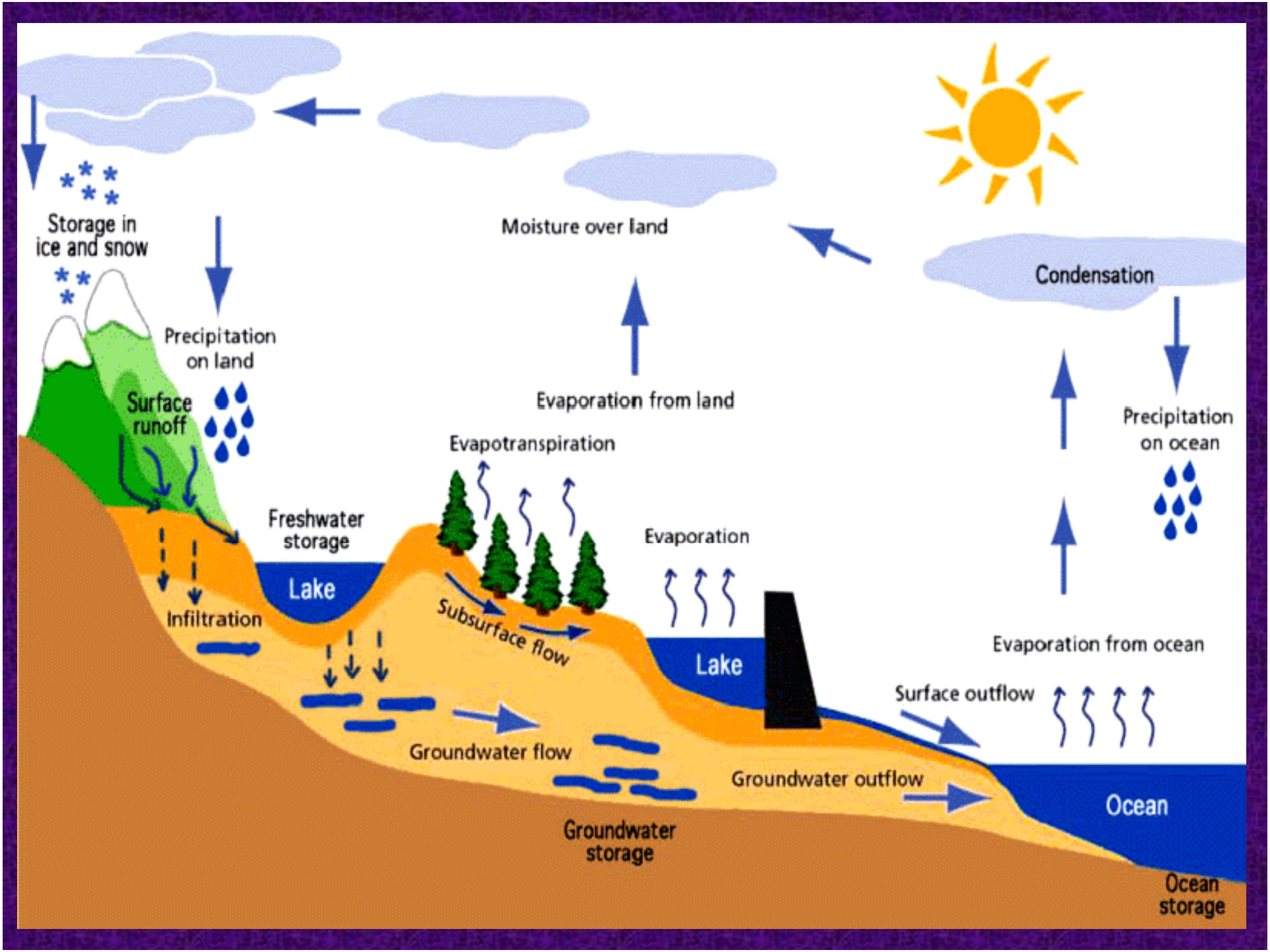
# INTRODUCTION

## Hydor + logos (Both are Greek words)

**“Hydor”** means water and **“logos”** means study.

**Hydrology** is a branch of Earth science which deals with the occurrence, circulation and distribution of water of the earth and earth’s atmosphere. It is basically an applied science.

**Hydrological Cycle:** It is also known as water cycle. The hydrologic cycle is a continuous process in which water is evaporated from water surfaces and the oceans, moves inland as moist air masses, and produces precipitation, if the correct vertical lifting conditions exist.


Storage in ice and snow
Precipitation on land
Surface runoff
Moisture over land
Evaporation from land
Evapotranspiration
Condensation
Precipitation on ocean
Freshwater storage
Lake
Infiltration
Subsurface flow
Evaporation
Lake
Evaporation from ocean
Surface outflow
Groundwater flow
Groundwater outflow
Ocean
Groundwater storage
Ocean storage

# STAGES OF HYDROLOGICAL CYCLE

The main components of the hydrological cycle are classified as transportation (flow) component and storage component.

| Transportation components | Storage components |
| --- | --- |
| Precipitation | Interception |
| Run-off | Depression storage |
| Infiltration | Groundwater |
| Evaporation | |
| Transpiration | |

Hydrological cycle is a continuous recirculating cycle in the sense that there is neither a beginning nor an end or a pause.

# SCOPE OF HYDROLOGY

The study of hydrology helps us to know:

1) The max. probable flood that may occur at a given site and its frequency. This is required for the safe design of drains, culverts, dams, reservoirs, channels and other flood control structures.

2) The water yield from a basin: its occurrence, quantity, frequency, etc. for the design of dams, water supply , water power, river navigation, etc.

3) The groundwater development.

4) The max. intensity of storms and its frequency for the design of a drainage project in the area.

# APPLICATION IN ENGINEERING PROBLEMS

- It is used to find out maximum probable flood at proposed sites e.g. Dams.
- The variation of water production from catchments can be calculated and described by hydrology.
- It enables us to find out the relationship between a catchments' surface water and groundwater resources
- The expected flood flows over a spillway, at a highway Culvert, or in an urban storm drainage system can be known by this very subject.
- **I**t helps us to know the required reservoir capacity to assure adequate water for irrigation or municipal water supply in droughts condition.
- It tells us what hydrologic hardware (e.g. rain gauges, stream gauges etc) and software (computer models) are needed for real-time flood forecasting.

- Used in connection with design and operations of hydraulic structure
- Used in prediction of flood over a spillway, at highway culvert or in urban storm drainage
- Used to assess the reservoir capacity required to assure adequate water for irrigation or municipal water supply during drought
- Hydrology is an indispensable tool in planning and building hydraulic structures.
- Hydrology is used for city water supply design which is based on catchments area, amount of rainfall, dry period, storage capacity, runoff evaporation and transpiration
- Dam construction, reservoir capacity, spillway capacity, sizes of water supply pipelines and affect of afforest on water supply schemes, all are designed on basis of hydrological equations.

# DRAINAGE BASIN

•Also known as catchment area or drainage area.

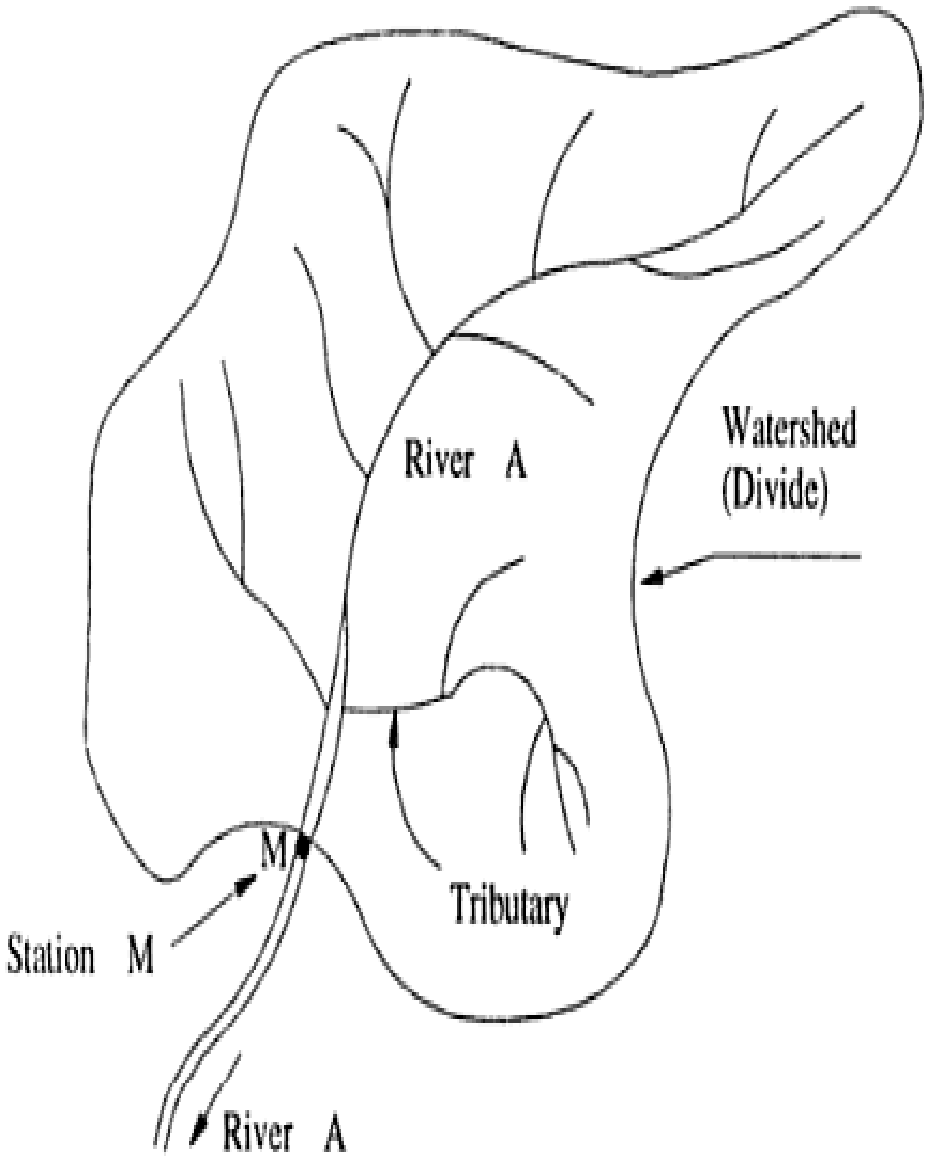
•It is the area of land draining into a stream or a water course at a given location.

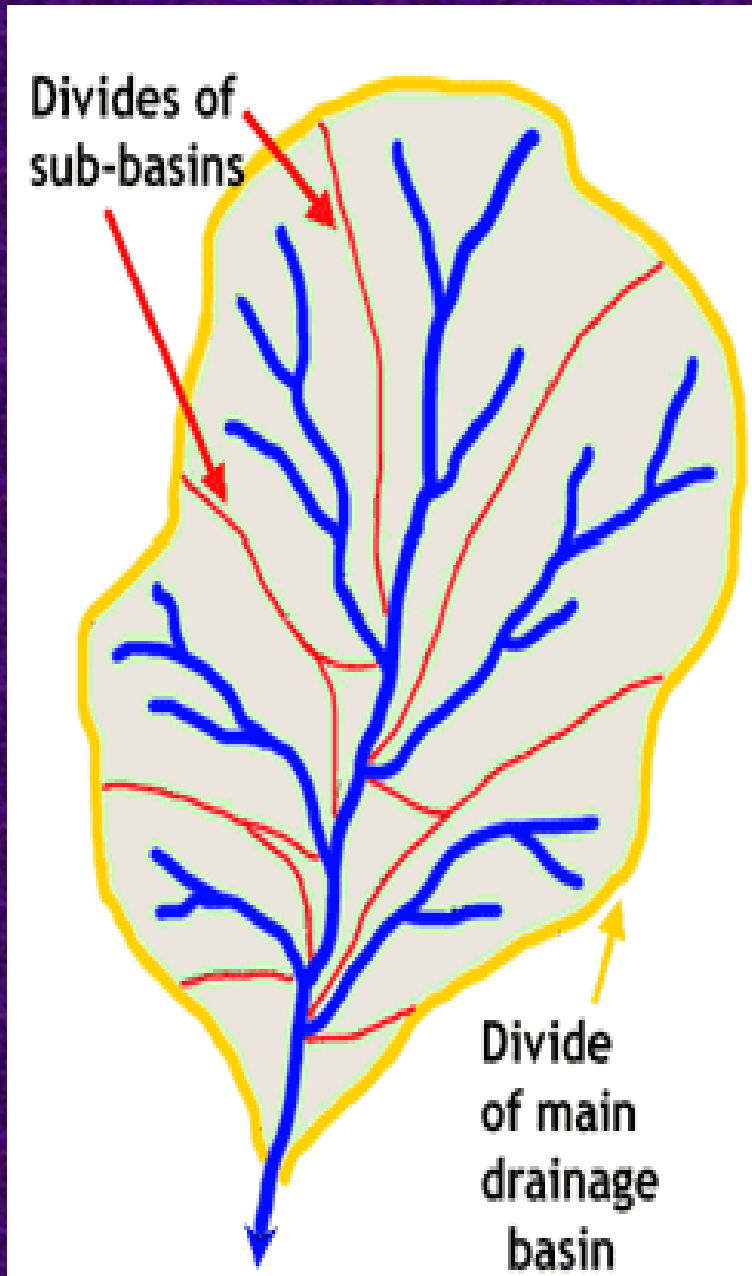
• In USA, it is known as watershed.

•The drainage basin acts as a funnel by collecting all the water within the area covered by the basin and channeling it to a single point. Each drainage basin is separated topographically from adjacent basins by a geographical barrier such as a ridge, hill or mountain.

•Drainage basins are open systems. Inputs to these systems include precipitation, snow melt, and sediment. Drainage basins lose water and sediment through evaporation, deposition, and stream flow.

Drainage basin



# CHARACTERISTICS OF DRAINAGE BASINS

•It is the basic hydrological unit in the analysis of runoff phenomenon.

•Physical characteristics of the drainage basin such as area, shape, slope, drainage channel pattern in the catchment are some of the major static characteristics.

1. Area ($km^2$)
2. Stream order
3. Stream density ($S_d$ )
4. Drainage density ($D_d$ )
5. Relief
6. Slope
7. Length (L)
8. Shape
9. Hypsometric curve

# STREAM ORDER

It is the classification reflecting the pattern of branches that unite to form the trunk stream leaving the catchment.
The smallest stream at the start of network is designated as ‘ order 1’.
2 channels or order 1 joined to produce order 2.
2 channels of order 2= order 3 and so on…….

Lower order stream meets higher order then resulting stream is still higher order stream.
The trunk stream discharging out of the basin has the highest order.

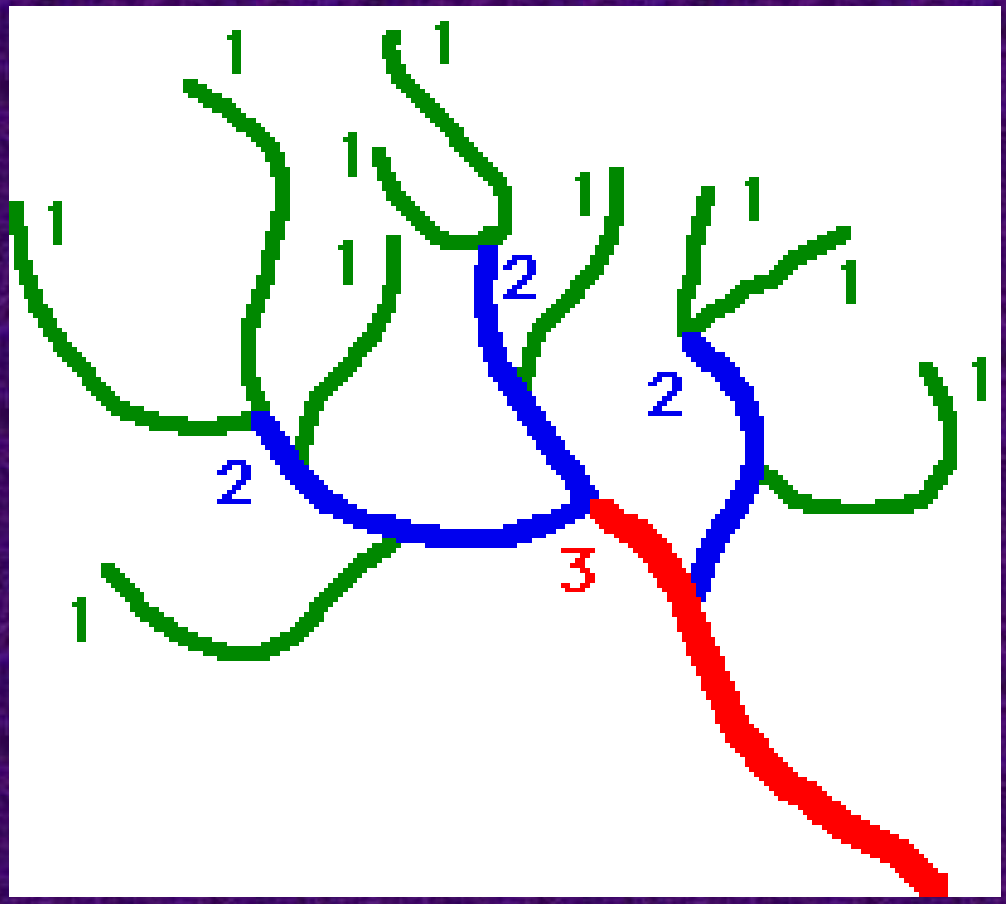
Different methods can be used to classify streams according to their position in the network, but the most commonly used is the method proposed by the famous hydrologist Robert Horton.

•The ratio between the number of stream segments in one order and the next, called the **bifurcation ratio.**

•R.E. Horton called this association the law of stream numbers.

•Stream order is helpful in designating the nature of drainage pattern of a drainage basin

•It is of use in locating watershed treatment structures such as check dams, nala bunds, etc.



**Stream density** ($S_d$) is the ratio of the number of streams of all orders to the area of basin.

$S_d = N/A$

**Drainage density** is a measure of the length of stream channel per unit area of drainage basin. Mathematically it is expressed as:

Drainage Density ($D_d$) = Stream Length / Basin Area

Maximum basin **relief** is the elevation difference (in m) between the catchment outlet and the highest point on the basin perimeter.

**Length** of the catchment is defined as the length of the main stream measured from the basin outlet to the remotest point on the basin boundary.

# HYPSOMETRIC CURVE

•It is a plot of horizontal cross-sectional drainage basin area to elevation.

•In the hypsometric curve of the total Earth surface there exist two maxima of frequencies—at the 100-metre (109-yard) and the 4,700-metre (5,140-yard) elevations, which correlate with the mean level of the lowland continental areas and the deep-sea floor.

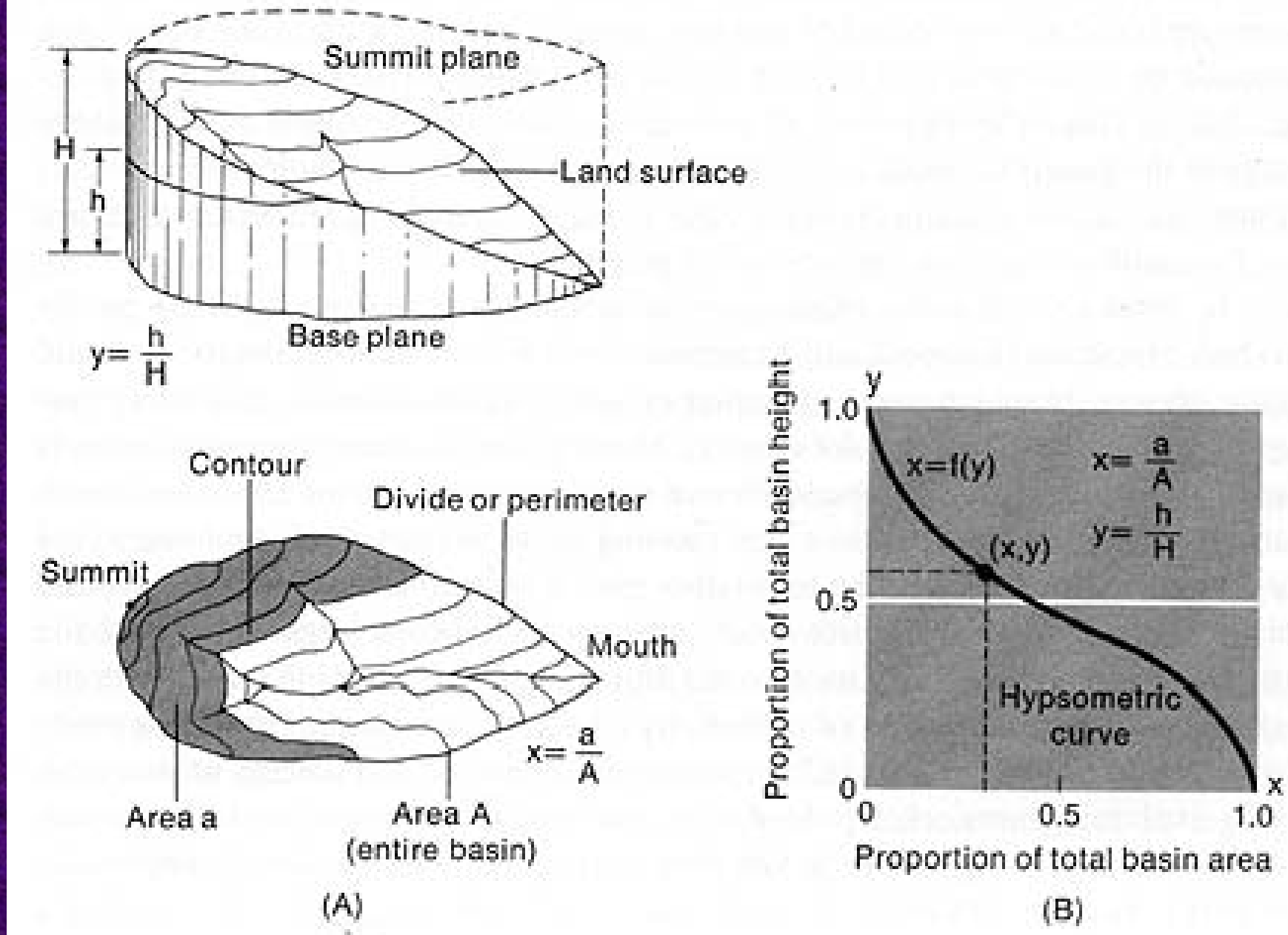
•It plots the curve in a non-dimensional form as a relative height h/H plotted against relative area a/A.

h= height of given contour

H= basin height/ relief

a= basin area at contour h

A= total basin area


Summit plane
H
h
Land surface
Base plane
y= h/H
Contour
Divide or perimeter
Summit
Mouth
x= a/A
Area a
Area A
(entire basin)
(A)
Proportion of total basin height
y
1.0
x=f(y)
x= a/A
y= h/H
(x,y)
0.5
Hypsometric
curve
0
0
0.5
1.0
x
Proportion of total basin area
(B)

•It describes the proportion of basin area that is above a certain basin elevation.

• It represents an overall basin slope.

•It embodies much of geomorphic information of the basin.

•Hypsometric curves are generated through the use of GIS and its applications.

•These curves finds use in some watershed models.