Streams are characterized by a continual downstream movement of water, dissolved substances, and suspended particles. These components are derived primarily from the drainage basin or watershed*, which is the total land area draining into a given stream channel. Thus the hydrological, chemical, and biological characteristics of a stream reflect the climate, geology, and vegetational cover of the drainage basin [cf., Beaumont (1975), Likens and Bormann (1995), Hynes (1970), Oglesby et al. (1972) and Whitton (1975)]. Water from rain or snow, falling on hilly or mountainous terrain, actually follows diverse routes in moving downhill (Fig. 5.1). Precipitation first may be intercepted by vegetation, then by litter on the surface of the ground. When water is added to the surface of a soil more rapidly than it can soak in (i.e., the infiltration capacity is exceeded) it will run off overland. Normally, most of the water from precipitation infiltrates into the soil. Soils have variable capacity to store water depending on depth, structure, composition, and other factors. Before stream flow can occur, this storage capacity must be exceeded. Storage capacity continually is made available by evaporation and transpiration (evapotranspiration). Until recently, limnologists have ignored, for the most part, the importance of hydrologic flow paths in regulating the metabolism and biogeochemistry of streams and lakes, as well as their role in the historical generation and accumulation of lake sediments [see Likens (1984)].

Flow through the soil may be channeled by macropores, often produced by cracks, worm or other animal burrows, and old root channels. Impermeable layers can impede the vertical movement of water and cause lateral flow at intermediate depths in the soil (Fig. 5.1). The chemistry of precipitation may be altered considerably as the water passes through the terrestrial ecosystem(s) comprising the drainage basin (Likens and Bormann, 1995; Likens 1984). The surface of the saturated zone of permeable soil is called the water table; water in the soil above the water table is termed vadose water and that below the water table ground water. Ground water provides the relatively stable base flow component in streams. Overland flow, in addition to water that infiltrates the soil and then flows laterally to the stream channel (i.e., subsurface storm flow), are the main components of peak flows or floods [cf., Dunne (1978), Chorley (1978), Winter (1985b)].

---

*R In American usage, watershed is equivalent to drainage basin or the European term, catchment, all of which refer to the region or area drained by a river system.
DRAINAGE AREA

A variety of methods have been proposed for ordering the tributary streams in a drainage network [cf., Gregory and Walling (1973)]. The Horton-Strahler method (Horton, 1945; Strahler, 1952) is probably the most widely used in the United States. In this method each headwater or “finger-tip” tributary is designated as the first order. Two first-order tributaries combine to produce a second-order stream, two second-order tributaries produce a third order, and so on (Fig. 5.2). The order of the trunk stream is not changed by the addition of a stream of lower order. Only when two tributaries of equal order are joined is the order increased. Practical limitations for this method include: (1) hydrological and ecological conditions may not be represented adequately since numerous tributaries can enter the main stream without changing order, and (2) ephemeral headwater streams or topographic maps of different scales can change significantly the order within the drainage network.

A variety of patterns may be observed in drainage networks (Fig. 5.3). Boundaries of drainage basins usually are determined from surface features (topographic divides) obtained from aerial photographs, field surveys, or topographic maps. However, subsurface flow may have different boundaries (phreatic divides), particularly in areas underlain with relatively soluble or permeable rocks. The drainage density for a watershed is defined as:

\[
\frac{\text{total stream length}}{\text{area of drainage basin}}
\]

When the log of the stream length (successive or cumulative distance), from headwaters to mouth, is plotted against the log of total drainage area for each point along the stream, a linear relationship is observed:

\[
L = jA^m
\]