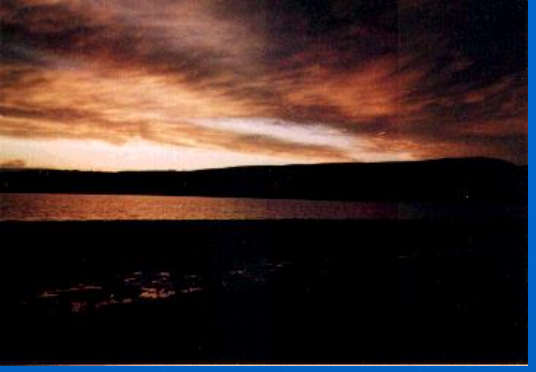
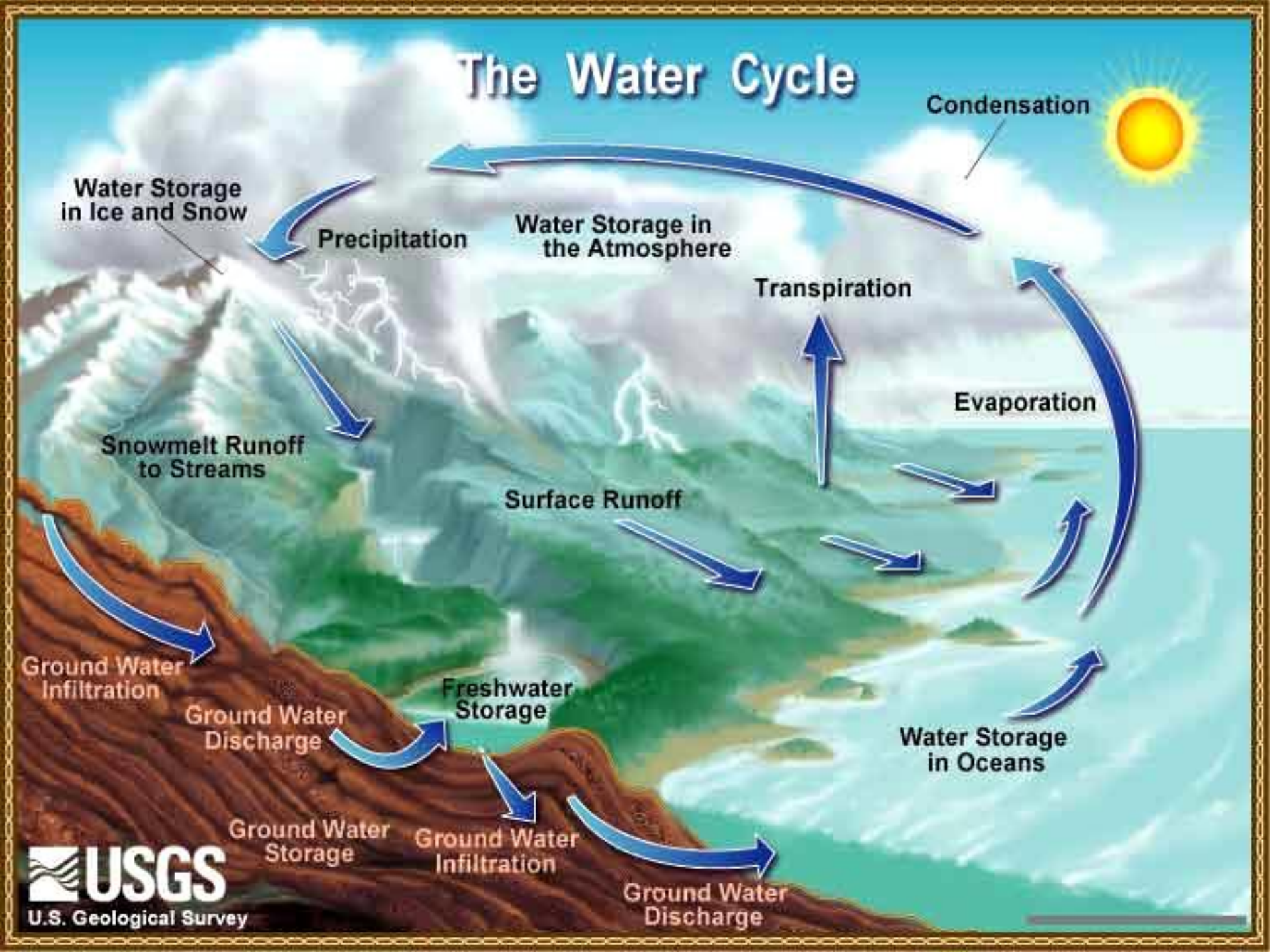
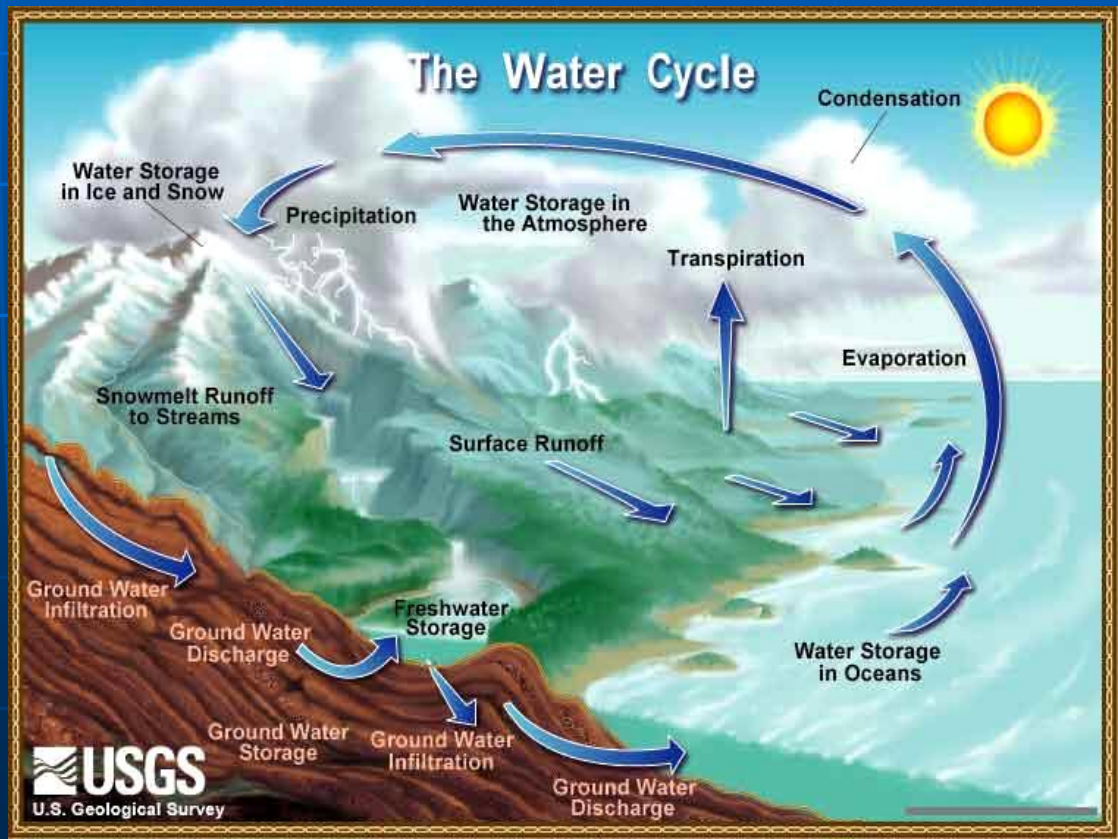


SOIL AND THE HYDROLOGIC CYCLE


The Water Cycle
Condensation
Water Storage in Ice and Snow
Precipitation
Water Storage in the Atmosphere
Transpiration
Evaporation
Snowmelt Runoff to Streams
Surface Runoff
Ground Water Infiltration
Freshwater Storage
Ground Water Discharge
Water Storage in Oceans
Ground Water Storage
Ground Water Infiltration
Ground Water Discharge
USGS
U.S. Geological Survey

THE HYDROLOGIC CYCLE

- **Cycling of water from earth's surface to the atmosphere and back again**



THE HYDROLOGIC CYCLE

- Cycle is driven by **solar energy**
  - 1/3 of energy stimulates evaporation
  - Water vapor rises to form clouds
  - Water vapor condenses into liquid in the form of rain and snow

FATE OF PRECIPITATION AND IRRIGATION WATER

- **Interception** by plants (30-60%)

- **Infiltration** – down movement in soil profile

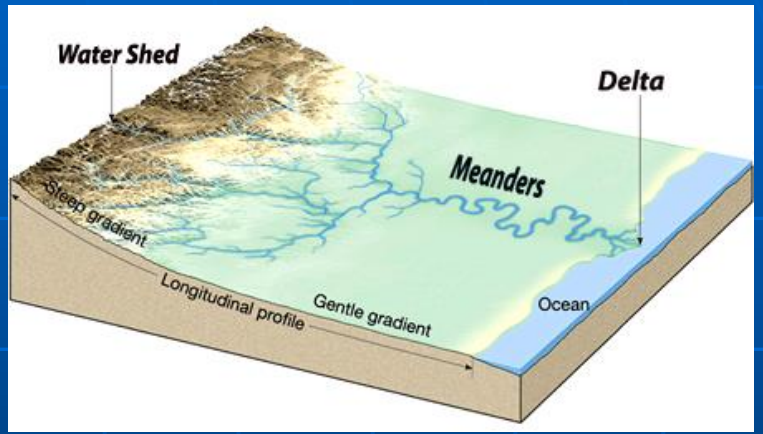
- **Surface runoff** – water moving along the soil surface

FATE OF PRECIPITATION AND IRRIGATION WATER

- **Drainage** – downward movement and lost from root zone
- **Capillary rise** – upward movement of water back up into plant-root zone
- **Soil storage water** – water retained by the soil

FACTORS AFFECTING WATER PARTITIONING

- Timing of precipitation
- Type of vegetation
- Stem flow
- Soil management
- Soil properties



TWO POINTS OF RESISTANCE

- Factors determining whether plants are supplied with water:
  - **Rate at which water is supplied** to absorbing roots
  - **Rate at which water is evaporated** from plant leaves

EVAPOTRANSPIRATION

- **Evaporation** component is considered a "waste" from a plant production view

- **Transpiration** helps the plant by:
  - Cooling
  - Nutrient transport
  - Photosynthesis
  - Turgor maintenance

EVAPOTRANSPIRATION

- **Potential ET** – rate at which water vapor would be lost from a densely vegetated plant-soil system if water is maintained at an optimal level

- **Potential ET is determined by:**
  - Temperature
  - Cloud cover
  - Relative humidity
  - Wind speed

MEASURING PET

- PET = 1500 mm/yr. for dry regions
- PET = 40 mm/yr. in very cold regions
- PET < 1mm/yr. in temperate regions (winter)
- PET = 10-12 mm/day with hot, dry winds

EVAPOTRANSPIRATION

- **Effect of Soil Moisture**
  - Upper 15-25 cm of soil provides most of water for surface evaporation
  - Water lost via evapotranspiration (ET) comes from subsoil layers
  - Important for plants in Ustic or Xeric moisture regimes

EVAPOTRANSPIRATION

- **Plant water stress**
  - ET = PET when soil moisture is optimum
  - ET < PET the plant will experience water stress

- **Water deficit** is the difference between PET and ET

EVAPOTRANSPIRATION

- **Influence of plant characteristics**
  - **Leaf area index (LAI)** – leaf area per unit land area
  - As LAI increases, more radiation will be absorbed by the foliage to stimulate transpiration (T) and less will reach the soil for evaporation (E)

EVAPOTRANSPIRATION

- Climatic conditions
- Plant cover related to soil surface (LAI)
- Water use efficiency by the plants
- Length and season of growing period

CONTROL OF EVAPOTRANSPIRATION

- Addition of water by irrigation
- Limit plant growth factors
- Reduce LAI lower plant populations per unit area and plant spacing

CONTROL OF EVAPOTRANSPIRATION

- Eliminate weeds
- Elimination of all plants to recharge soil moisture levels

CONTROL OF SURFACE EVAPORATION (E)

- Nearly 50% of precipitation in arid and semiarid areas is lost to E

- **Mulches** and certain tillage practices can help reduce E

VEGETATIVE MULCHES

- Reduce spread of soil-borne diseases
- Clean path for foot traffic
- Reduces weed growth
- Moderates soil temperatures

VEGETATIVE MULCHES

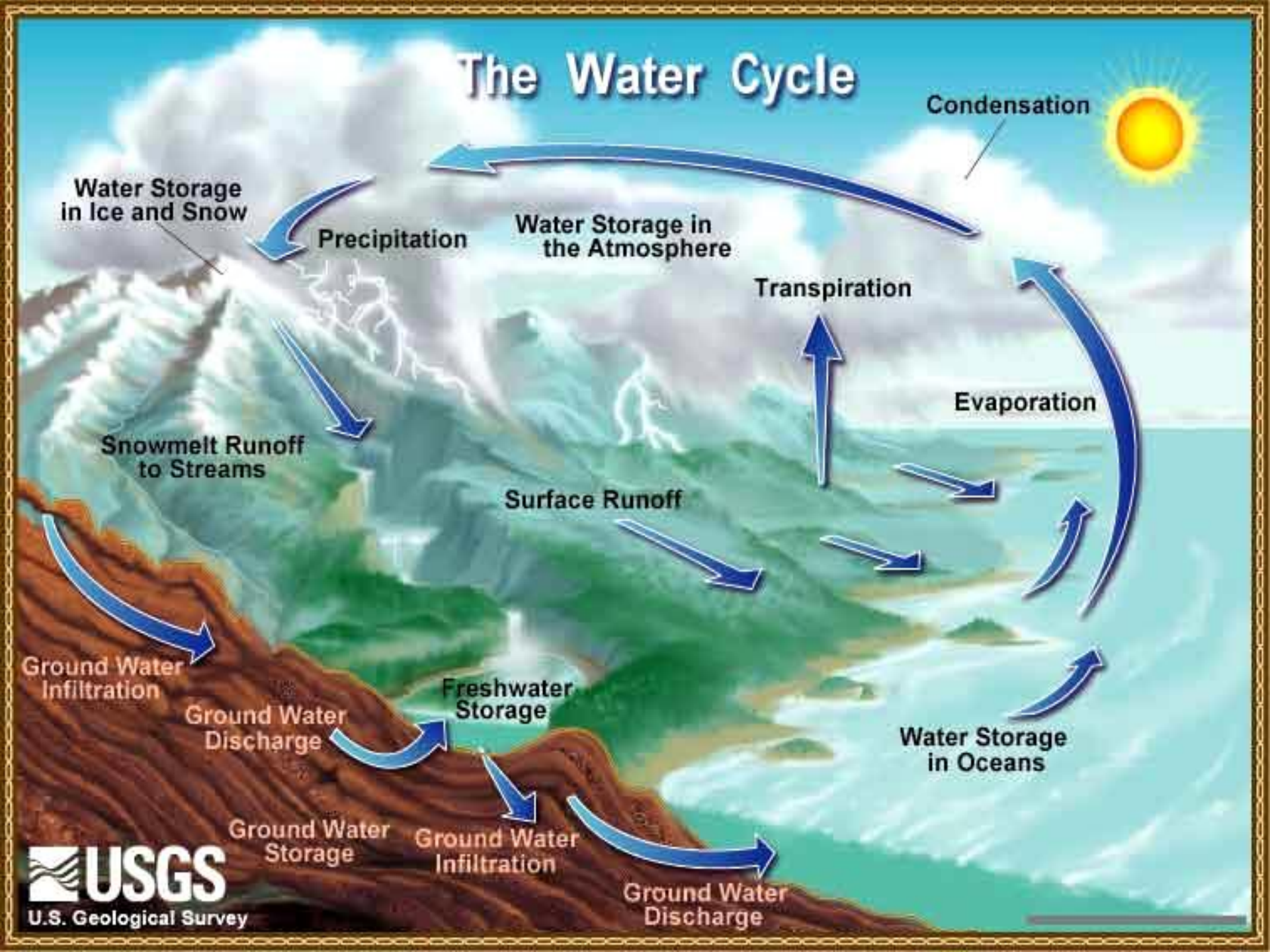
- Increases water infiltration
- Provides organic matter
- Encourages earthworm populations
- Reduces soil erosion

PERCOLATION-EVAPORATION BALANCE

- **Percolation water recharges groundwater supplies and moves chemicals out of the soil**
- Runoff water carries soil and dissolved chemicals off site

PERCOLATION LOSSES

- Amount and distribution of rainfall
- Runoff from the soil
- Evaporation
- Character of soil
- Vegetation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PERCOLATION AND GROUNDWATER

- **Water table** – upper surface of the zone of saturation
  - Humid areas: within 1-10 m.
  - Arid areas: 200 m.
  - Swamps: at land surface
- **Groundwater** – water within the saturated zone
- **Acquifers** – porous geological materials
- **Capillary fringe** – zone of wetting by capillary movement

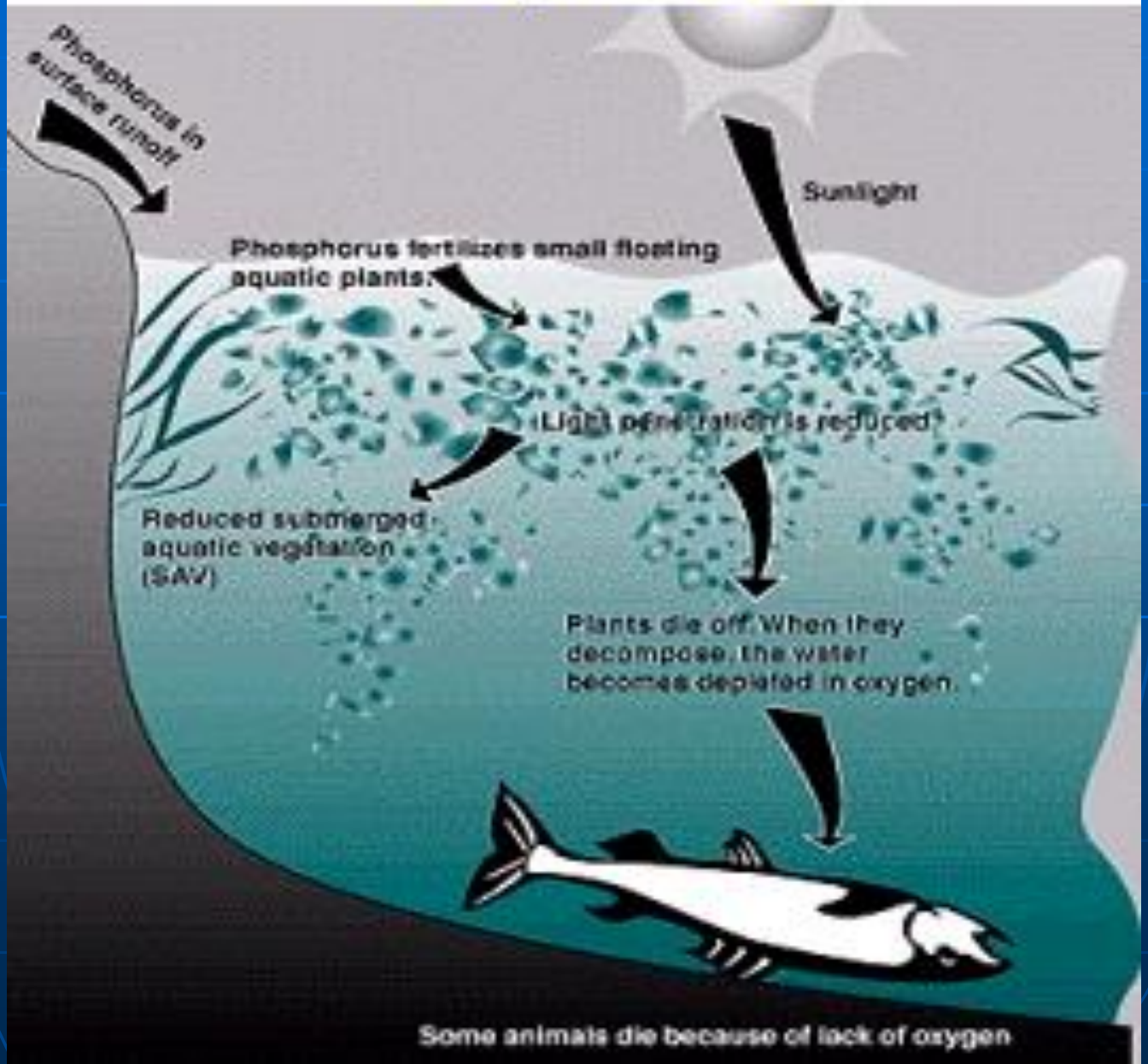
PERCOLATION AND GROUNDWATERS

- **Leaching** – removal of materials in solution from soil by percolating waters
  - Elements weathered from minerals
  - Natural organic compounds
  - Plant nutrients
  - Synthetic chemicals

PERCOLATION AND GROUNDWATERS

- **Downward movement of nitrogen**
- Leads to **eutrophication**
  - Oxygen content is depleted
  - Water supplies are contaminated
- **Contamination of human water supplies** with pathogens and pesticides

Biological Effects of Eutrophication



CHEMICAL MOVEMENT THROUGH MACROPORES

- Old root channels
- Earthworm burrows
- Clay shrinkage cracks

- **Remember: Once chemicals pass through areas of greatest root and microbial activity they are less likely to be broken down**

PREFERENTIAL/BYPASS FLOW

- **Water that flows down through large pores with minimal contact with soil**

- **Intensity of rain or irrigation**
  - Bypass flow is greatest during high-intensity rainfall and/or irrigation events that follow a dry period (Table 6.3)

CHEMICAL MOVEMENT THROUGH MACROPORES

- **Human activity that affects the hydrologic cycle:**
  - Use of artificial drainage
  - Application of additional water via wastewater disposal
  - Use of irrigation

SUBSURFACE (INTERNAL) DRAINAGE SYSTEMS

- Designed to remove groundwater from **within** the soil and lower the water table

- **Remember:** Internal drainage will occur only when the pathway for drainage is located below the water table level

SUBSURFACE (INTERNAL) DRAINAGE SYSTEMS

- **Buried perforated pipe or drain tiles**
- **Building foundation drains**

SPRINKLER SYSTEMS

- Simulates rainfall
- **Advantage:** plants respond better to the cooling effect

SPRINKLER SYSTEMS

- **Disadvantage:** Wet foliage promote foliar leaf diseases

SPRINKLER SYSTEMS

- **Water control**
  - Water delivery rate must be compatible with soil infiltration rate
  - FEW is usually higher for sprinkler systems
- **Suitable soils**
  - Practical on a wide range of soils

MICROIRRIGATION

- Most efficient system

- Also know as **drip (trickle) irrigation**
- Other forms include:
  - **Spitters** (microsprayers)
  - **Bubblers** (small vertical standpipes)

MICROIRRIGATION

- **Water Control**
  - Helps facilitate application of fertilizers and pesticides (**chemigation**)
  - High maintenance in temperate climates

MICROIRRIGATION

- **Equipment**
  - Higher initial capital investment (Table 6.5)
  - More profitable where water is scarce and on high value crops (i.e. fruit trees)

PULSE IRRIGATION

- **Practice of splitting irrigation intervals into smaller increments**
  - Reduces the amount of water applied by irrigating in smaller increments that can be used more effectively by plants
  - Eliminates larger increments that may produce excessive leach rates and runoff

IRRIGATION WATER MANAGEMENT

- **Salinity buildup**
  - Can cause a buildup of salts in the irrigation water and groundwater supplies

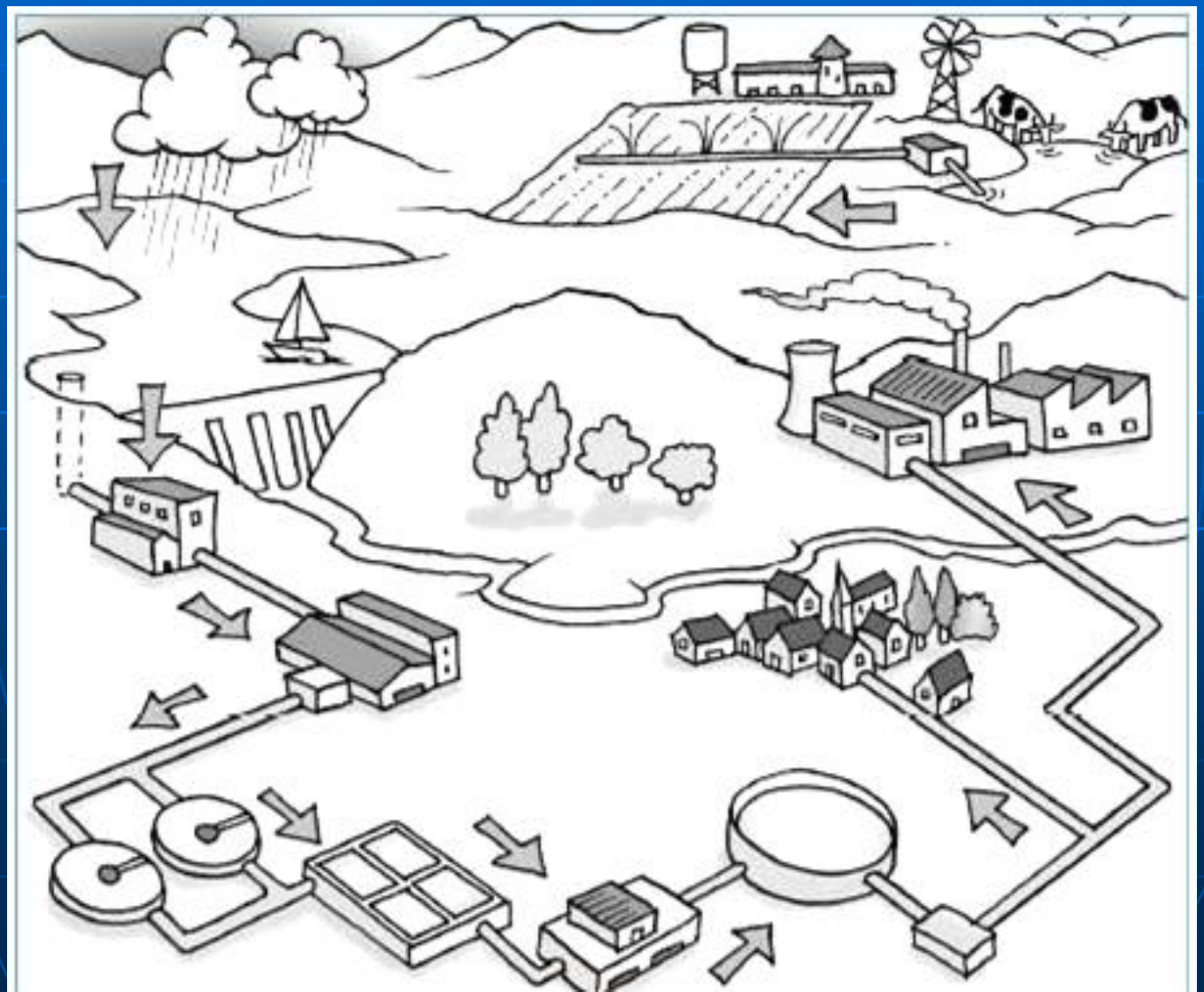
RECYCLING IRRIGATION WATER

- Helps eliminate runoff into sewage and storm water systems
- Can be blended with fresh water for re-use
- Use qualified engineers for design and implementation

RECYCLING IRRIGATION WATER

- Options for water re-use and/or treatment will depend on:
  - pH
  - EC
  - Nitrates
  - Phosphates
  - Pesticides

RECYCLING WATER IN AN URBAN SETTING



END OF PRESENTATION