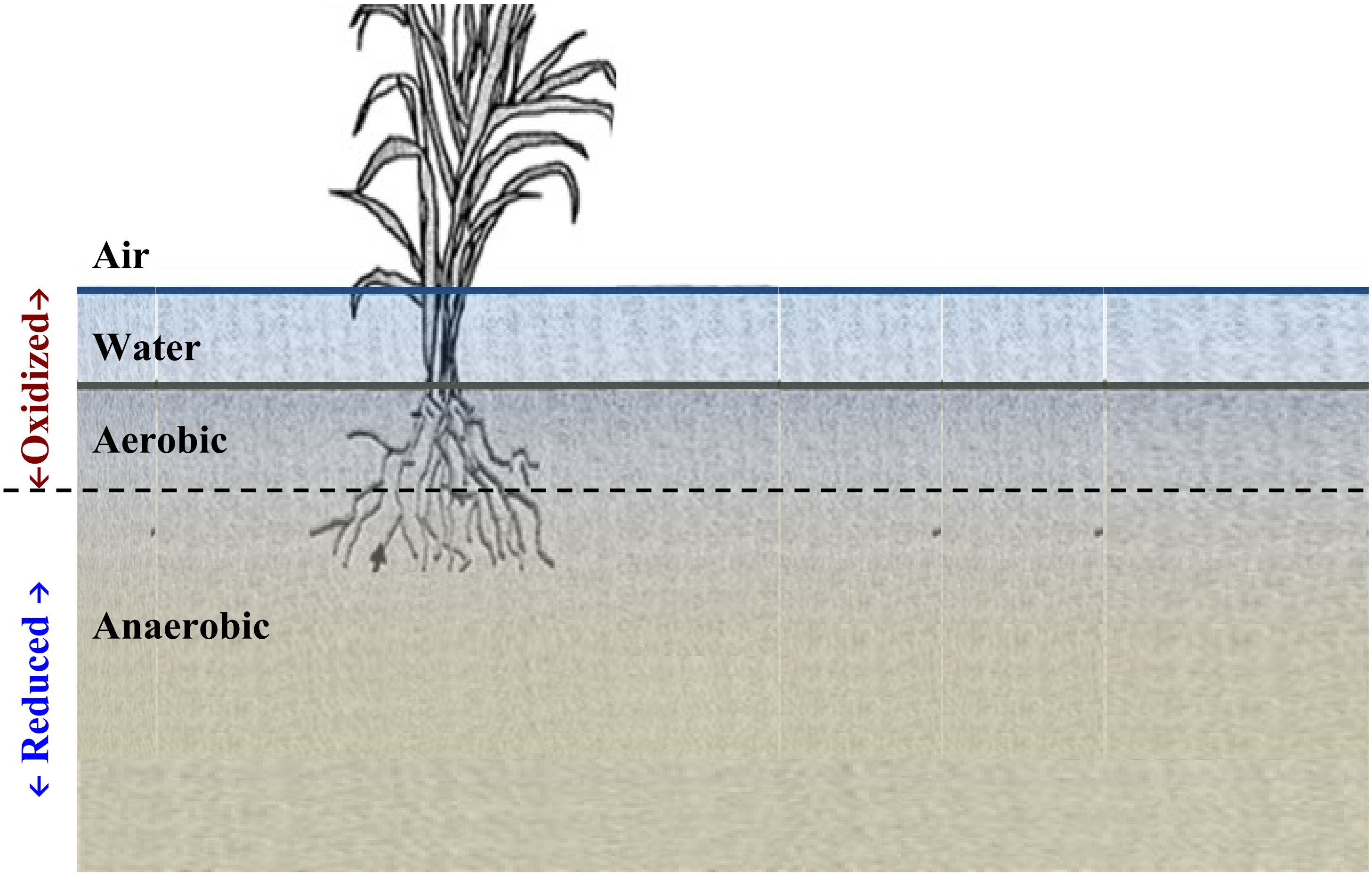
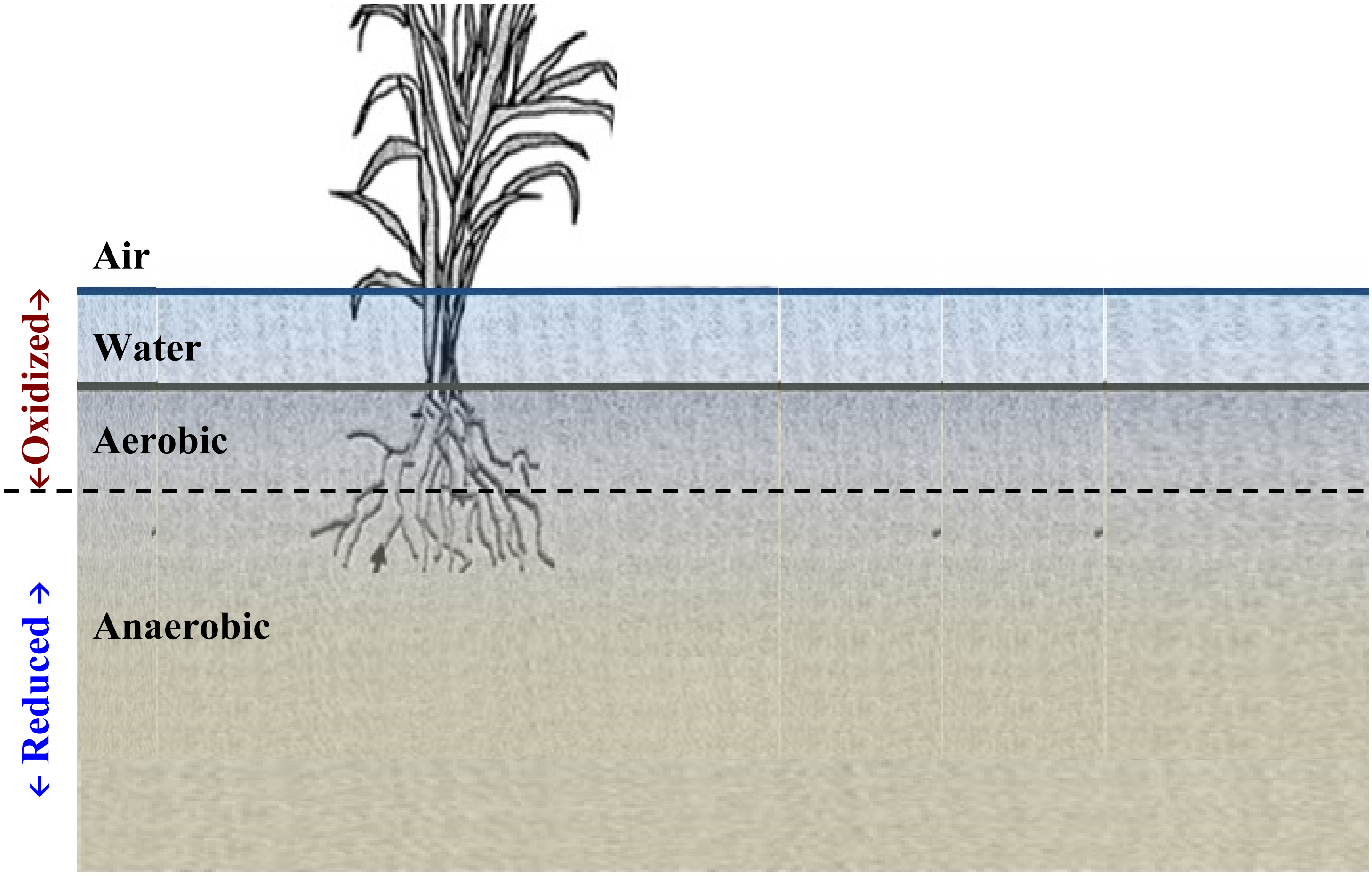
Phosphorous Cycle



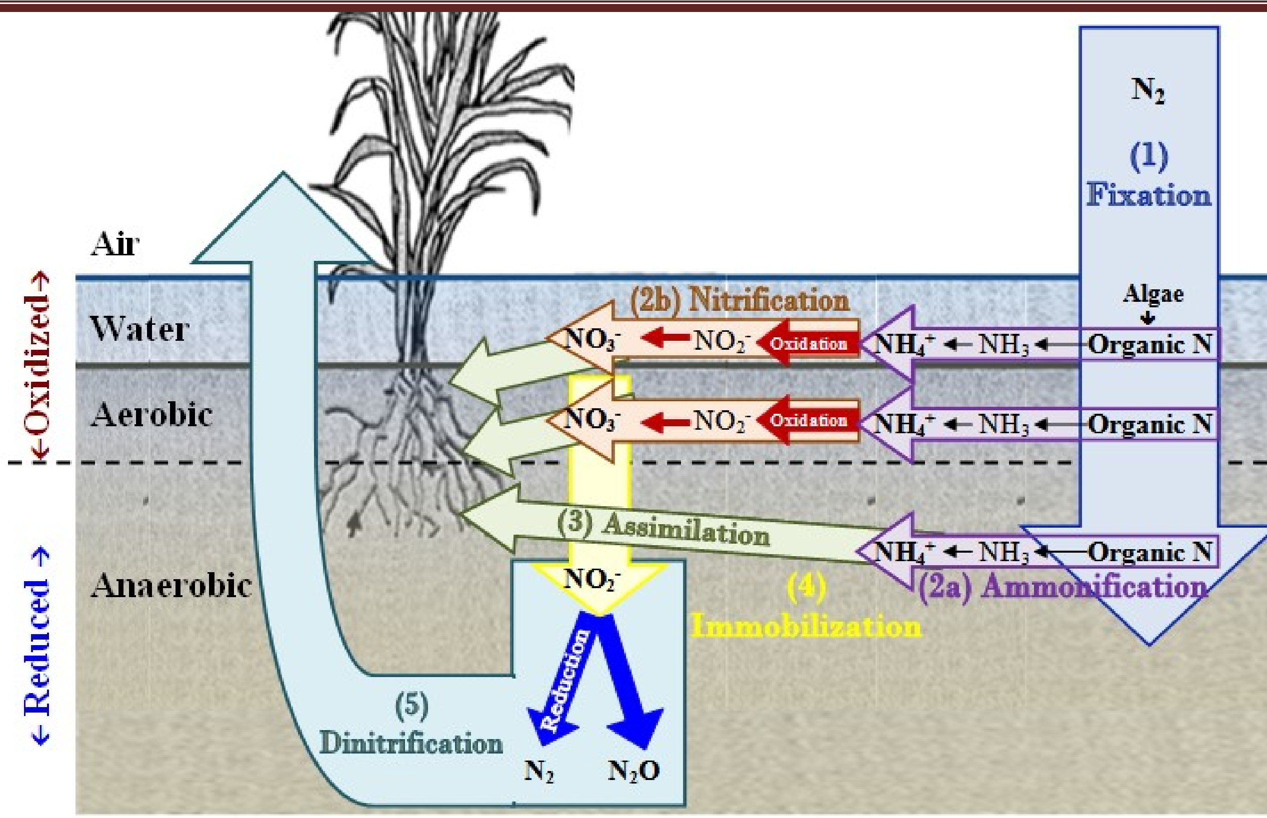
Importance	- P is a **major nutrient,** often **limiting** in **agricultural soils & freshwaters systems** (not limiting in wetlands) - One of the **most limiting** nutrients regulating productivity in terrestrial, wetland, & aquatic ecosystems
Harmful Impacts	- Causes **Eutrophication**
Forms	- **Organic** P: organic P is not available, it only becomes available through mineralization, represents a large proportion of total P - **Inorganic** (**Soluble**) P: (**PO_4^{3-}, HPO_4^{2-}, $H_2PO_4^{-}$**); P is **strongly retained by sorption** → significant P doesn't leach out - **Inorganic <u>Compounds</u>** containing P: (**Al-PO_4, Fe-PO_4, Ca-PO_4** which is very INsoluble at high pHs) ↳ P is most available at pHs 6-7.5. Availability ↓ as pH either ↓ (Al & Fe phosphates form) or ↑ (Ca phosphates form) ↳ In **flooded, Reduced** sediments [soluble P & dissolved Fe] ↑ vs **Oxidized** where these forms have already precipitated out - **Reductant Soluble Phosphate**: in **Oxidized** soils **ferric** Fe **trap** & hold P, vs. **Reduced** soils soluble **Ferrous Fe** releases P
Transportation Processes	- P cycle has **<u>NO</u>** significant transformation or transportation through a gas **phase** - Rivers are the main transport process for moving P to the oceans, & turnover time for organic P in oceans is rapid
Other	- **Microbial processes** are important in the **transformation** between **available Inorganic & Organic P** - P is not subject to valence state changes, instead changes in redox potential & pH cause chemical changes that affect the solubility & availability of P, but NOT its removal from the soils

Sulfur Cycle



Importance	- S is a **major terminal electron acceptor** in **strongly reduced** coastal sediments - Important in the **energy transport** in salt marshes, & in **trace & toxic metal chemistry**
Harmful Impacts	- **Sulfur Toxicity to Plants & Animals** - **Acidic Deposition, Acidic Sulfate Soils, Acidic Mine Drainage** - **Geothermal Activity** - **Groundwater contamination**
Forms	- **Organic** S: **humic material** - **Inorganic** S: ↳ **Sulfate** (**SO_4^{2-}**) is an important **oxidized** form b/c its soluble & abundant in seawater (mean oxidation state= **+6**) ↳ **Sulfide** (**S^{2}**) at normal pHs it becomes H_2S or a metal precipitate as soon as it forms (mean oxidation state= **-2**) ↳ **Hydrogen sulfide** (**H_2S**) very soluble & it's a gas → toxic ↳ **Pyrite** (**FeS_2**) an inert solid precipitate under **strongly reducing** conditions (causes extreme Acidity exposed to O_2) ↳ **Elemental Sulfur** (**S^0**) important **reduced** form
Transformation Processes	
Transportation Processes	-
Other	

Nitrogen Cycle



Importance	- N is the **most abundant gas** in the atmosphere (~78%) - N is **limiting** in **coastal waters** & **wetlands** (Not limiting in agricultural soils & freshwaters systems) - One of the **most limiting** nutrients regulating productivity in terrestrial, wetland, & aquatic ecosystems ↳ N reactions are **key regulators** of ecosystem productivity & functions
Harmful Impacts	- Humans have greatly ↑ amount of N in the environment ↳ Anthropogenic production of **Nutrient, Organic N** for use as fertilizers (**NH_4^+**) → **Eutrofication by NO_3^-**
Forms	- **Organic** (**Nutrient**) N: Proteins, Nucleic Acids, Amino Sugars, & Urea - **Inorganic** (**non-nutrient**) N: Atmospheric N (**NO, N_2 , & N_2O**), **NH_3, NH_4^+, NO_2^-, & NO_3^-**
Transformation Processes	(1) **Fixation:** Atmospheric, non-nutrient (N_2) → **Organic N** — O_2 ~~O_2~~ (2) **Mineralization** : conversion of **Organic** (Nutrient) N → **Inorganic** N *soil pH↓ as [Nitrate]↑* Regulated by substrate quality, C:N ratio, Microbial biomass & enzyme activity, temperature, Redox potential & Hydrology, & soil pH (2a) **Ammonification** : conversion of **Organic** N → **NH_3** → **NH_4^+** *sub-processes soil pH range 6.5 – 8.5* — O_2 ~~O_2~~ (2b) **Nitrification** : ***Nitrosomonas*** oxidizes **NH_4^+** ⊃ **NO_2^-** & then ***Nitrobacter*** oxidizes **NO_2^-** ⊃ **NO_3^-** — O_2 Regulated by: [Ammonium], O_2 availability, pH Alkalinity & CO_2, temperature, Nitrifying population, cation exchange capacity, & Redox potential (3) **Assimilation** : conversion of **Inorganic** N (**NH_4^+** or **NO_3^-**) → **Organic** N for **uptake** by **Plants** — O_2 ~~O_2~~ (4) **Immobilization** : conversion of **Inorganic** N (**NO_3^-**) → **Organic** N (**NO_2^-**) for **uptake** by **Microbes** — O_2 ~~O_2~~ (5) **Denitrification : microbial** reduction of **Organic** N (**NO_2^-**) ⊃ **Atmospheric** N (**N_2 & N_2O**) — ~~O_2~~
Transportation Processes	-
Other	- **C:N ratio :** differences in microbial N requirements explains why Ammonium release is higher under anaerobic conditions ↳ **Carbon Assimilation** ↳ C:N < 25 →**Ammonification** → **release of Inorganic N** (**NH_4^+**) (microbial demand for N is met) vs. C:N > 25→**Immobilization** of Inorganic N (NO_3^-→ NO_2^-) ↳ **Anaerobic** conditions: C:N < 100→ **Nh_4^+ is released** (microbial detritus decomposition) vs. C:N > 100 → **Buildup of Organic Matter** (low microbial N demand for N) - **Ammonia Volatilization**: (**Nh_4^+**→ **Nh_3^+**gas) is low at pH < 7.5, & rapidly ↑ as pH ↑ above 7.5