

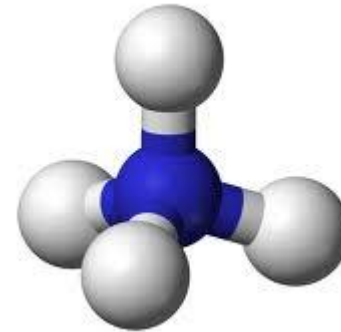
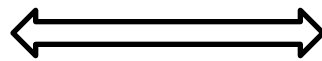
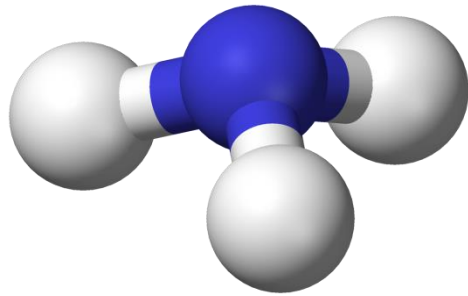
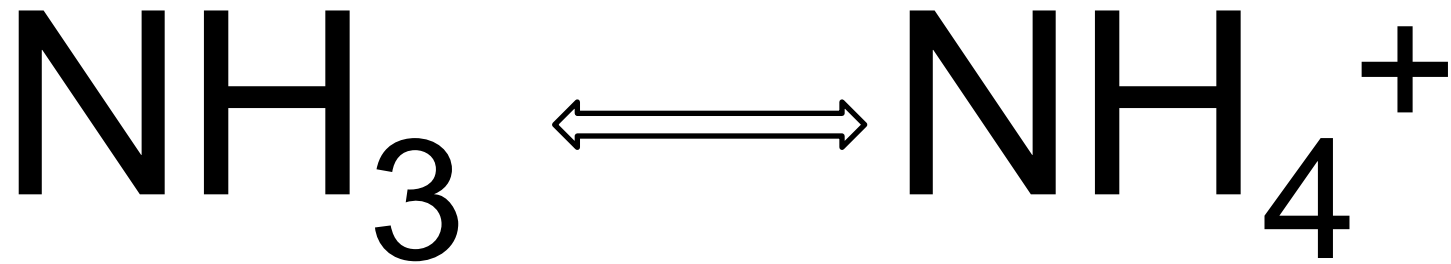
The importance of ammonia in aquaponics systems

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Ammonia in water is either unionized ammonia (NH_3) or the ammonium ion (NH_4^+).



The most common derivative
under physiological pH



Essential

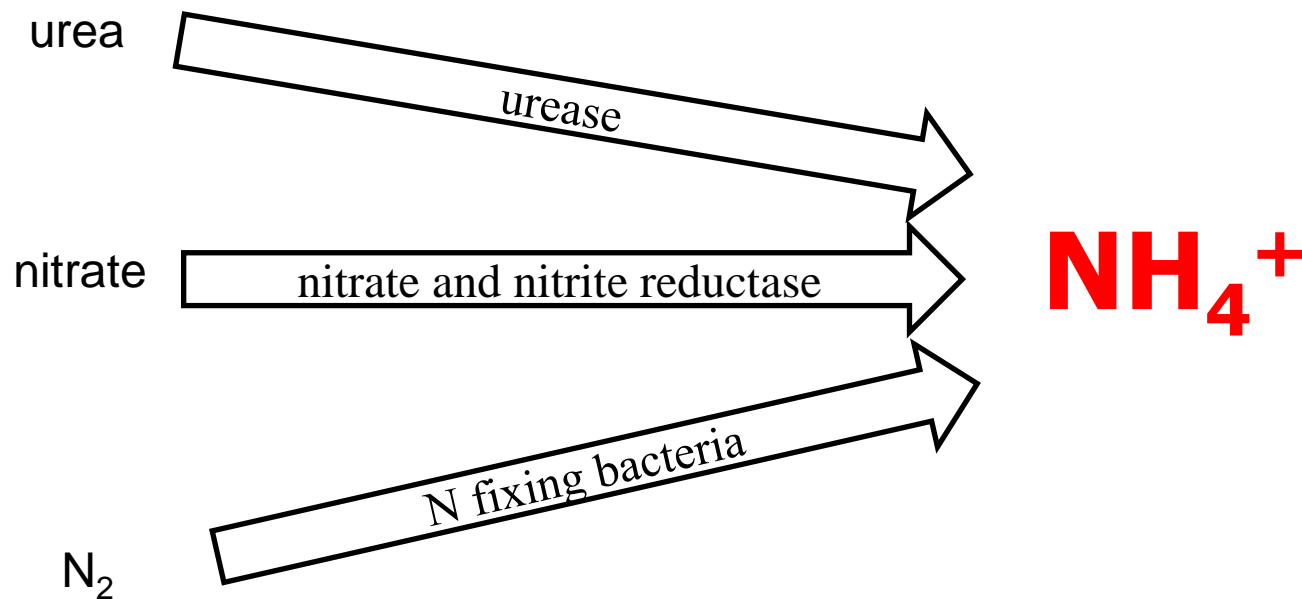
Toxic



Plant Protection Institute

Centre for Agricultural Research
Hungarian Academy of Sciences

- ◆ NH_4^+ - the form N is used in AA synthesis in plants
- ◆ NH_4^+ - plant nutrient (taken up by active transport)



Aquaponics and NH_4^+



◆ Good

- ❖ **fish produce** a lot of it as waste
 - ❖ **plants** can directly use it as a N source
-

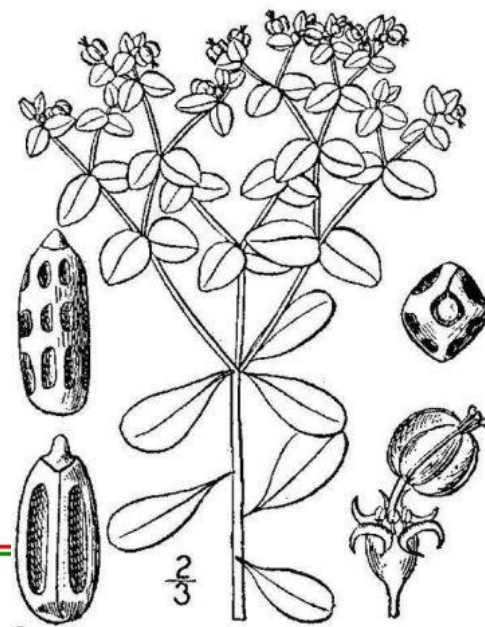
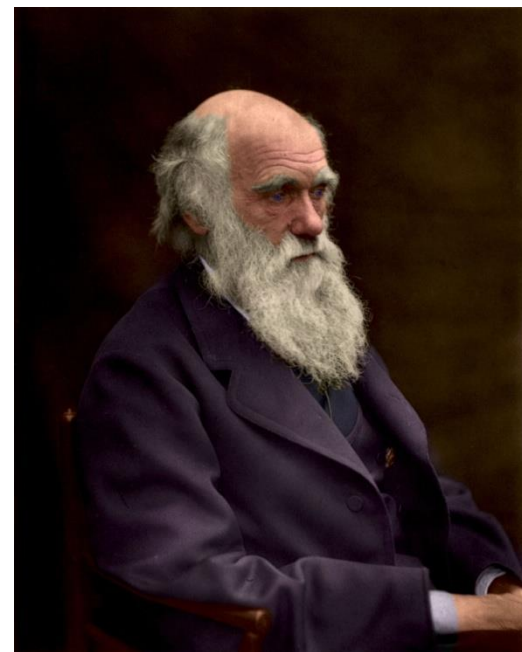
◆ Bad: NH_4^+ toxicity to fish and plants



NH_4^+ toxicity to plants

◆ Charles Darwin (1882)

- ❖ The action of carbonate of ammonia on the roots of certain plants
- ❖ Journal of the Linnean Society of London 239-261.
- ❖ *Euphorbia peplus*



NH₄⁺ **toxicity to fishes**

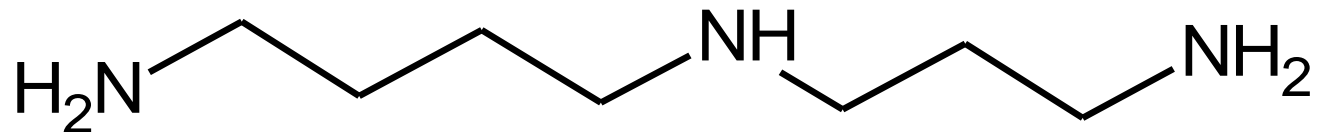
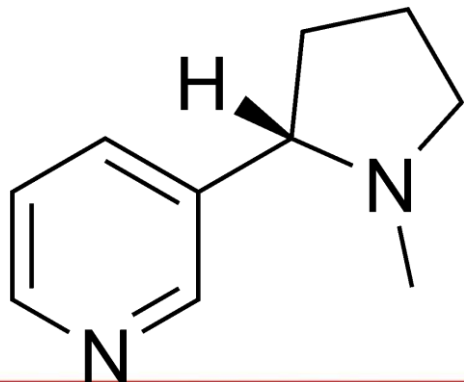
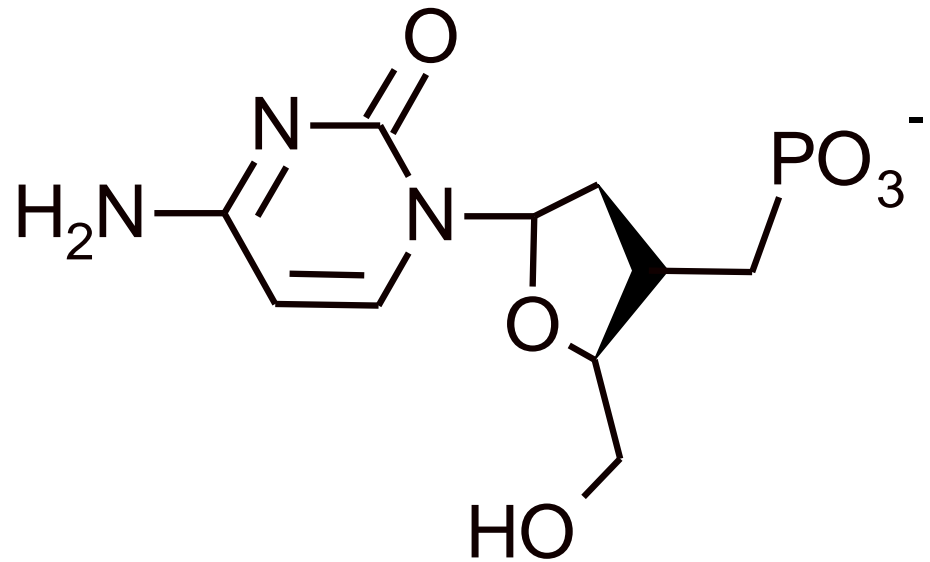
- fishes usually ammonotelic (excretes soluble ammonia)
- ammonia toxicity can be a major issue that leads to mass mortality or sublethal effects under unfavorable aquacultural conditions



NH_4^+ sources

◆ N-containing compounds in fish feed

- **amino acids** (proteins), **nucleotides** (DNA), secondary products, polyamines, heme (hemoglobin, chlorophyll, etc.), etc.



NH_4^+ production rate

◆ **Fish species**

- ❖ fast growers produce more

◆ **Water temperature**

- ❖ higher is faster

◆ **Fish density**

- ❖ more fish is faster

◆ **Amount of feed**

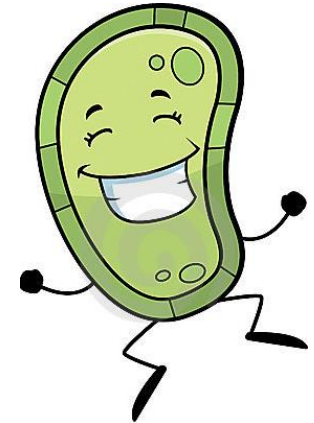
- ❖ more feed faster

◆ **No ammonia removal**

- ❖ fish tolerance: a few hours survival

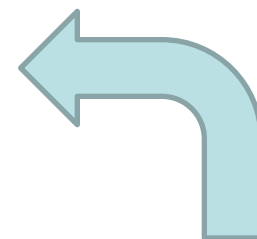
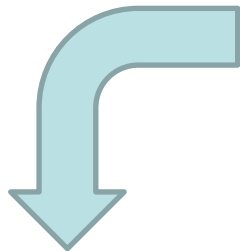


- ◆ **Improve bacterial conversion**
 - ❖ optimize environment
 - ❖ bacterium species

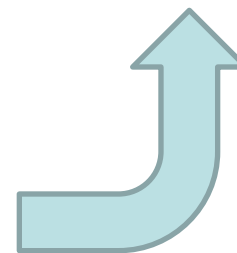


Nitrogen in aquaponics

NO_3^- (nontoxic)

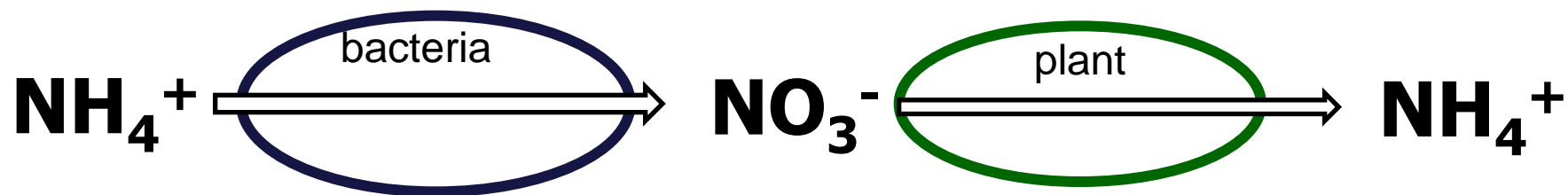


**NO_2^-
(toxic)**



NH_4^+ (toxic)

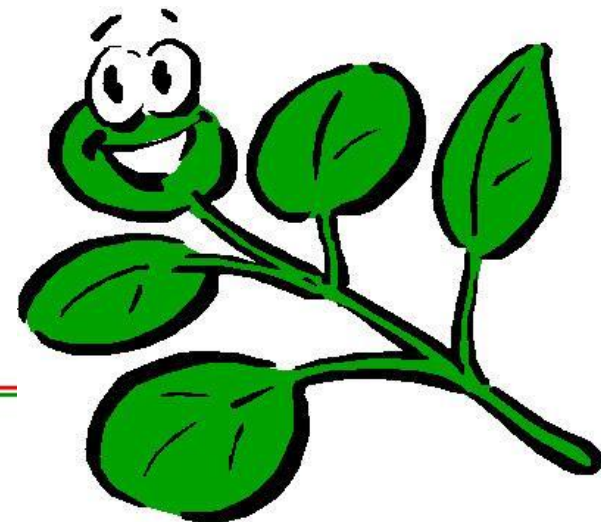




Solution 2 Plants

◆ **Improve plant tolerance**

- ❖ optimize environment - light, nutrients, temperature, water quality, etc.
- ❖ plant species



Ammonium toxicity may be universal, but the threshold at which symptoms of toxicity become manifested differs widely among plant species

NH₄⁺ tolerant

Rice
Onion
Leek
Blueberry
Cranberry

NH₄⁺ sensitive

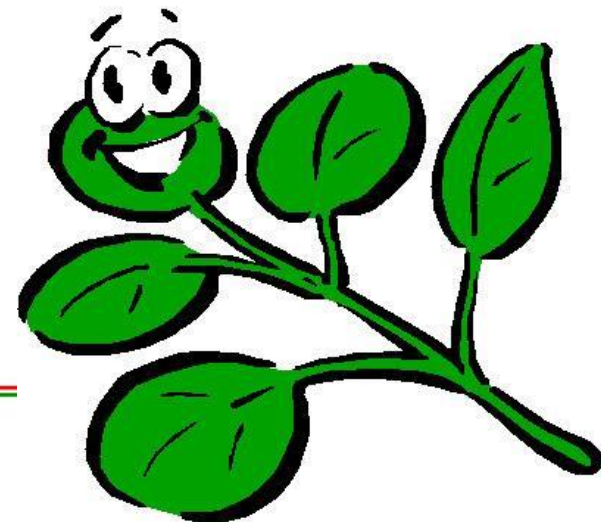
Tomato
Potato
Barley
Pea
Strawberry
Sage



Solution 2 Plants

◆ **Improve plant tolerance**

- ❖ optimize environment - light, nutrients, temperature, water quality, etc.
- ❖ plant species
- ❖ breeding
- ❖ GMOs?



Thank you!

