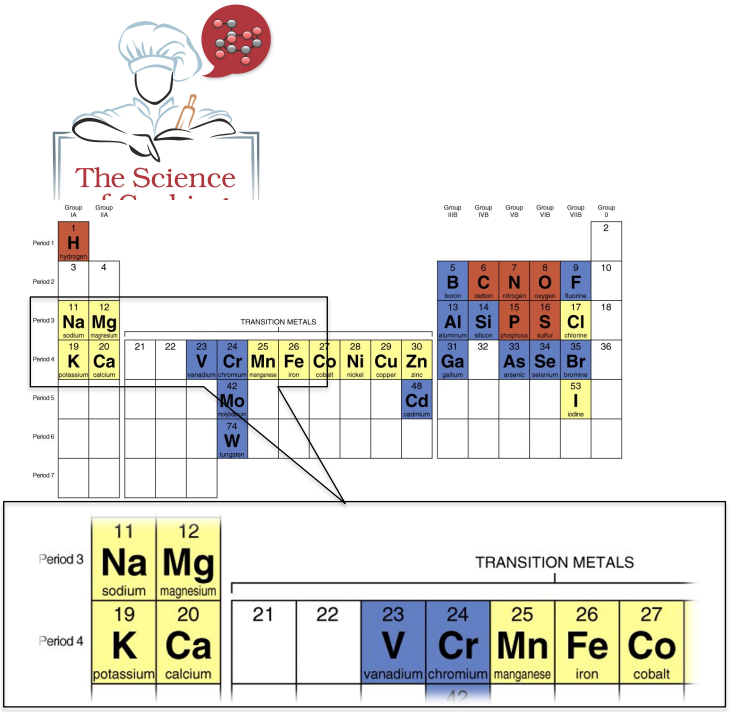
IONIC BONDING



What about sodium, calcium, iron and potassium?

Nutrition Facts

8 servings per container

Serving size 2/3 cup (55g)

Amount per 2/3 cup

Calories 230

% DV*	
12%	**Total Fat** 8g
5%	Saturated Fat 1g
	Trans Fat 0g
0%	**Cholesterol** 0mg
7%	**Sodium** 160mg
12%	**Total Carbs** 37g
14%	Dietary Fiber 4g
	Sugars 1g
	Added Sugars 0g
	Protein 3g
10%	**Vitamin D** 2mcg
20%	**Calcium** 260mg
45%	**Iron** 8mg
5%	**Potassium** 235mg

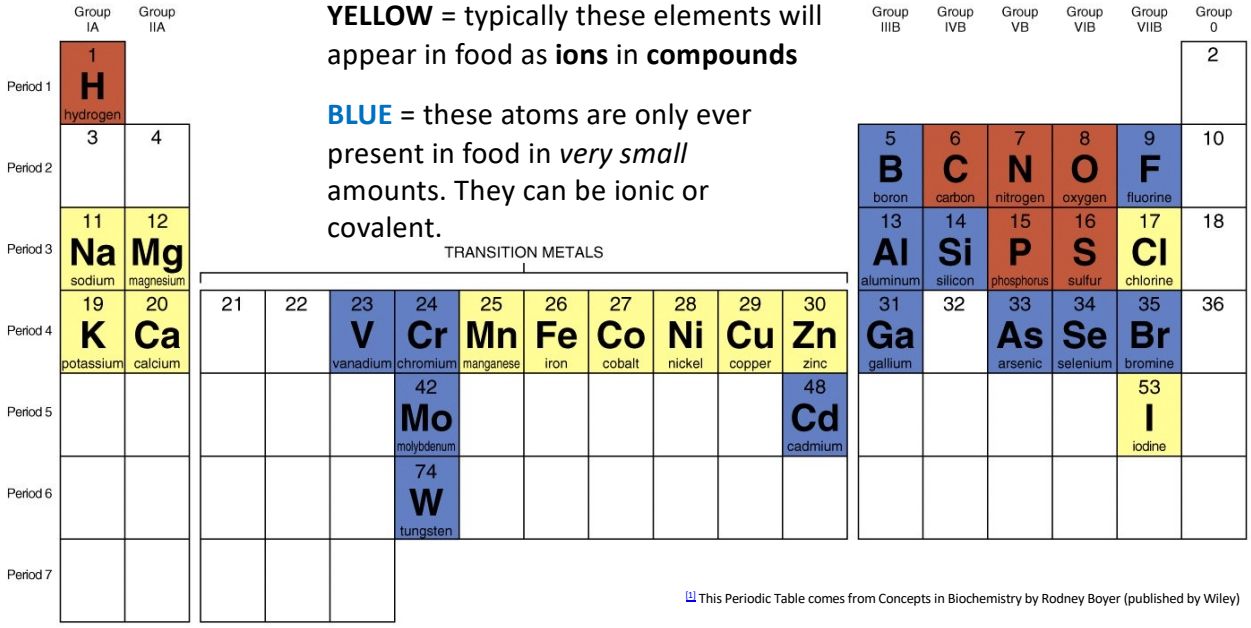
* Footnote on Daily Values (DV) and calories reference to be inserted here.

The Periodic Table…of Food

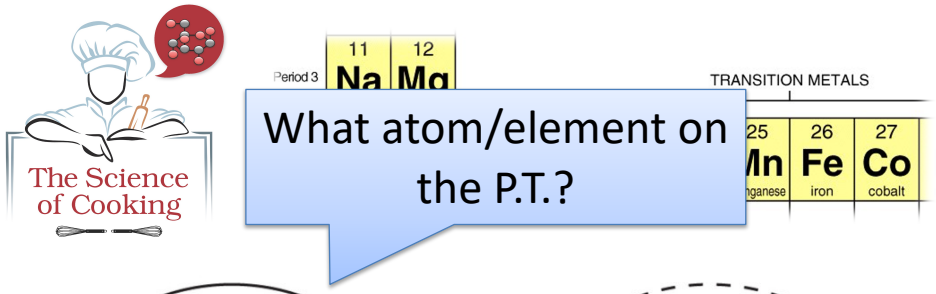
RED = typically these elements will form **covalent bonds** to make **molecules** with other red atoms. Sometimes a red atom can make an ion.

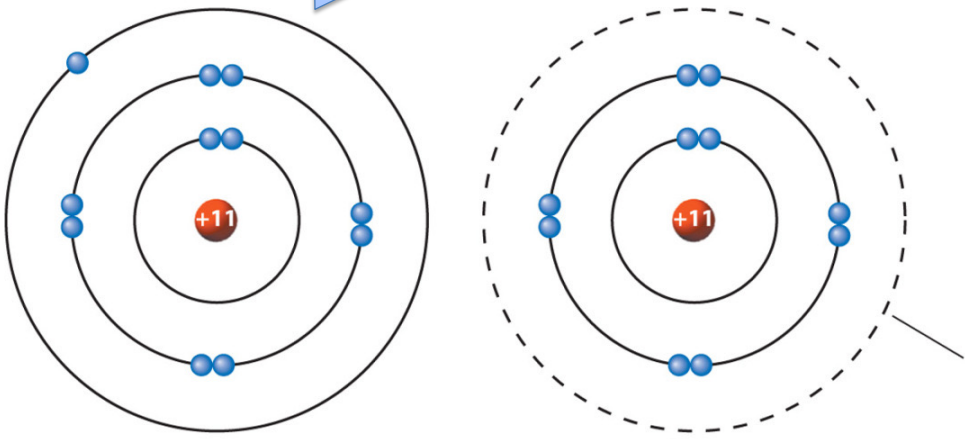
YELLOW = typically these elements will appear in food as **ions** in **compounds**

BLUE = these atoms are only ever present in food in *very small* amounts. They can be ionic or covalent.



[1] This Periodic Table comes from Concepts in Biochemistry by Rodney Boyer (published by Wiley)





Na

11 protons
11 electrons
0 net charge

Na^{1+} (positive ion)

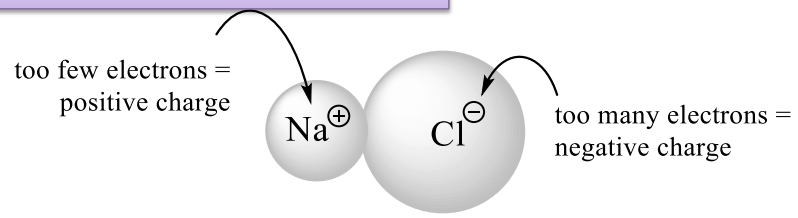
11 protons
10 electrons
+1 net charge

You do not need to worry about why there are 3 concentric circles drawn in this cartoon.

Covalent vs. Ionic bonds

Electrons are very tiny particles with negative charge

What seems to be holding the NaCl (i.e. table salt) molecule together?



In some cases, the electrons are not shared. In the compound, NaCl or sodium chloride, **the Cl anion has extra electrons** - which give the Cl an overall **negative charge**. The **Na cation has too few electrons**, which give the Na an overall **positive charge**.

The association between the Na+ and Cl- is called an **ionic bond**.

Chapter 1: Covalent vs. Ionic bonds

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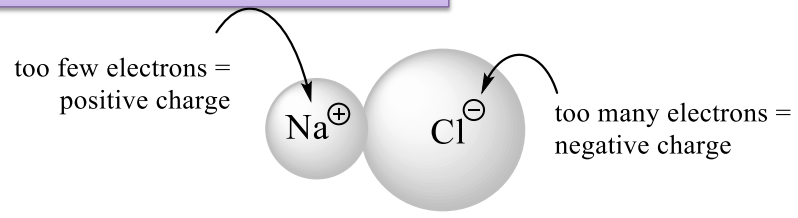

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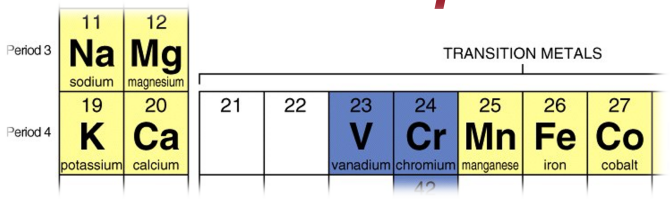
The association between the Na+ and Cl- is called an ionic bond.

Food is made of *compounds*

How are we able to consume and benefit from the sodium, calcium and iron in our diets?



Pure Element	As found in food	Food sources
Sodium (Na)	sodium chloride (i.e. table salt, NaCl), monosodium glutamate (i.e. MSG, $NaC_5H_8O_4N$), sodium bicarbonate (baking soda, $NaHCO_3$), sodium benzoate ($NaC_7H_5O_2$)	Milk, celery, bacon and condiments like Worcestershire sauce.
Calcium (Ca)	calcium citrate ($Ca_3C_{12}H_{10}O_{14}$) calcium lactate ($CaC_6H_{10}O_6$)	Calcium supplements, cheese
Iron (Fe)	Heme ($FeC_{34}H_{32}O_4N_4$) ferrous sulfate ($FeSO_4$) ferrous fumarate ($FeC_4H_4O_2$)	Meat, fortified infant cereal

The word *ferrous* is derived from the latin word *ferrum*, which means *iron*

Sodium, calcium and iron are examples of *metals.* In food, these metals are usually <u>not elemental,</u> rather they are part of *ionic compounds*.

Ionic Compounds in Food

An ion carries a charge

Sometimes the ionic compound will be represented with cation and anion listed one after the other (e.g. NaCl) – without the charges explicitly shown

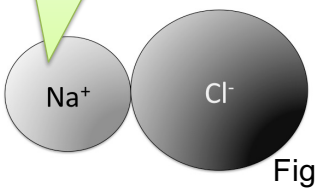


Fig. 1-5

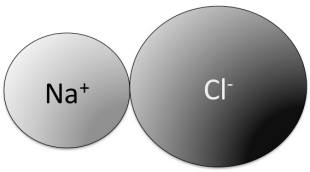
Ionic Compound	Molecular formula	Cation	Anion
sodium chloride	NaCl	Na^+	Cl^-
monosodium glutamate	$NaC_5H_8O_4N$	Na^+	$[C_5H_8O_4N]^{-1}$
sodium bicarbonate	$NaHCO_3$	Na^+	$[HCO_3]^{-1}$
sodium benzoate	$NaC_7H_5O_2$	Na^+	$[C_7H_5O_2]^{-1}$
calcium citrate			
calcium lactate			
ferrous sulfate			
ferrous fumarate	$FeC_4H_4O_2$	Fe^{+2}	$[C_4H_4O_2]^{-2}$

The cation carries positive charge, while the anion carries negative charge – together the charges balance each other and the overall compound is net neutral.

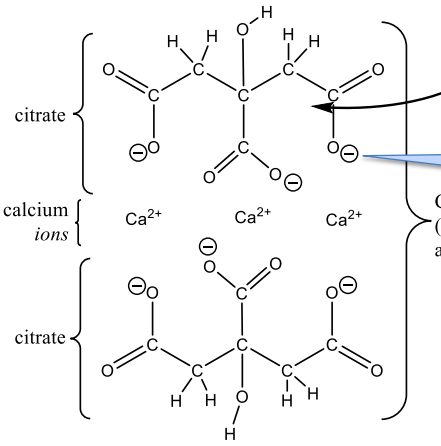
What can you tell about the pattern of naming ionic compounds? What comes first, what comes second?

Ion vs. element??

Ionic Compounds are balanced



Ionic Compound	Molecular formula	Cation	Anion
sodium chloride	NaCl	Na^+	Cl^-
calcium citrate	$Ca_3C_{12}H_{10}O_{14}$	3x Ca^{+2}	2x $[C_6H_5O_7]^{-3}$



these lines connecting the atoms are *covalent bonds*

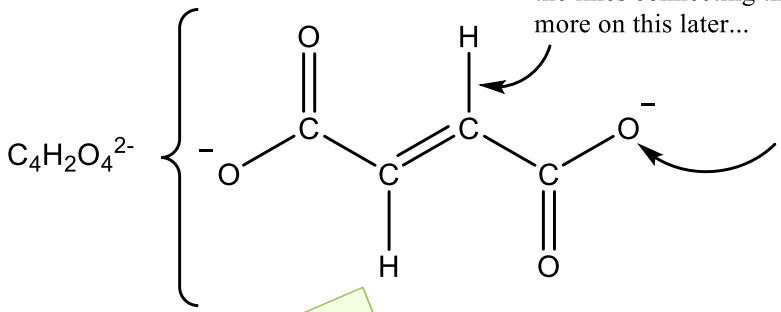
Calcium citrate (food preservative and flavor additive)

This is one of the cases where a red atom makes an ion…here, oxygen is carrying a negative charge.

Explain how calcium citrate is a net neutral ionic compound. Remember, the negative and positive charges must balance out in the final compound.

Polyatomic ions

e.g. the fumarate anion



the lines connecting the atoms are called *bonds*, more on this later...

the two negative charges in the anion fumarate are located on two different oxygen atoms

Some ions are made of multiple atoms joined together…but specific atoms carry the charge

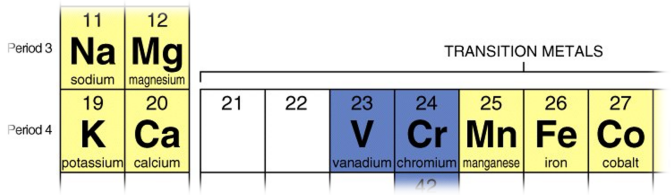
Propose a molecular formula for calcium (Ca^{2+}) fumarate…

Poly = many, atomic = atoms

Some elemental exceptions

On the cereal box shown below, the zinc and iron in this cereal are listed under *Vitamins and Minerals* as “Iron and Zinc (mineral nutrients)”. In this case, the elemental iron was added to the food by the manufacturer.

VITAMINS AND MINERALS: IRON AND ZINC (MINERAL NUTRIENTS), VITAMIN C (SODIUM ASCORBATE), A B VITAMIN (NIACINAMIDE), VITAMIN B_6 (PYRIDOXINE HYDROCHLORIDE), VITAMIN B_2 (RIBOFLAVIN), VITAMIN B_1 (THIAMIN MONONITRATE), VITAMIN A (PALMITATE), A B VITAMIN (FOLIC ACID), VITAMIN B_{12}, VITAMIN D.



While the body is unable to directly absorb elemental iron, the reaction that occurs with our stomach acid produces ferrous iron (Fe^{2+}), which is absorbed in the small intestines.

https://www.acs.org/content/dam/acsorg/education/outreach/iron-for-breakfast.pdf