

# Bioorganic Chemistry

## Chemical Bonding \_ Ionic Bond

### Lecture-1

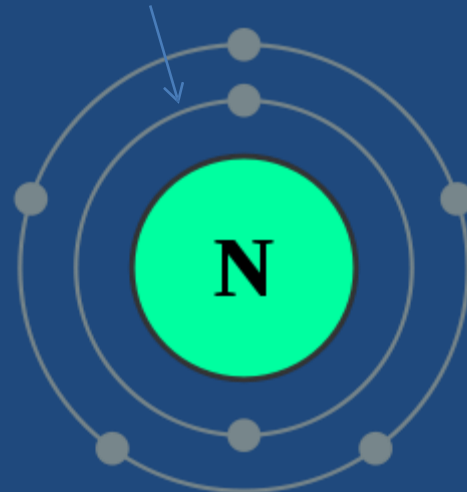
Rifat Bin Amin  
National Institute of Science & Technology

# Ionic Bonding

# Valence Electrons

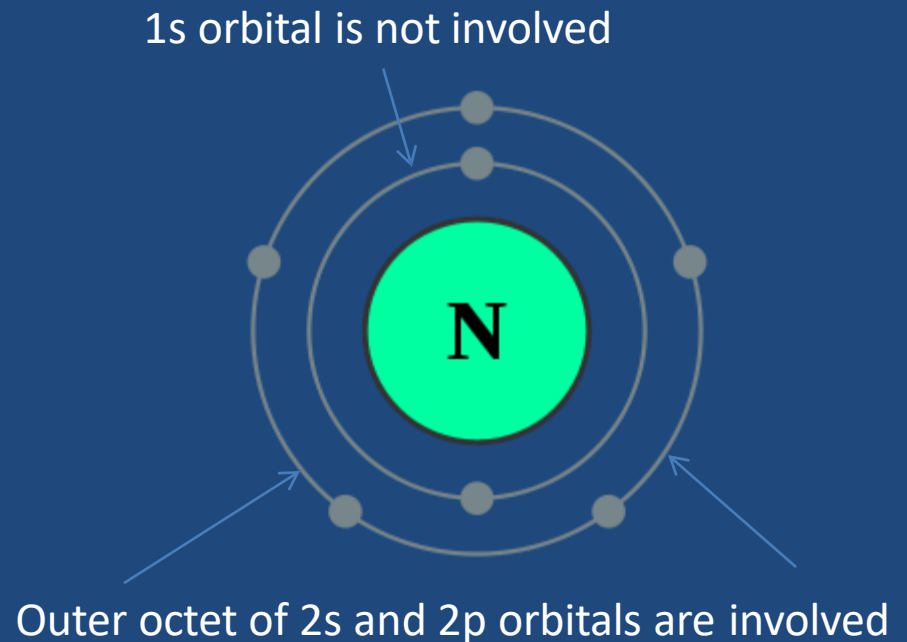
- Valence electrons are the electrons in the outermost **s-** and **p-orbitals** that can be involved in chemical reactions.

1s orbital is not involved



# Valence Electrons

- Valence electrons are the electrons in the outermost s and p-orbitals that can be involved in chemical reactions.



# Ions

<b>Cation</b>	Positively Charged Atom (loses electrons)	$\text{K}^{+1}$
<b>Anion</b>	Negatively Charged Atom (gains electrons)	$\text{Cl}^{-1}$

# Ions

<b>Cation</b>	Positively Charged Atom (loses electrons)	$K^{+1}$
<b>Anion</b>	Negatively Charged Atom (gains electrons)	$Cl^{-1}$

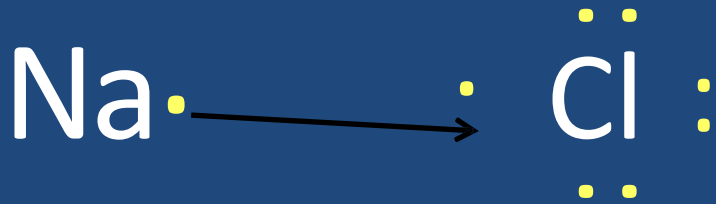
**Ionic Bonding** occurs when a **cation** gives electrons to an **anion** and the atoms become attracted to each other due to the opposite charges.

# Ionic Bonds



- Sodium has one valence electron it wants to lose
- Chlorine has 7 valence electrons, so it wants to gain one more to make it to eight.

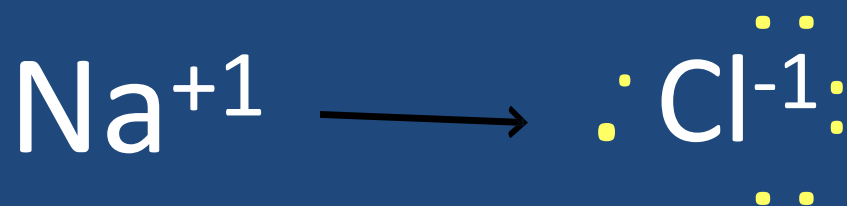
# Ionic Bonds



- The Sodium atom donates its one valence electron to Chlorine.



# Ionic Bonds

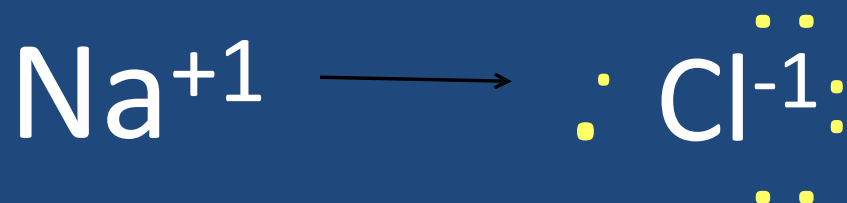


# Periodic Table of the Elements 2005

1 H 1.01																	18 He 4.00	
3 Li 6.94	4 Be 9.01																	10 Ne 20.18
11 Na 22.99	12 Mg 25.31																	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80	
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29	
55 Cs 132.91	56 Ba 137.33	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97		
87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)		

- This means Na has the electron configuration of the noble gas before it, which is **Neon**
- Sodium's electron configuration is now written as **[Ne]<sup>+</sup>**

# Ionic Bonds



# Periodic Table of the Elements 2005

1 H 1.01	2 He 4.00
3 Li 6.94	4 Be 9.01
11 Na 22.99	12 Mg 25.31
19 K 39.10	20 Ca 40.08
37 Rb 85.47	38 Sr 87.62
55 Cs 132.91	56 Ba 137.33
87 Fr (223)	88 Ra (226)

21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41
39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41
57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59
89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (270)	109 Mt (268)	110 Ds (281)	111 Rg (272)	

5 B 10.81	6 C 12.01	7 N 14.01	8 O 15.99	9 F 18.99	10 Ne 20.18
13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

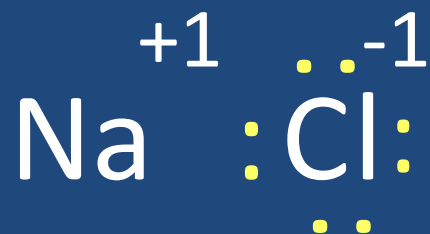
- Chlorine now has the electron configuration of the noble gas after it, which is **Argon**.
- Chlorine's electron configuration is now written as **[Ar]**

# Ionic Bonds



- Sodium and Chloride are now **ionically** bonded to form a new compound known as sodium chloride (NaCl).
- This is known to most of us as Table Salt.

# Ionic Bonds



- Now each sodium is positively charged and each chlorine is negatively charged.
- They are attached because opposite charges attract electrostatically.
- However, together they balance each other out.

# Ionic Bonds

- Bonding that involves a transfer of electrons.
- Positively and negatively charged atoms (ions) result from this transfer
- The resulting positive and negative charged atoms are “attracted” to each because of their opposite charges.

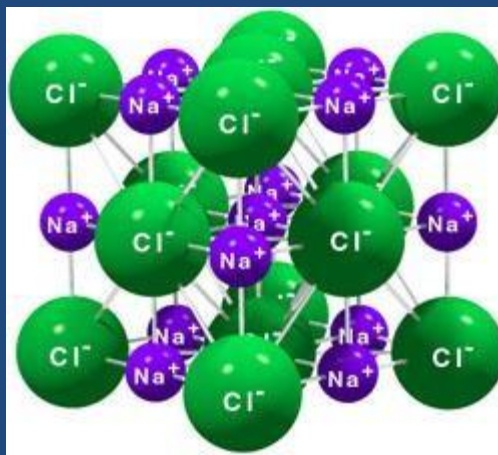
Na<sup>+</sup>



Cl<sup>-</sup>

# Solvents and Solutions

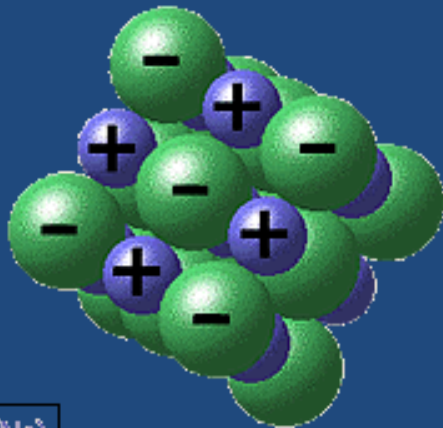
- Because ionic molecules have positive and negative atoms, they can be pulled apart by other substance with positive and negative charges.



# Solvents and Solutions

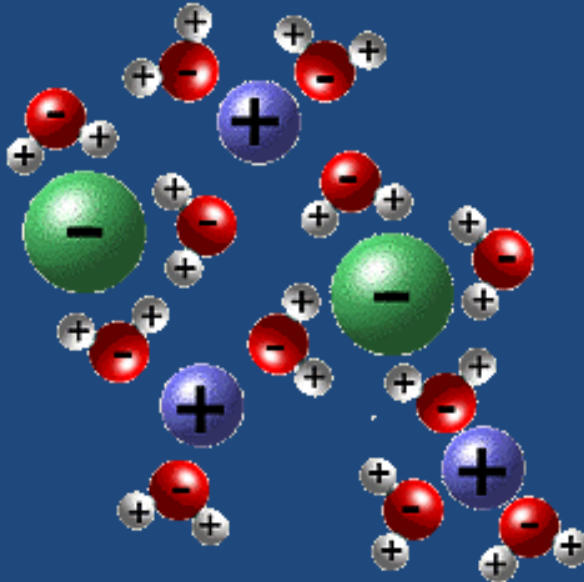
- One example is dissolving salt into water
- Water molecules have positive ends near the hydrogens and negative ends near the oxygen.

NaCl crystal structure



sodium (Na)  
chlorine (Cl)

NaCl in water





# Solutions

- Since all of the ions are evenly dispersed and dissolved in the water, it makes a solution of salt water.
- This solution is transparent.





# Reforming Crystals

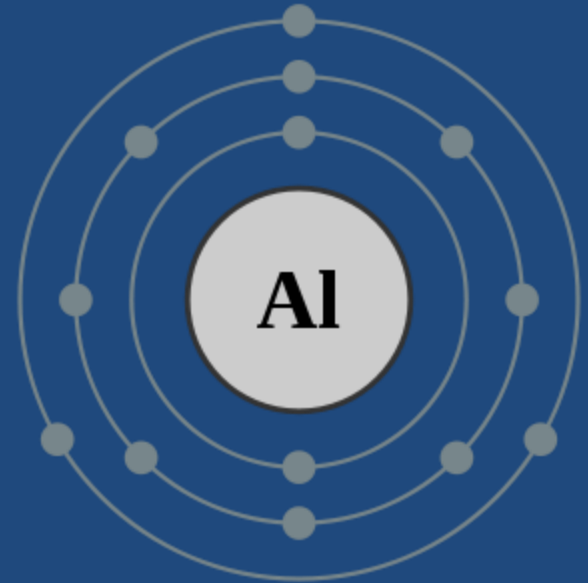
- When the water evaporates, the positive Na<sup>+</sup> ions and the negative Cl<sup>-</sup> ions come back together again!



# So, Who Makes Ions Anyways?

- It all depends on how many valence electrons they have and what they need to get to noble gas configuration.

Question #1: How many valence electrons does Aluminum have?



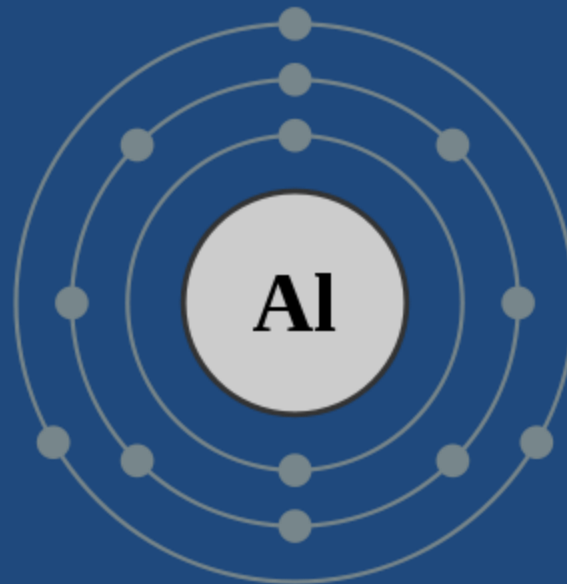
# So, Who Makes Ions Anyways?

- It all depends on how many valence electrons they have and what they need to get to noble gas configuration.

Question #1: How many valence electrons does Aluminum have?

Answer: 3

Question #2: What ionic charge will it have to become noble gas configuration?



# So, Who Makes Ions Anyways?

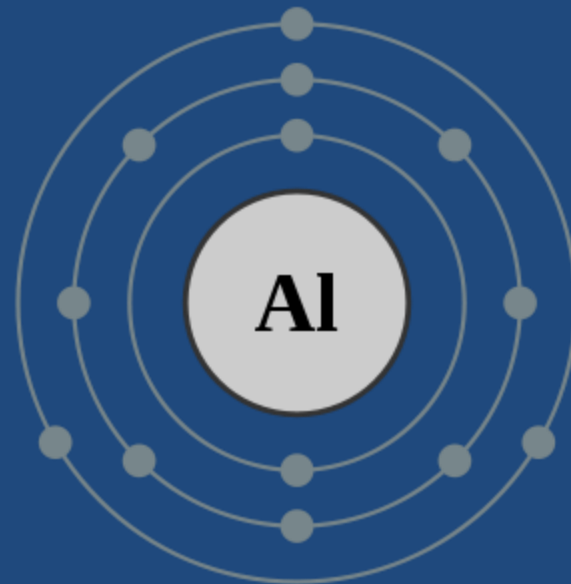
- It all depends on how many valence electrons they have and what they need to get to noble gas configuration.

Question #1: How many valence electrons does Aluminum have?

Answer: 3

Question #2: What ionic charge will it have to become noble gas configuration?

Answer:  $\text{Al}^{+3}$



# Alkali Metals

# PERIODIC CHART OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES		
1 H 1.00797																	
	4 Be 9.0122										5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183	
	12 Mg 24.312										13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948	
	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80
	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
	56 Ba 137.34	*57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)
	88 Ra (226)	†89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 ? (271)	111 ? (272)	112 ? (277)						

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

## \* Lanthanide Series

58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97
--------------------	---------------------	--------------------	-------------------	--------------------	--------------------	--------------------	---------------------	--------------------	---------------------	--------------------	---------------------	--------------------	--------------------

## † Actinide Series

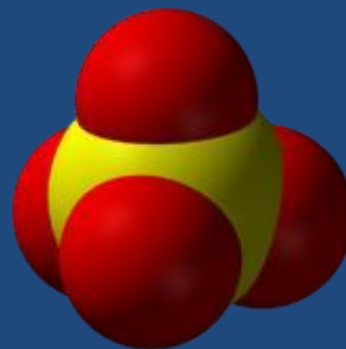
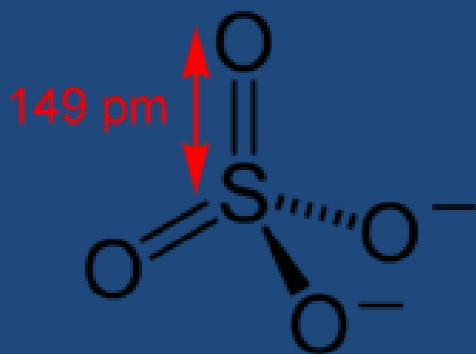
90 Th 232.038	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (256)	103 Lr (257)
---------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	--------------------	--------------------	--------------------	--------------------

Charge: +1



# Polyatomic Ion

- Polyatomic ions are ions that have multiple atoms attached to each other, but as a unit have a net charge.
- Sulfate ( $\text{SO}_4^{2-}$ ) is an example.





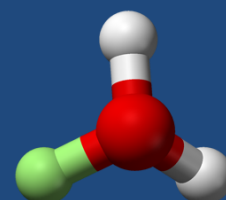
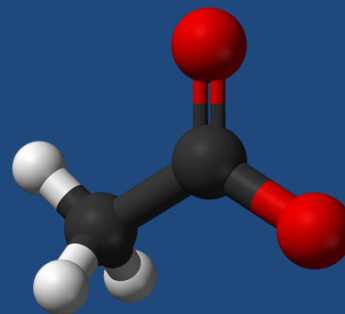
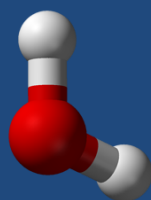
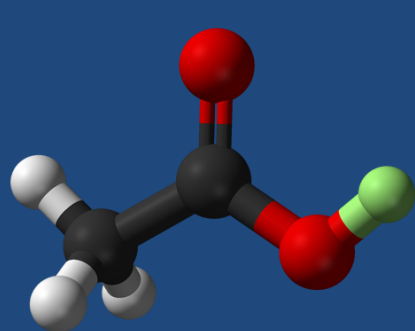
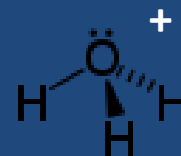
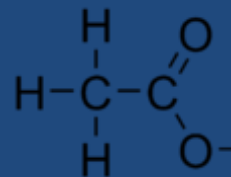
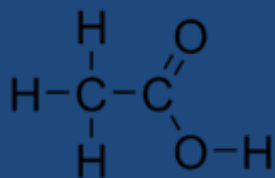
# Acetic Acid Dissolving in Water

Acetic Acid

Water

Acetate ion

Hydronium ion





The End