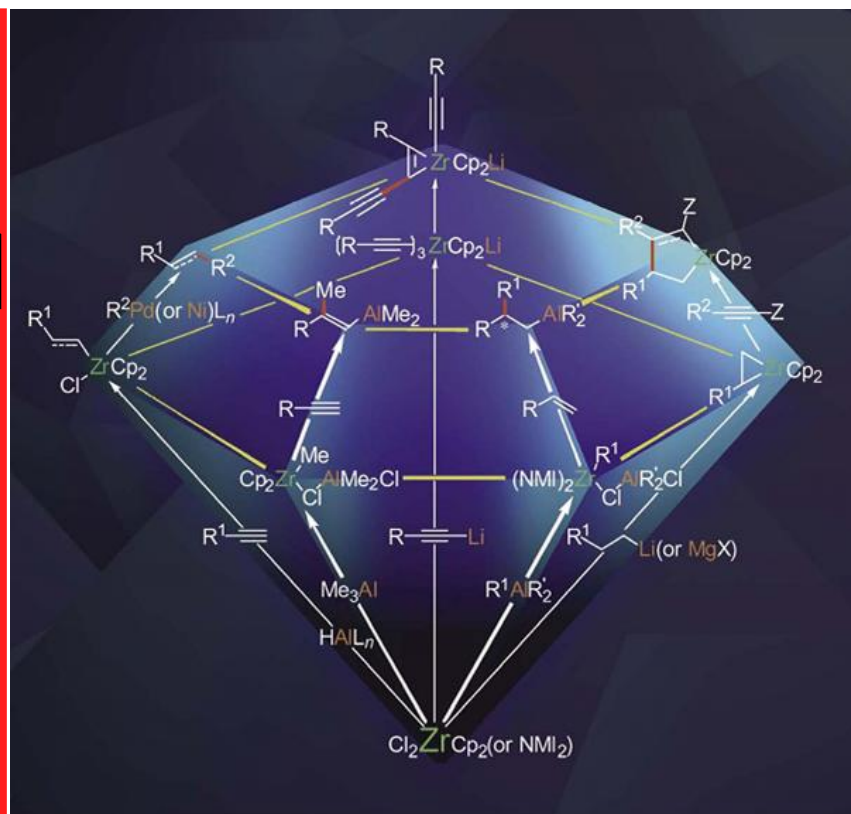
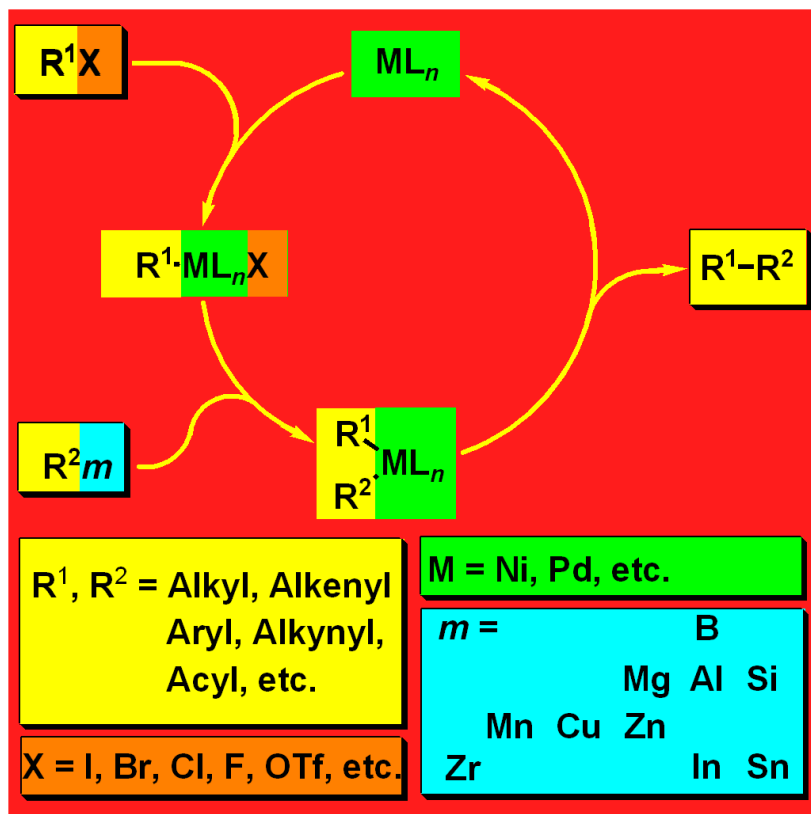
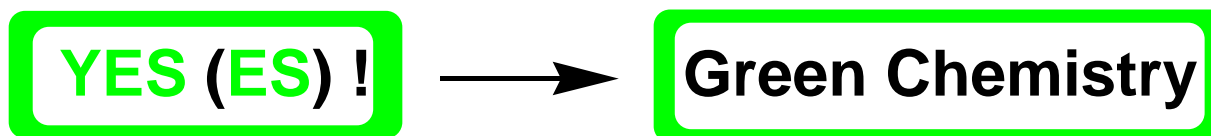


# Magical Power of Transition Metals: Past, Present, and Future

Ei-ichi Negishi, Purdue University



# How to Synthesize Any Organic Compounds in High **Y**ields, **E**fficiently, **S**electively, **E**conomically, **S**afely



1. **Consider all usable elements (ca. 70).**

Avoid (i) radioactive, (ii) inert, and (iii) inherently toxic elements.

2. If desirable and necessary, **consider their binary combinations** (ca. 5,000).  
**(Two is Better than One!)<sup>a</sup>**







3. **Use metals for desirable reactivities.**

4. **Use transition metals mainly as catalysts.**

<sup>a</sup> E. Negishi, *CEJ* **1999**, *5*, 411-420.

# Anatomy of the Periodic Table

H																	He		
Li	Be											B	C	N	O	F	Ne		
Na	Mg											Al	Si	P	S	Cl	Ar		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
Cs	Ba											Hf	Ta	W	Re	Os	Ir	Pt	Au
Fr	Ra											Rf	Db	Sg	Bh	Hs	Mt	Uun	
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu					
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr					

-  = Radioactive elements (26)
  -  = Organic elements (12 - 1 = 11)
  -  = Main group metals (27 - 6 = 21)
  -  = Intrinsically toxic (?) (7)
  -  = d-Block transition metals (24 - 1 = 23)
  -  = f-Block transition metals (15 - 1 = 14)
- 58 metals usable  
in Organic Synthesis**

ПЕРИОДИЧЕСКАЯ СИСТЕМА ЭЛЕМЕНТОВ  
 Д.И. МЕНДЕЛЕЕВА

	I	II	III	IV	V	VI	VII	VIII						
1	H													
2	He	Li	Be	B	C	N	O	F						
3	Ne	Na	Mg	Al	Si	P	S	Cl						
4	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni			
5			Cu	Zn	Ga	Ge	As	Se	Br			Ru	Rh	Pd
6	Kr	Rb	Sr	Y	Zr	Nb	Mo							
7			Ag	Cd	In	Sn	Sb	Te	J					
8	Xe	Cs	Ba	La	Ce	Pr	Nd	Pl						
9			Sm	Eu	Gd	Tb	Dy	Ho	Er					
10			Tu	Yb	Lu	Hf	Ta	W	Re	Os	Jr	Pt		
11			Au	Hg	Tl	Pb	Bi	Po	-					
12	Rn	-	Ra	Ac	Th	Pa	U							
	R	R'O	RO	R'O'	RO'	R'O'	RO'	R'O'	RO'	R'O'	RO'	RO'	RO'	RO'
				RH'	RH'	RH'	RH'	RH'	RH'	RH'	RH'	RH'	RH'	RH'





# Effects of Product Yield and Number of Steps on Overall Yield

Number of Steps	Overall Yield (%)		
	90% Ave. Yield	80% Ave. Yield	70% Ave. Yield
5	59	33	17
10	35	11	3
15	21	3.6	0.5
20	12	1	0.1
30	4	0.1	
40	1.5		
50	0.5		

**"Step-economy" is of utmost importance !**

