

# Chemical Evidence

## Chapter 4

**Groups** ↓

|                        |                        |                        |                         |
|------------------------|------------------------|------------------------|-------------------------|
| <b>1</b><br><b>H</b>   |                        |                        |                         |
|                        | <b>2</b>               |                        |                         |
| <b>3</b><br><b>Li</b>  | <b>4</b><br><b>Be</b>  |                        |                         |
|                        |                        | <b>3</b>               | <b>4</b>                |
| <b>11</b><br><b>Na</b> | <b>12</b><br><b>Mg</b> |                        |                         |
|                        |                        |                        |                         |
| <b>19</b><br><b>K</b>  | <b>20</b><br><b>Ca</b> | <b>21</b><br><b>Sc</b> | <b>22</b><br><b>Ti</b>  |
|                        |                        |                        |                         |
| <b>37</b><br><b>Rb</b> | <b>38</b><br><b>Sr</b> | <b>39</b><br><b>Y</b>  | <b>40</b><br><b>Zr</b>  |
|                        |                        |                        |                         |
| <b>55</b><br><b>Cs</b> | <b>56</b><br><b>Ba</b> | <b>57</b><br><b>La</b> | <b>72</b><br><b>Hf</b>  |
|                        |                        |                        |                         |
| <b>87</b><br><b>Fr</b> | <b>88</b><br><b>Ra</b> | <b>89</b><br><b>Ac</b> | <b>104</b><br><b>Rf</b> |

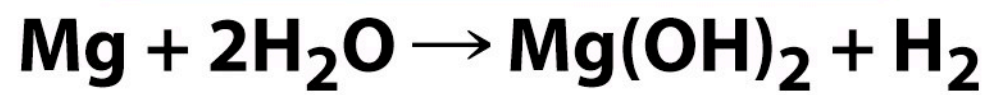
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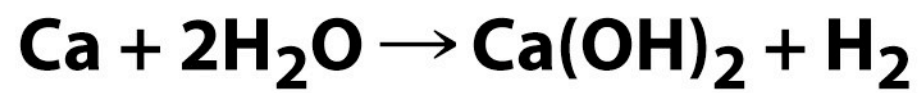
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Unnumbered figure pg 94e  
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|   |   | Alkali metals   |  |  |  |  |  |  |  |  |  | Alkaline earth metals |  |  |  |  |  |  |  |  |  | Transition metals |  |  |  |  |  |  |  |  |  | Halogens |  |  |  |  | Noble gases |  |
|---|---|---|--|--|--|--|--|--|--|--|--|-----------------------|--|--|--|--|--|--|--|--|--|-------------------|--|--|--|--|--|--|--|--|--|----------|--|--|--|--|-------------|--|
|   |   | 1   |  |  |  |  |  |  |  |  |  | 2                     |  |  |  |  |  |  |  |  |  | 3                 |  |  |  |  |  |  |  |  |  | 4        |  |  |  |  | 5           |  |
| 1 | 2 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 1 | 2 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 1 | 2 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 2 | 3 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 3 | 4 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 4 | 5 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 5 | 6 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 6 | 7 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
| 7 | 8 |   |  |  |  |  |  |  |  |  |  |                       |  |  |  |  |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
|   |   | Lanthanide  |  |  |  |  |  |  |  |  |  |                       |  |  |  | Actinide   |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |
|   |   | 58 Ce 59 Pr 60 Nd 61 Pm 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy 67 Ho 68 Er 69 Tm 70 Yb 71 Lu |  |  |  |  |  |  |  |  |  |                       |  |  |  | 90 Th 91 Pa 92 U 93 Np 94 Pu 95 Am 96 Cm 97 Bk 98 Cf 99 Es 100 Fm 101 Md 102 No 103 Lr |  |  |  |  |  |                   |  |  |  |  |  |  |  |  |  |          |  |  |  |  |             |  |

Figure 4-1  
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|                        |                        |                        |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |                        |                        |                        |                        |          |  |
|------------------------|------------------------|------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|------------------------|------------------------|------------------------|------------------------|----------|--|
| <b>+1</b>              |                        |                        |                         |                         |                         |                         |                         |                         |                         |                         |                         | <b>+3</b>               |                         |                        | <b>-3</b>              | <b>-2</b>              | <b>-1</b>              | <b>0</b> |  |
| <b>1</b>               | <b>2</b>               |                        |                         |                         |                         |                         |                         |                         |                         |                         |                         | <b>13</b>               | <b>14</b>               | <b>15</b>              | <b>16</b>              | <b>17</b>              | <b>18</b>              |          |  |
| <b>1</b><br><b>H</b>   | <b>4</b><br><b>Be</b>  |                        |                         |                         |                         |                         |                         |                         |                         |                         |                         | <b>5</b><br><b>B</b>    | <b>6</b><br><b>C</b>    | <b>7</b><br><b>N</b>   | <b>8</b><br><b>O</b>   | <b>9</b><br><b>F</b>   | <b>10</b><br><b>Ne</b> |          |  |
| <b>3</b><br><b>Li</b>  | <b>12</b><br><b>Mg</b> | <b>3</b>               | <b>4</b>                | <b>5</b>                | <b>6</b>                | <b>7</b>                | <b>8</b>                | <b>9</b>                | <b>10</b>               | <b>11</b>               | <b>12</b>               | <b>13</b><br><b>Al</b>  | <b>14</b><br><b>Si</b>  | <b>15</b><br><b>P</b>  | <b>16</b><br><b>S</b>  | <b>17</b><br><b>Cl</b> | <b>18</b><br><b>Ar</b> |          |  |
| <b>19</b><br><b>K</b>  | <b>20</b><br><b>Ca</b> | <b>21</b><br><b>Sc</b> | <b>22</b><br><b>Ti</b>  | <b>23</b><br><b>V</b>   | <b>24</b><br><b>Cr</b>  | <b>25</b><br><b>Mn</b>  | <b>26</b><br><b>Fe</b>  | <b>27</b><br><b>Co</b>  | <b>28</b><br><b>Ni</b>  | <b>29</b><br><b>Cu</b>  | <b>30</b><br><b>Zn</b>  | <b>31</b><br><b>Ga</b>  | <b>32</b><br><b>Ge</b>  | <b>33</b><br><b>As</b> | <b>34</b><br><b>Se</b> | <b>35</b><br><b>Br</b> | <b>36</b><br><b>Kr</b> |          |  |
| <b>37</b><br><b>Rb</b> | <b>38</b><br><b>Sr</b> | <b>39</b><br><b>Y</b>  | <b>40</b><br><b>Zr</b>  | <b>41</b><br><b>Nb</b>  | <b>42</b><br><b>Mo</b>  | <b>43</b><br><b>Tc</b>  | <b>44</b><br><b>Ru</b>  | <b>45</b><br><b>Rh</b>  | <b>46</b><br><b>Pd</b>  | <b>47</b><br><b>Ag</b>  | <b>48</b><br><b>Cd</b>  | <b>49</b><br><b>In</b>  | <b>50</b><br><b>Sn</b>  | <b>51</b><br><b>Sb</b> | <b>52</b><br><b>Te</b> | <b>53</b><br><b>I</b>  | <b>54</b><br><b>Xe</b> |          |  |
| <b>55</b><br><b>Cs</b> | <b>56</b><br><b>Ba</b> | <b>57</b><br><b>La</b> | <b>72</b><br><b>Hf</b>  | <b>73</b><br><b>Ta</b>  | <b>74</b><br><b>W</b>   | <b>75</b><br><b>Re</b>  | <b>76</b><br><b>Os</b>  | <b>77</b><br><b>Ir</b>  | <b>78</b><br><b>Pt</b>  | <b>79</b><br><b>Au</b>  | <b>80</b><br><b>Hg</b>  | <b>81</b><br><b>Tl</b>  | <b>82</b><br><b>Pb</b>  | <b>83</b><br><b>Bi</b> | <b>84</b><br><b>Po</b> | <b>85</b><br><b>At</b> | <b>86</b><br><b>Rn</b> |          |  |
| <b>87</b><br><b>Fr</b> | <b>88</b><br><b>Ra</b> | <b>89</b><br><b>Ac</b> | <b>104</b><br><b>Rf</b> | <b>105</b><br><b>Db</b> | <b>106</b><br><b>Sg</b> | <b>107</b><br><b>Bh</b> | <b>108</b><br><b>Hs</b> | <b>109</b><br><b>Mt</b> | <b>110</b><br><b>Ds</b> | <b>111</b><br><b>Rg</b> |                         |                         |                         |                        |                        |                        |                        |          |  |
|                        |                        |                        |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |                        |                        |                        |                        |          |  |
| <b>58</b><br><b>Ce</b> | <b>59</b><br><b>Pr</b> | <b>60</b><br><b>Nd</b> | <b>61</b><br><b>Pm</b>  | <b>62</b><br><b>Sm</b>  | <b>63</b><br><b>Eu</b>  | <b>64</b><br><b>Gd</b>  | <b>65</b><br><b>Tb</b>  | <b>66</b><br><b>Dy</b>  | <b>67</b><br><b>Ho</b>  | <b>68</b><br><b>Er</b>  | <b>69</b><br><b>Tm</b>  | <b>70</b><br><b>Yb</b>  | <b>71</b><br><b>Lu</b>  |                        |                        |                        |                        |          |  |
| <b>90</b><br><b>Th</b> | <b>91</b><br><b>Pa</b> | <b>92</b><br><b>U</b>  | <b>93</b><br><b>Np</b>  | <b>94</b><br><b>Pu</b>  | <b>95</b><br><b>Am</b>  | <b>96</b><br><b>Cm</b>  | <b>97</b><br><b>Bk</b>  | <b>98</b><br><b>Cf</b>  | <b>99</b><br><b>Es</b>  | <b>100</b><br><b>Fm</b> | <b>101</b><br><b>Md</b> | <b>102</b><br><b>No</b> | <b>103</b><br><b>Lr</b> |                        |                        |                        |                        |          |  |

Figure 4-2  
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# Sodium Fluoride



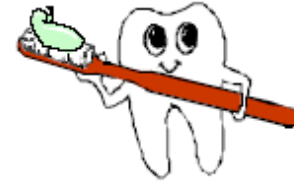
Used in tooth pastes to strengthen enamel  
and prevent decay

Used in blood collection tubes to preserve  
blood glucose and prevent ethanol  
production

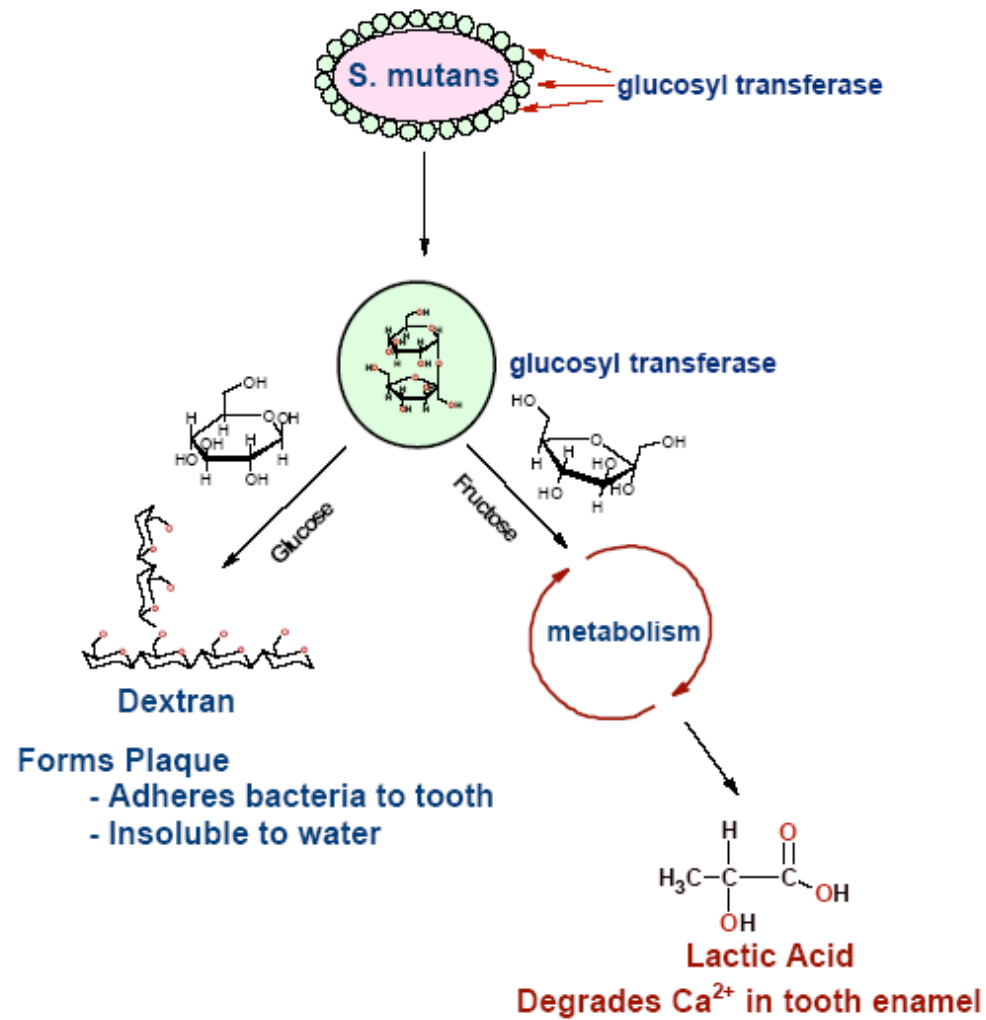




## Tooth Decay



**Streptococcus mutans cause of dental caries.  
Uses sucrose (table sugar).**





# Blood Sugar and Diabetes



Blood Sugar is very important

- Because your brain cannot use fat for energy
- Only carbohydrates
- Byproducts of fat metabolism called ketone bodies
  - Only under starvation conditions!



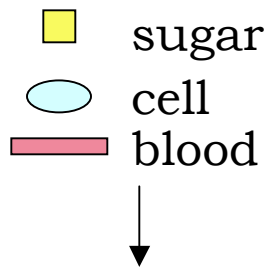
# Blood Sugar and Diabetes



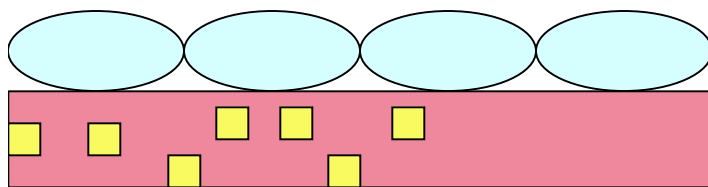
Blood sugar is regulated by two hormones  
both made in pancreas

1) Insulin – released in response to  
high blood sugar (after meal)  
-  $\beta$ -cells of pancreas

- Signals cells to take in sugar  
from blood

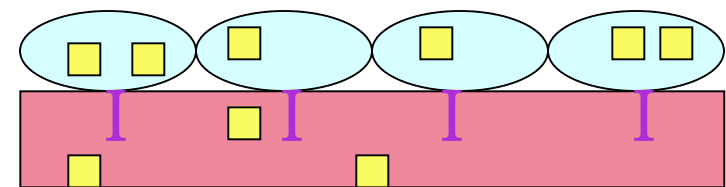


Cells cant absorb sugar



insulin

I



Insulin opens doors  
Sugar can come in



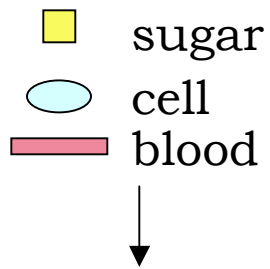
# Blood Sugar and Diabetes

Blood sugar is regulated by two hormones  
both made in pancreas

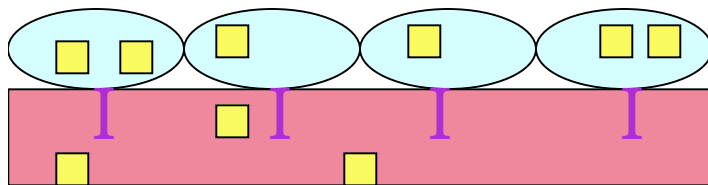


2) Glucagon – released in response to  
low blood sugar (hungry)  
-  $\alpha$ -cells of pancreas

- Signals cells to stop taking  
in sugar from blood

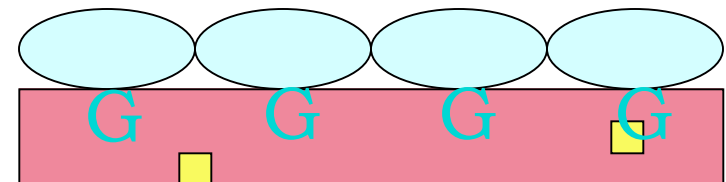


Cells absorb sugar



glucagon  
G

Glucagon closes doors  
Sugar cant come in





# Blood Sugar and Diabetes



- If no insulin, cells use fat
- Make byproduct called ketone bodies
- Put ketone bodies into blood
- Brain can use but only under starvation conditions! (not good)
- State called ketoacidosis or ketosis
- Same state as diabetics  
(because no insulin)

# Sodium Fluoride Summary

Helps strengthen tooth enamel by binding to tooth enamel and attracting  $\text{Ca}^{2+}$  ions

Lined tubes prevent changes in BAC and glucose levels in blood samples by inhibiting microbe growth.



Transition Metals

Elemental Hippies



# Ooohh... Pretty Colors!



Figure 4-6  
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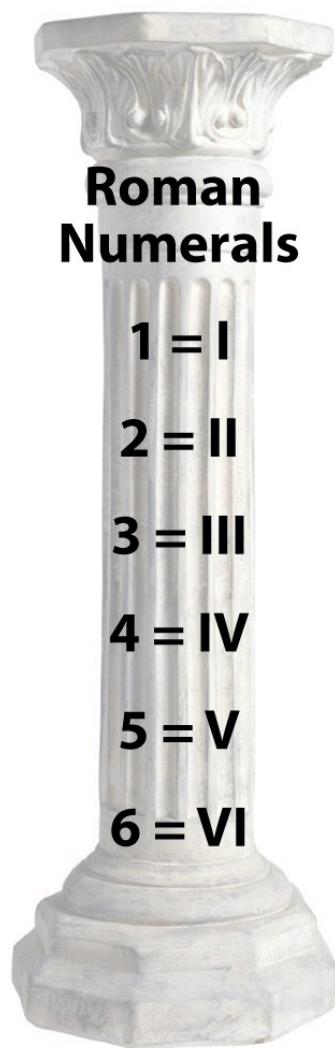
# Free Love

## Table 4.1

## Cations with Multiple Common Charges

| Element  | Common Ionic Forms                                     |
|----------|--|
| Iron     | $\text{Fe}^{2+}$ , $\text{Fe}^{3+}$                    |
| Chromium | $\text{Cr}^{2+}$ , $\text{Cr}^{3+}$ , $\text{Cr}^{6+}$ |
| Cobalt   | $\text{Co}^{2+}$ , $\text{Co}^{3+}$                    |
| Copper   | $\text{Cu}^{+}$ , $\text{Cu}^{2+}$                     |

# Roman Hedonism!



Unnumbered figure pg 103b  
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# Flower Power



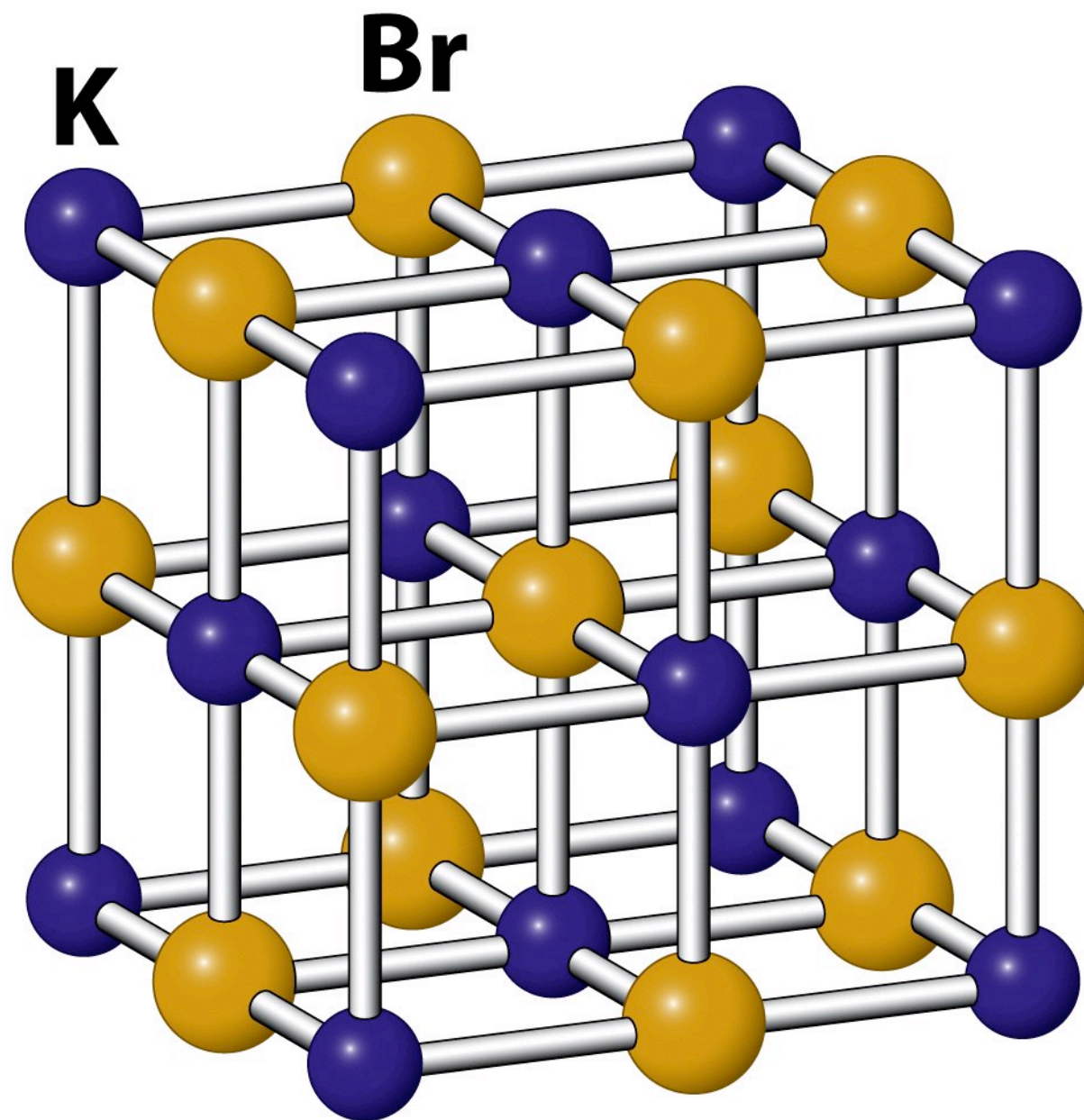
...and often toxic and reactive

# Promiscuous but Peaceful



## Table 4.2 Polyatomic Ions

| Polyatomic Ion   | Symbol                             |
|------------------|------------------------------------|
| Ammonium ion     | $\text{NH}_4^+$                    |
| Nitrate ion      | $\text{NO}_3^-$                    |
| Hydroxide ion    | $\text{OH}^-$                      |
| Acetate ion      | $\text{C}_2\text{H}_3\text{O}_2^-$ |
| Cyanide ion      | $\text{CN}^-$                      |
| Permanganate ion | $\text{MnO}_4^-$                   |
| Chlorate ion     | $\text{ClO}_3^-$                   |
| Carbonate ion    | $\text{CO}_3^{2-}$                 |
| Sulfate ion      | $\text{SO}_4^{2-}$                 |
| Chromate ion     | $\text{CrO}_4^{2-}$                |
| Phosphate ion    | $\text{PO}_4^{3-}$                 |



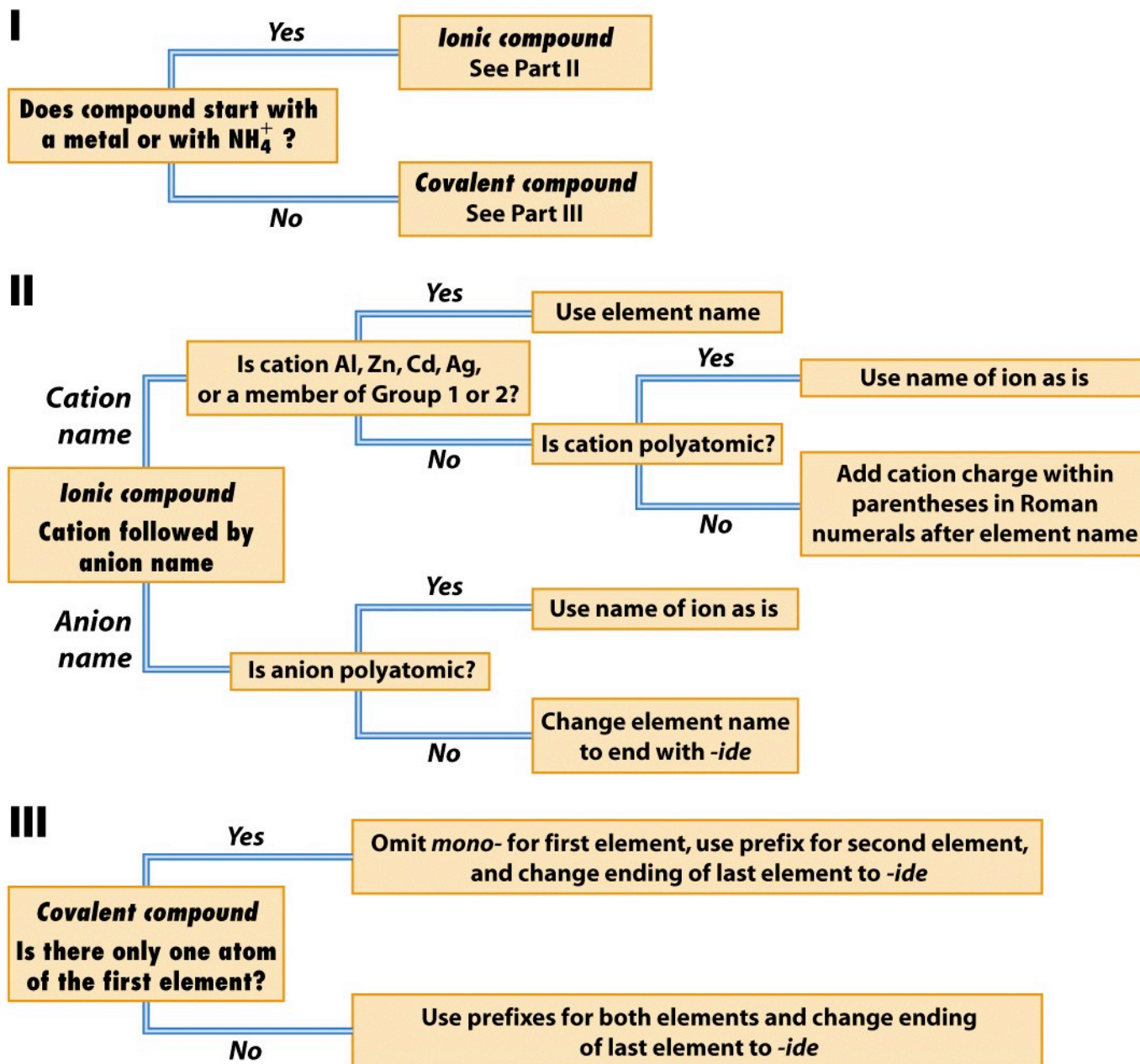
**Figure 4-3**  
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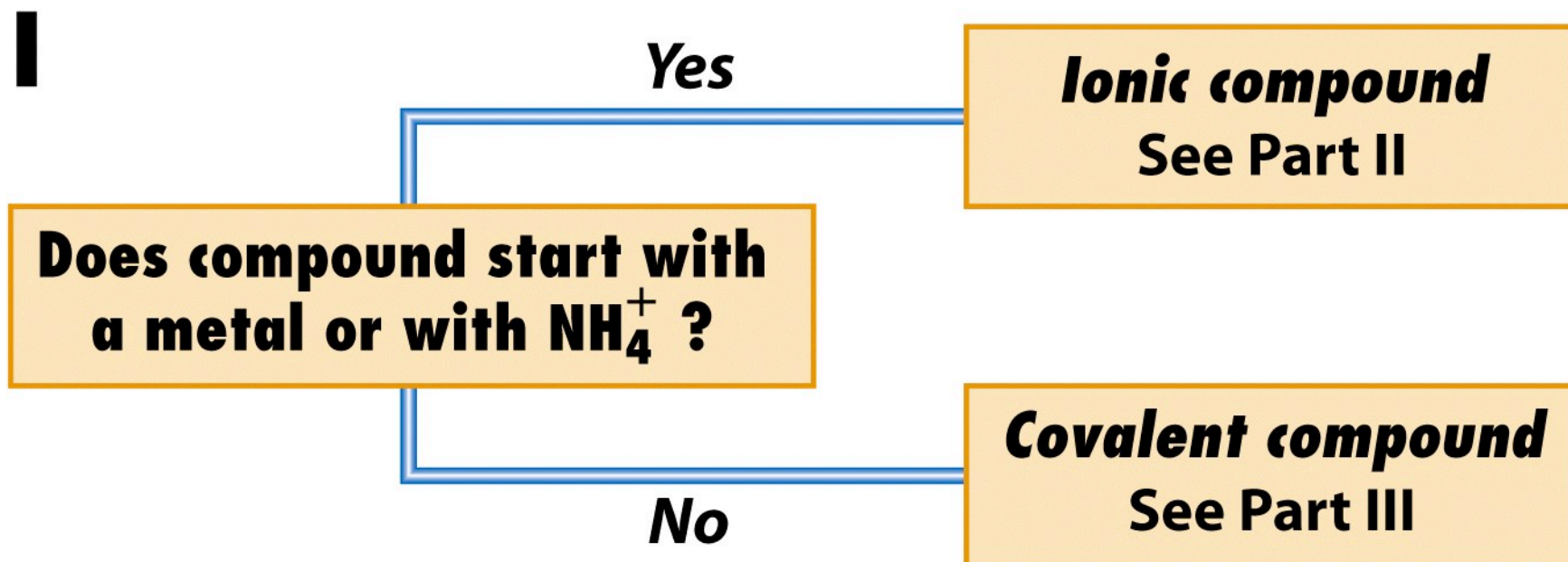
**Table 4.3**

## Prefixes for Covalent Compounds

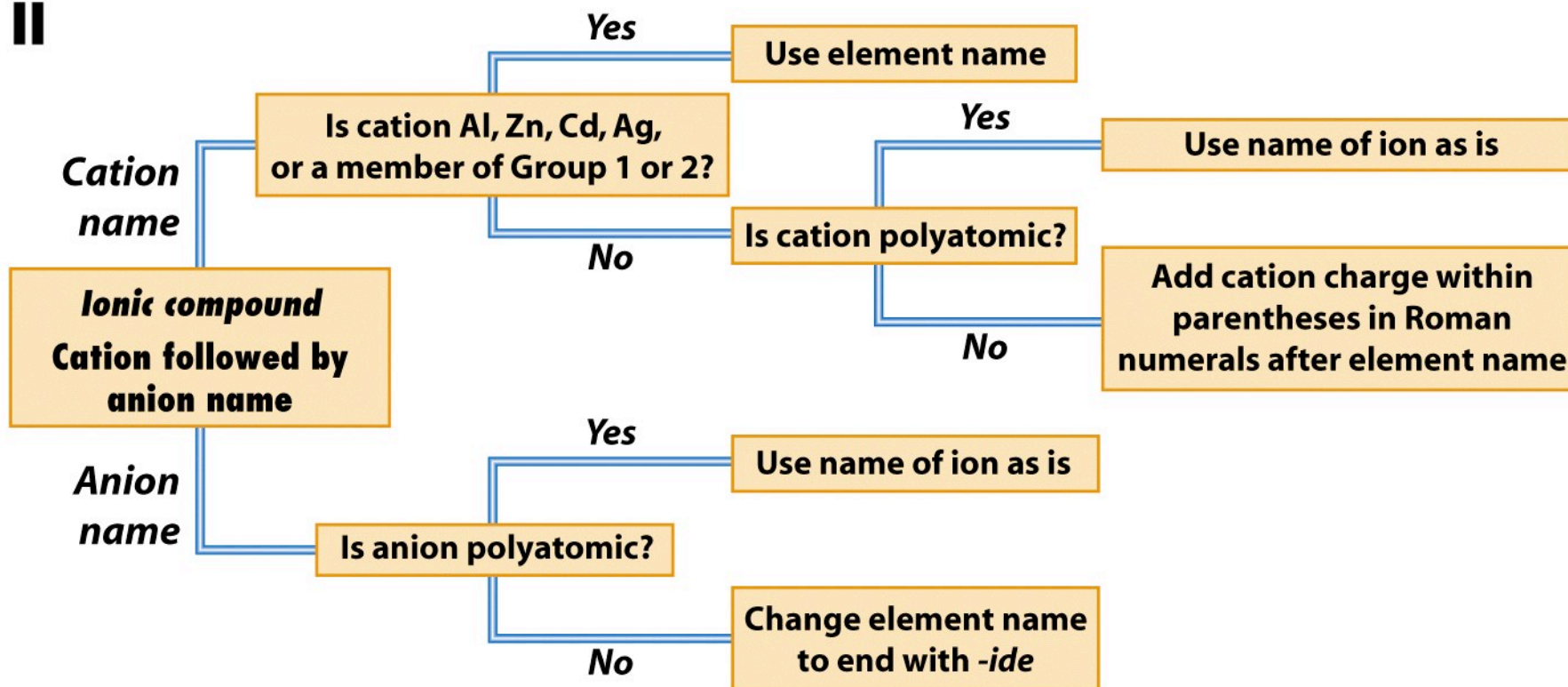
| <b>Prefix</b> | <b>Number</b> |
|---------------|---------------|
| <b>mono-</b>  | <b>1</b>      |
| <b>di-</b>    | <b>2</b>      |
| <b>tri-</b>   | <b>3</b>      |
| <b>tetra-</b> | <b>4</b>      |
| <b>penta-</b> | <b>5</b>      |
| <b>hexa-</b>  | <b>6</b>      |
| <b>hepta-</b> | <b>7</b>      |
| <b>octa-</b>  | <b>8</b>      |
| <b>nona-</b>  | <b>9</b>      |
| <b>deca-</b>  | <b>10</b>     |



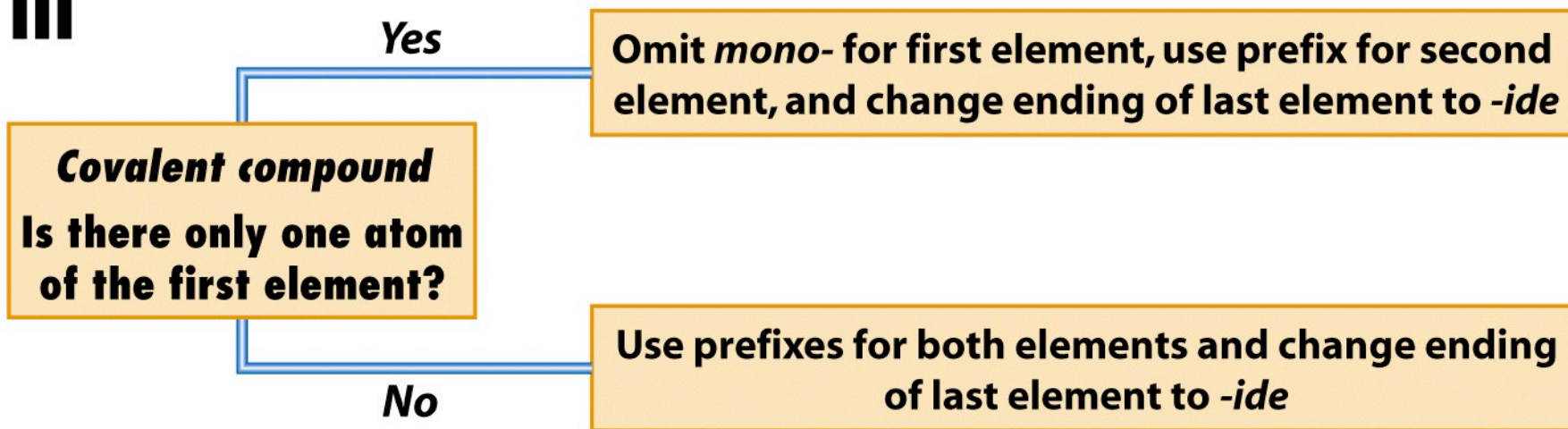




II

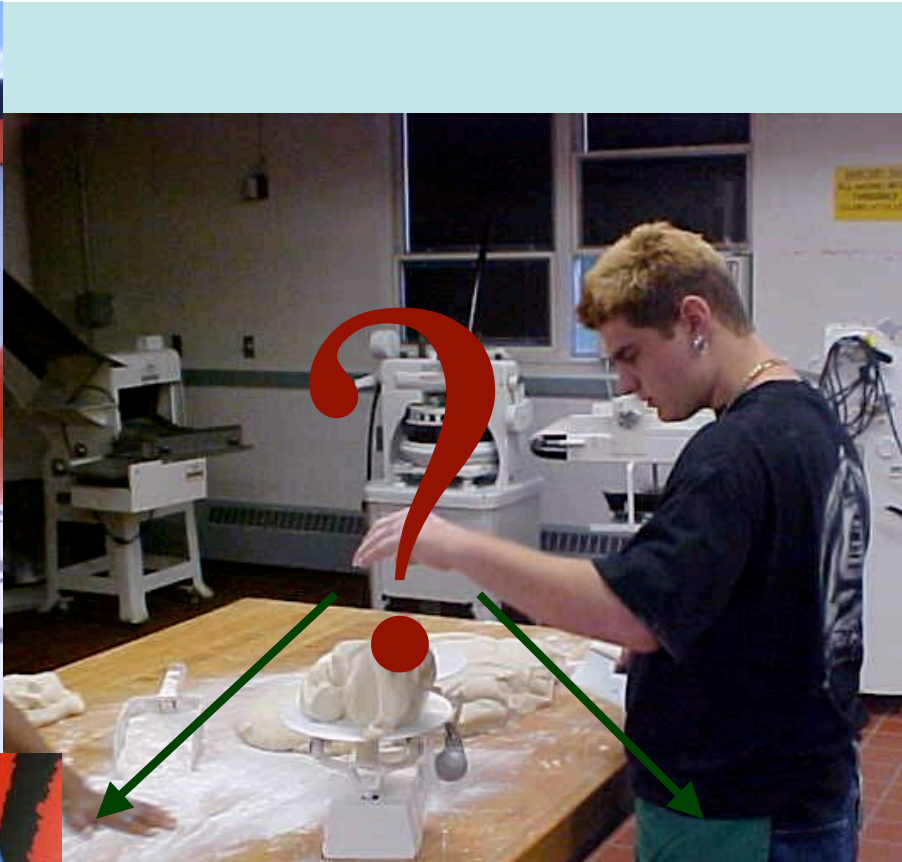


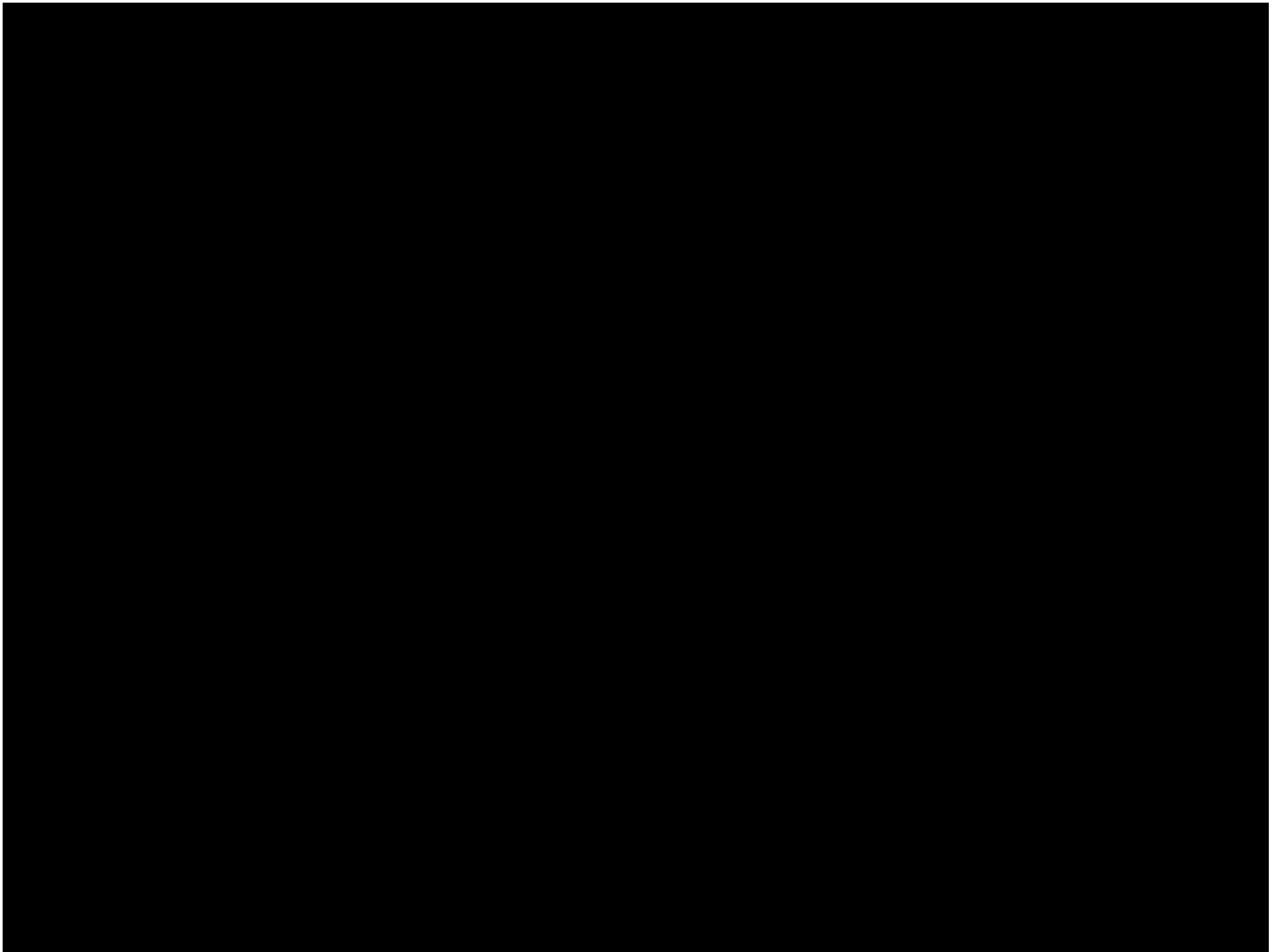
### III



|   |          |          |           |           |           |           |           |           |           |           |           |           |           |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
|---|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|
| 1<br>H  |          |          |           |           |           |           |           |           |           |           |           |           |           |          |          |          | 2<br>He  |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| 3<br>Li   | 4<br>Be  |          |           |           |           |           |           |           |           |           |           | 5<br>B    | 6<br>C    | 7<br>N   | 8<br>O   | 9<br>F   | 10<br>Ne |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| 11<br>Na  | 12<br>Mg |          |           |           |           |           |           |           |           |           |           | 13<br>Al  | 14<br>Si  | 15<br>P  | 16<br>S  | 17<br>Cl | 18<br>Ar |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| 19<br>K   | 20<br>Ca | 21<br>Sc | 22<br>Ti  | 23<br>V   | 24<br>Cr  | 25<br>Mn  | 26<br>Fe  | 27<br>Co  | 28<br>Ni  | 29<br>Cu  | 30<br>Zn  | 31<br>Ga  | 32<br>Ge  | 33<br>As | 34<br>Se | 35<br>Br | 36<br>Kr |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| 37<br>Rb  | 38<br>Sr | 39<br>Y  | 40<br>Zr  | 41<br>Nb  | 42<br>Mo  | 43<br>Tc  | 44<br>Ru  | 45<br>Rh  | 46<br>Pd  | 47<br>Ag  | 48<br>Cd  | 49<br>In  | 50<br>Sn  | 51<br>Sb | 52<br>Te | 53<br>I  | 54<br>Xe |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| 55<br>Cs  | 56<br>Ba | 57<br>La | 72<br>Hf  | 73<br>Ta  | 74<br>W   | 75<br>Re  | 76<br>Os  | 77<br>Ir  | 78<br>Pt  | 79<br>Au  | 80<br>Hg  | 81<br>Tl  | 82<br>Pb  | 83<br>Bi | 84<br>Po | 85<br>At | 86<br>Rn |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| 87<br>Fr  | 88<br>Ra | 89<br>Ac | 104<br>Rf | 105<br>Db | 106<br>Sg | 107<br>Bh | 108<br>Hs | 109<br>Mt | 110<br>Ds | 111<br>Rg |           |           |           |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| <table border="1"> <tbody> <tr> <td>58<br/>Ce</td> <td>59<br/>Pr</td> <td>60<br/>Nd</td> <td>61<br/>Pm</td> <td>62<br/>Sm</td> <td>63<br/>Eu</td> <td>64<br/>Gd</td> <td>65<br/>Tb</td> <td>66<br/>Dy</td> <td>67<br/>Ho</td> <td>68<br/>Er</td> <td>69<br/>Tm</td> <td>70<br/>Yb</td> <td>71<br/>Lu</td> </tr> <tr> <td>90<br/>Th</td> <td>91<br/>Pa</td> <td>92<br/>U</td> <td>93<br/>Np</td> <td>94<br/>Pu</td> <td>95<br/>Am</td> <td>96<br/>Cm</td> <td>97<br/>Bk</td> <td>98<br/>Cf</td> <td>99<br/>Es</td> <td>100<br/>Fm</td> <td>101<br/>Md</td> <td>102<br/>No</td> <td>103<br/>Lr</td> </tr> </tbody> </table> |          |          |           |           |           |           |           |           |           |           |           |           |           |          |          |          |          | 58<br>Ce | 59<br>Pr | 60<br>Nd | 61<br>Pm | 62<br>Sm | 63<br>Eu | 64<br>Gd | 65<br>Tb | 66<br>Dy | 67<br>Ho | 68<br>Er | 69<br>Tm | 70<br>Yb | 71<br>Lu | 90<br>Th | 91<br>Pa | 92<br>U | 93<br>Np | 94<br>Pu | 95<br>Am | 96<br>Cm | 97<br>Bk | 98<br>Cf | 99<br>Es | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |
| 58<br>Ce  | 59<br>Pr | 60<br>Nd | 61<br>Pm  | 62<br>Sm  | 63<br>Eu  | 64<br>Gd  | 65<br>Tb  | 66<br>Dy  | 67<br>Ho  | 68<br>Er  | 69<br>Tm  | 70<br>Yb  | 71<br>Lu  |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |
| 90<br>Th  | 91<br>Pa | 92<br>U  | 93<br>Np  | 94<br>Pu  | 95<br>Am  | 96<br>Cm  | 97<br>Bk  | 98<br>Cf  | 99<br>Es  | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |          |          |          |          |          |          |           |           |           |           |

Figure 4-5  
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