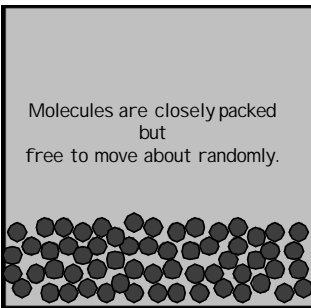


## When Intermolecular Forces Rule in Chemistry and Biology

PGCC CHM 101 Sinex

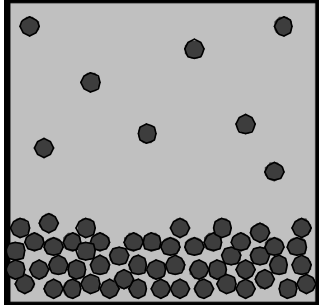
### The liquid state of matter

Molecules are closely packed but free to move about randomly.



There must be a force of attraction between the molecules.

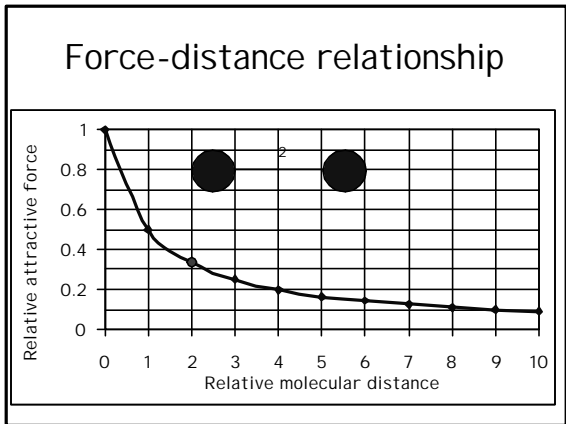
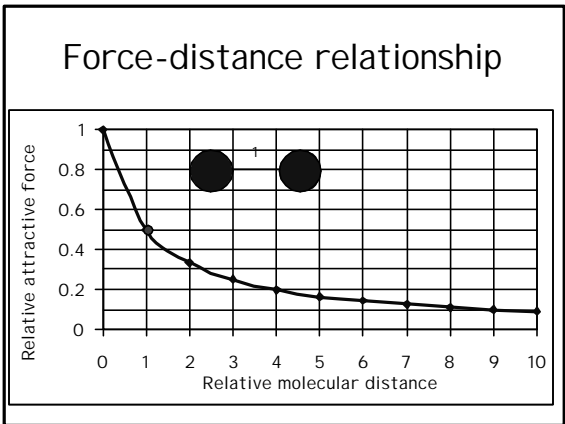
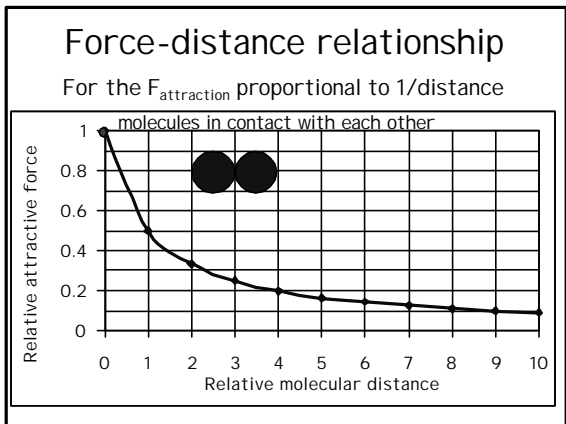
### As molecules start to vaporize

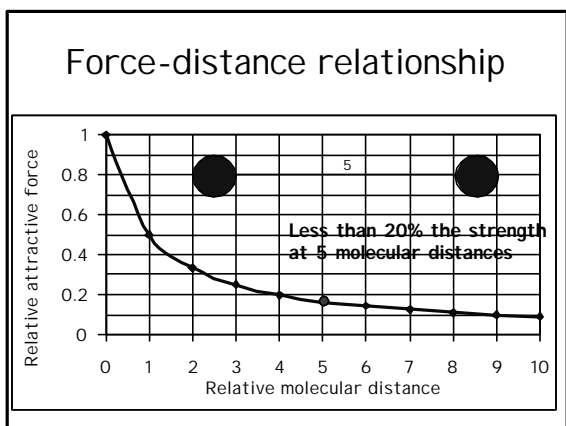
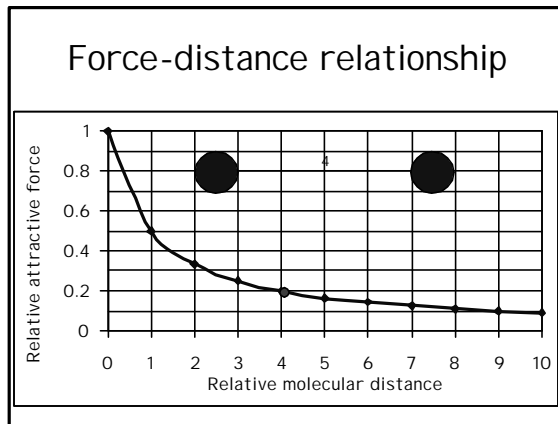
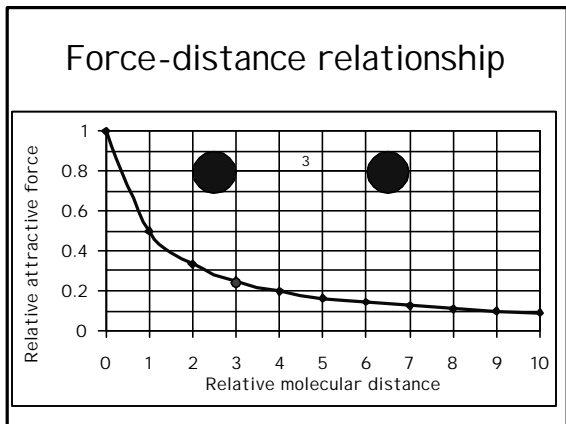


Molecules are great distances apart in gaseous state but free to move about randomly.

What about in solids?

[Click here](#) for a simulation of the states of matter





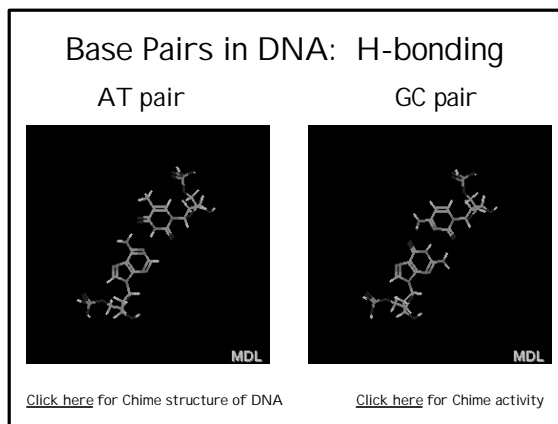
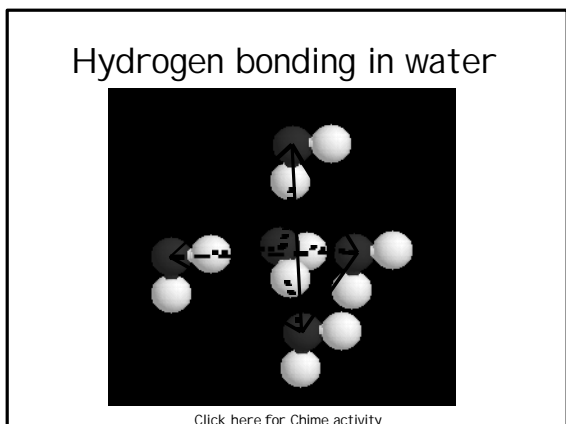
### The strength of IMF's

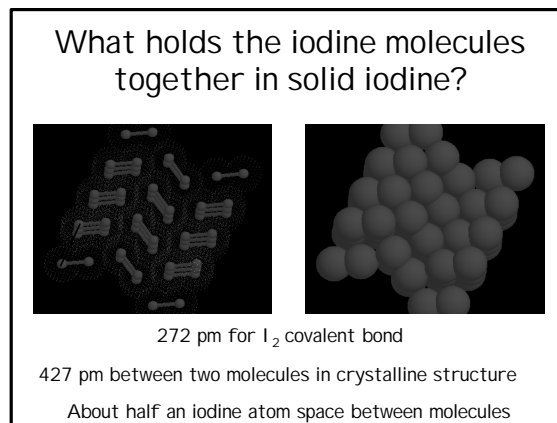
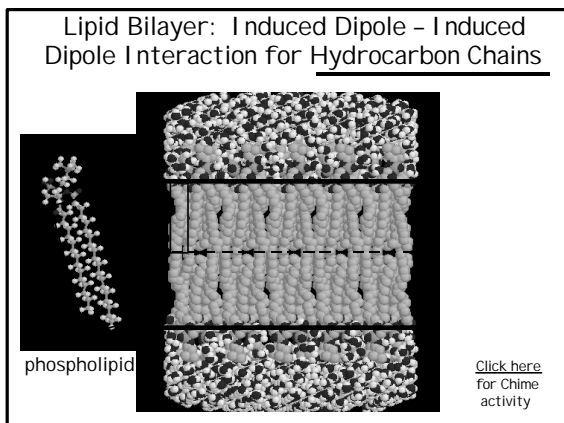
Increasing strengths of IMF ↑

- H-bonding (fixed distance ~200 pm)
- Ion-ion ( $1/r$ )
- Ion-dipole ( $1/r^2$ )
- Dipole-dipole ( $1/r^3$ )
- Ion-induced dipole ( $1/r^4$ )
- Dipole-induced dipole ( $1/r^6$ )
- Induced dipole-induced dipole ( $1/r^6$ )

Inverse functions of distance to various powers

How do the other functions behave compared to  $1/r$ ?  
[Click here](#) for an interactive Excel spreadsheet to explore





Why do low molar mass substances that are non-polar molecules, such as H<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, or CO<sub>2</sub> have very low boiling points?

Since they are non-polar, the IMF will be induced dipole- induced dipole, which is the weakest IMF.

To get the molecules to interact with one another, the temperature needs to be decreased considerably (lower kinetic energy).

For an ideal gas we assume there are no interactions between the atoms or molecules. Why is this a good assumption?

Atoms or molecules in the gaseous state at room conditions are too far apart for IMF's to operate. IMF's are short range attractive forces.

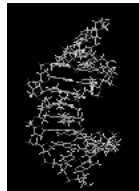
Attractive forces become important at low temperatures or high pressures. WHY?

Some review questions

1. If a gas is compressed to high pressures, it will liquefy. Why?

[Click here](#) for Chime structures to address the next two questions.

2. What holds a protein in the alpha-helix form?
3. How about a beta-sheet protein?



**LESSON LEARNED**  
All of biology is held together by chemistry!  
Go tell a biologist!!!!