INSET PROGRAM

2D DNA FILM

By: Virginia Raymond
Ventura Community College
Biology Major

Mentor: Emin Oroudjev
Faculty Advisor: Helen Hansma

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What They Are Doing

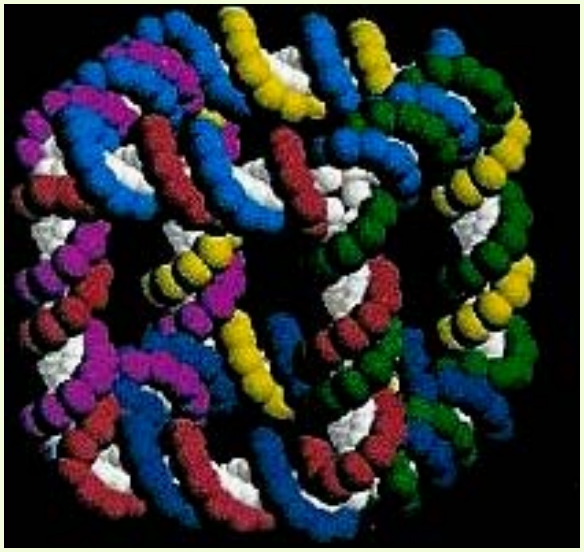
- Construction of 2D and 3D nanonetworks from relatively large pieces of DNA
- Used for construction of nanorobotic devices, nanosensors, and analysis of nanomaterials

What We Are Doing

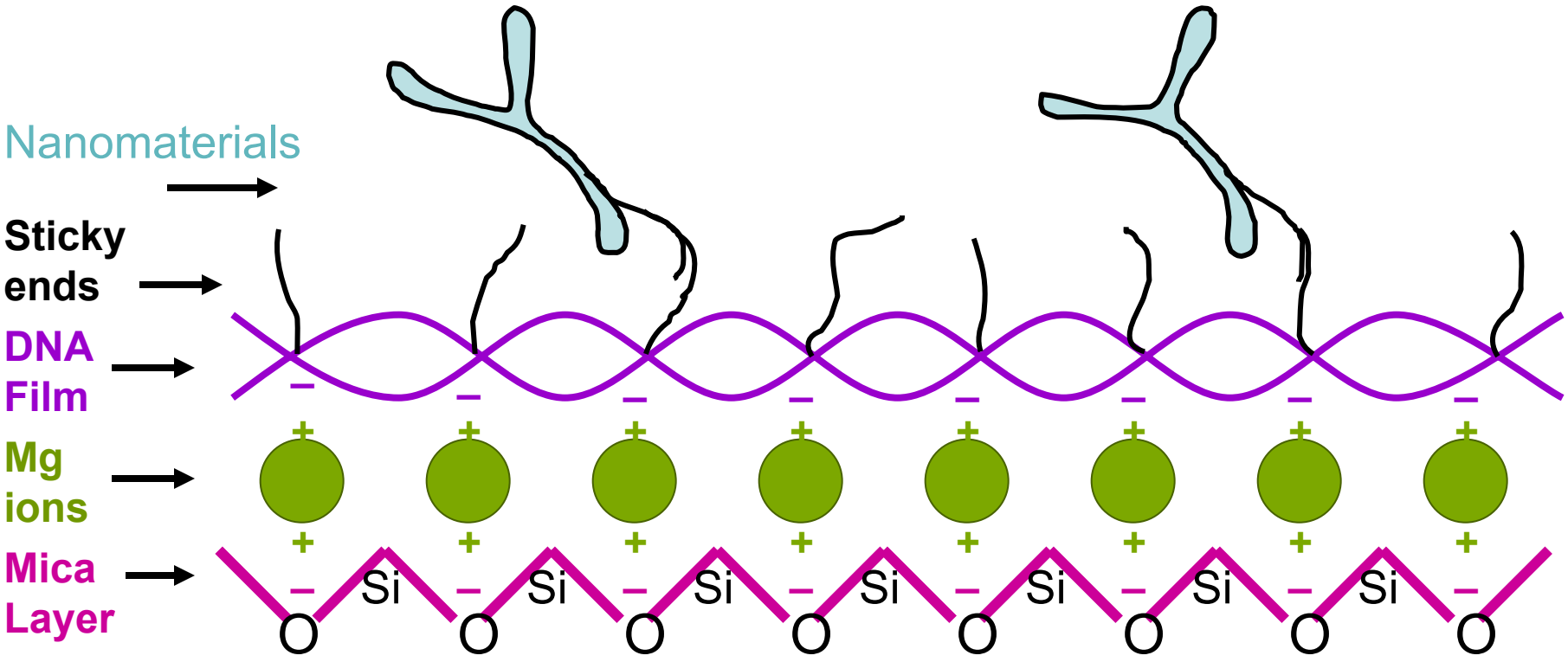
- Using small, single-stranded pieces of DNA called oligonucleotides
- Facilitate faster self-assembly and allow smaller features
- Creating a film or ribbon of DNA for same applications

Truncated Octahedron

Cube



Molecular View

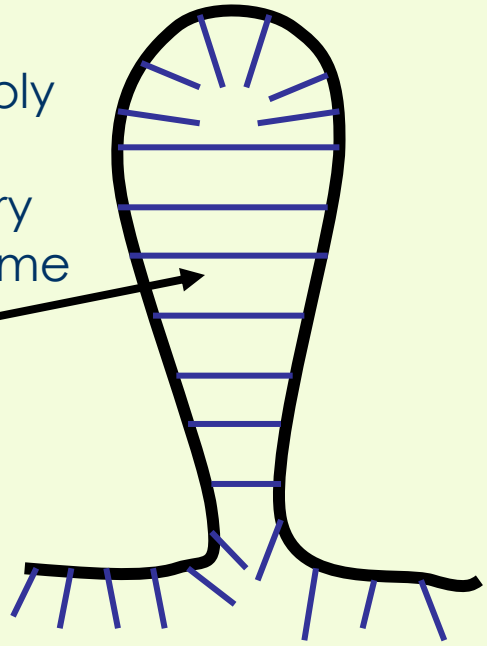


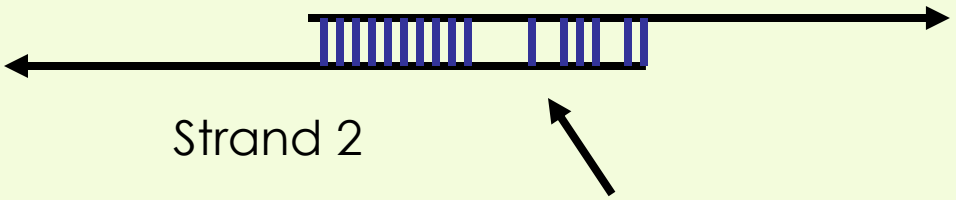
Designing the Oligonucleotides

Hairpins: DNA bases on one strand bind to itself

Dimers: bases from two strands of DNA bind at unfavorable locations

Areas of assembly due to complementary base pairs on same strand



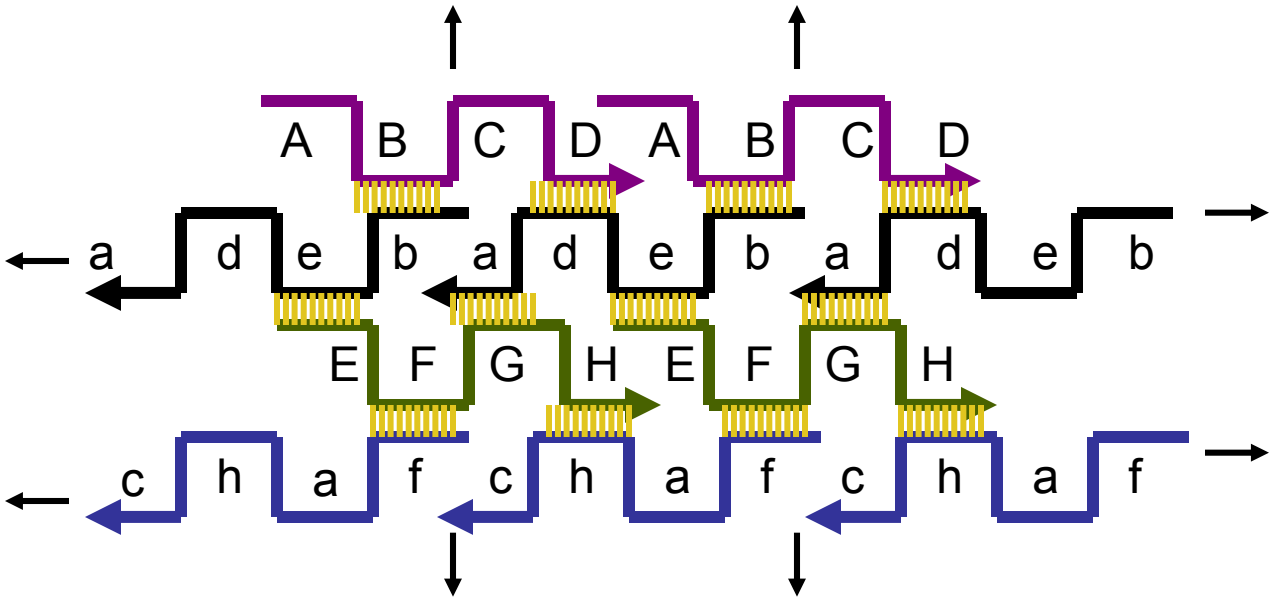


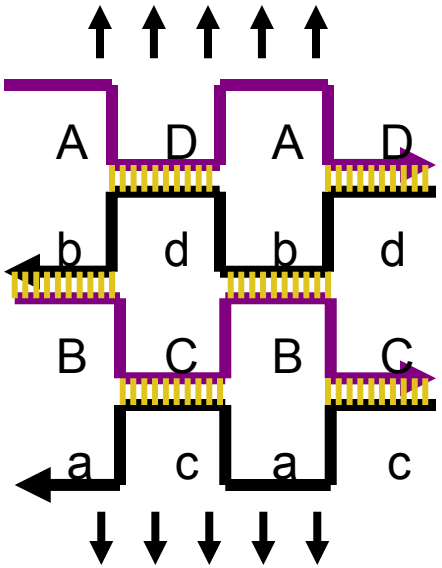
Areas of assembly due to complementary base pairs at various sites on separate strands of DNA

These cause interruptions or defects in the film formations

The Difference Between DNA Film and DNA Ribbons

DNA Film=
has growth in all four directions

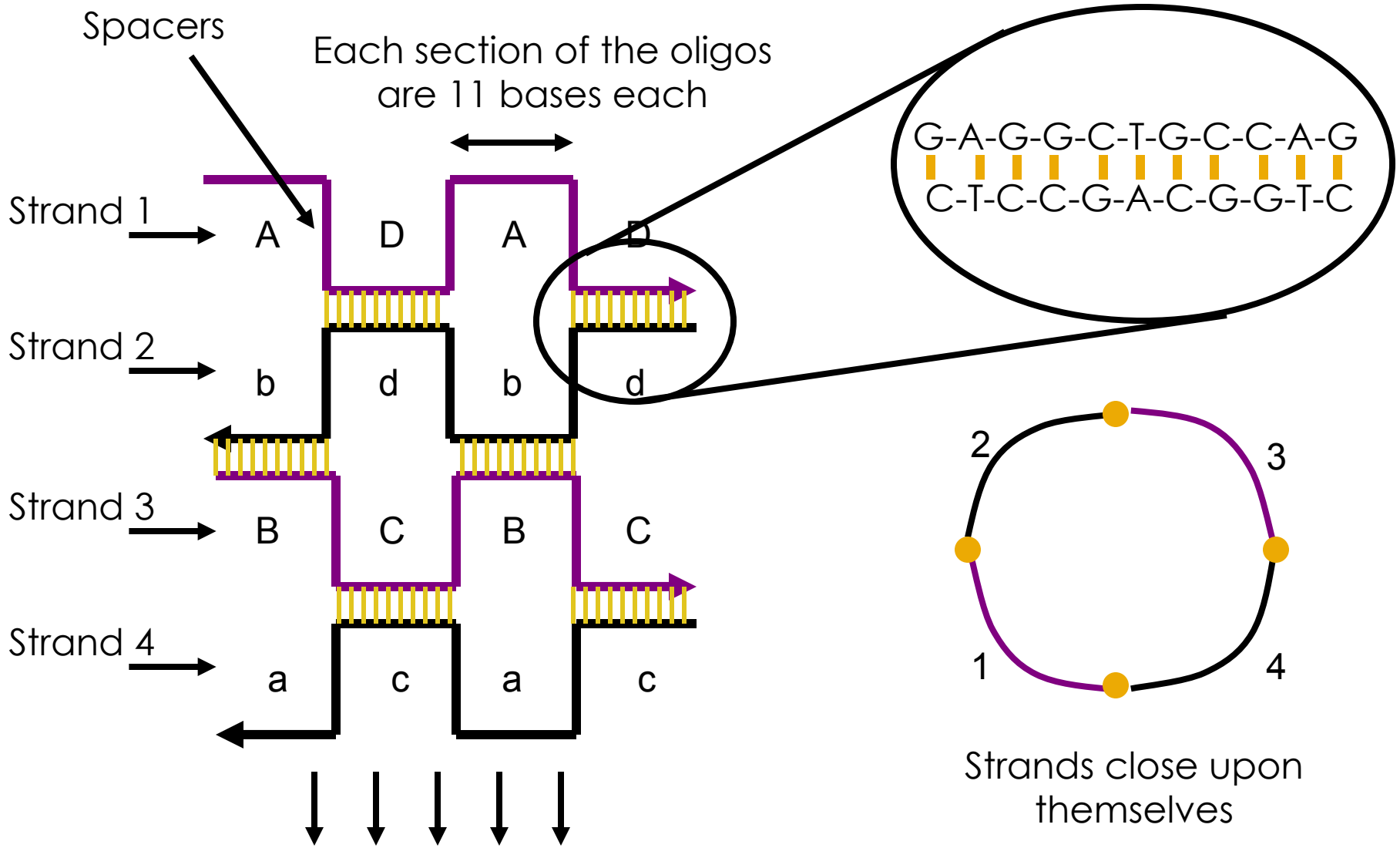




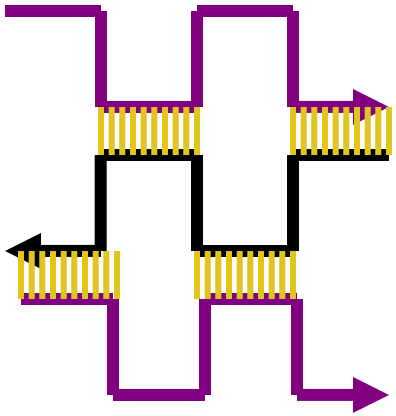
DNA Ribbon=
only has growth in two directions

What forms, film or ribbons, all depend upon the sequence of the base pairs on the oligonucleotides

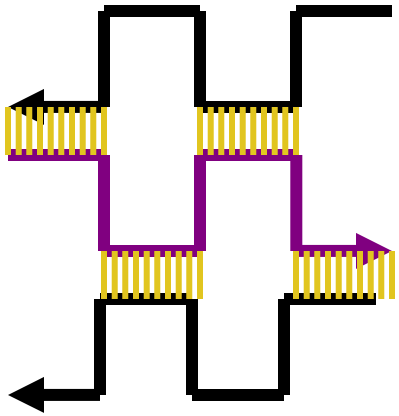
2D Film Assembly



Assembly of 2D DNA Ribbons with “Triplet” Technique

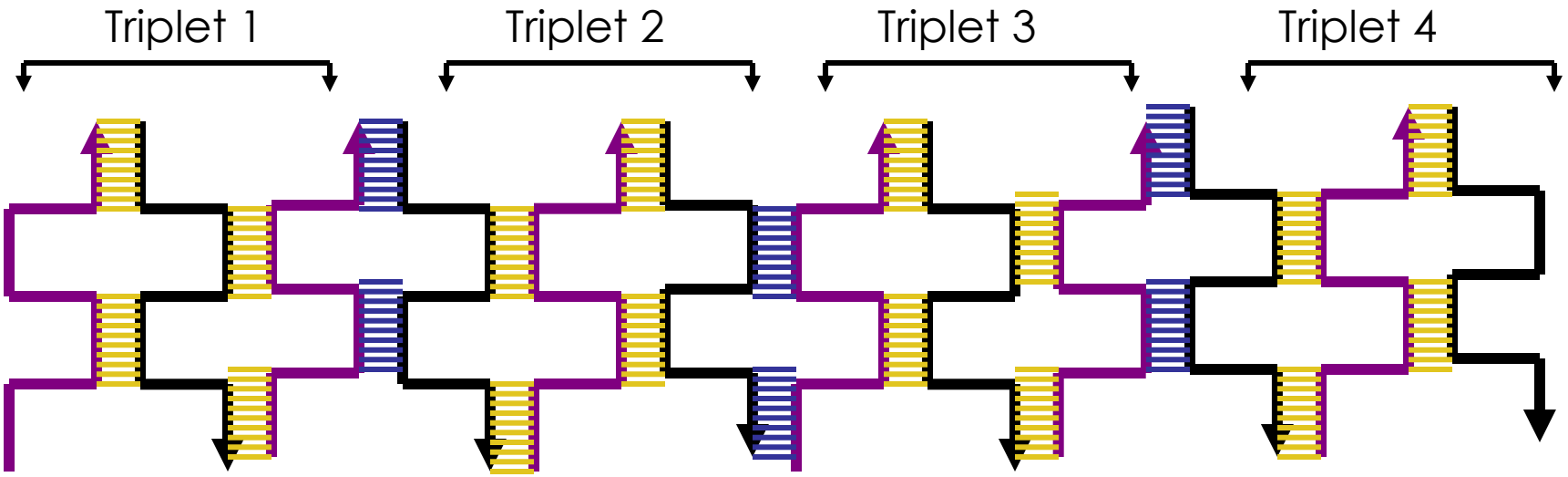


Triplet 1



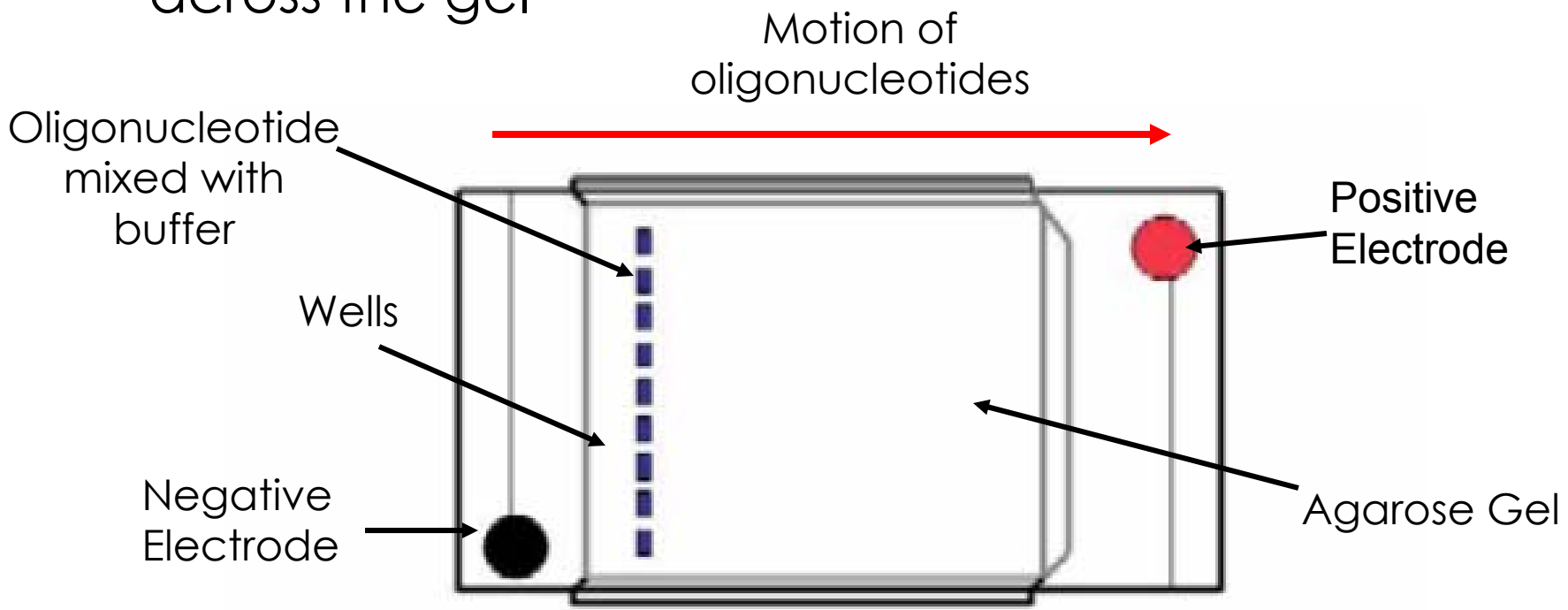
Triplet 2

Assemble Triplets Separately

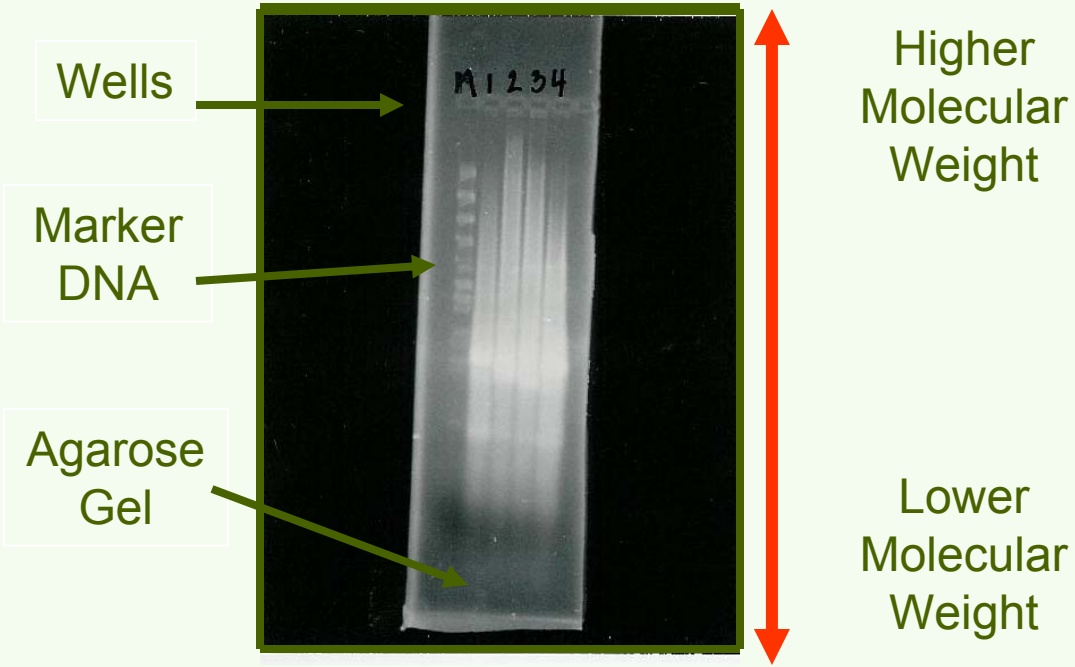


Agarose Gel Electrophoresis

- Will separate the structures that formed according to size
- Higher molecular weight structures stay closer to the wells
- Lower molecular weight structures migrate across the gel



Oligonucleotide Assembly: Without Triplet Technique

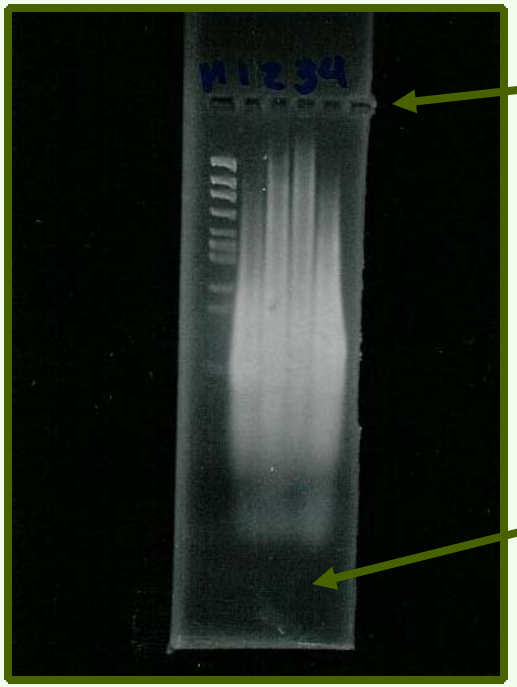


Mixtures prepared with four types of oligonucleotide strands per sample. Concentration of magnesium chloride varied for samples 1-4. Not many high molecular weight compounds formed.

Using Oligonucleotides Triplets: to Prevent DNA Bundles

Higher Molecular Weight

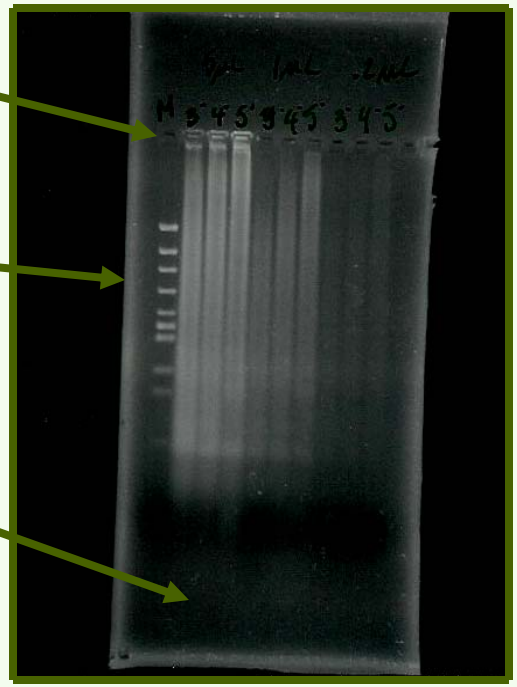
Lower Molecular Weight



Wells

Marker DNA

Agarose Gel



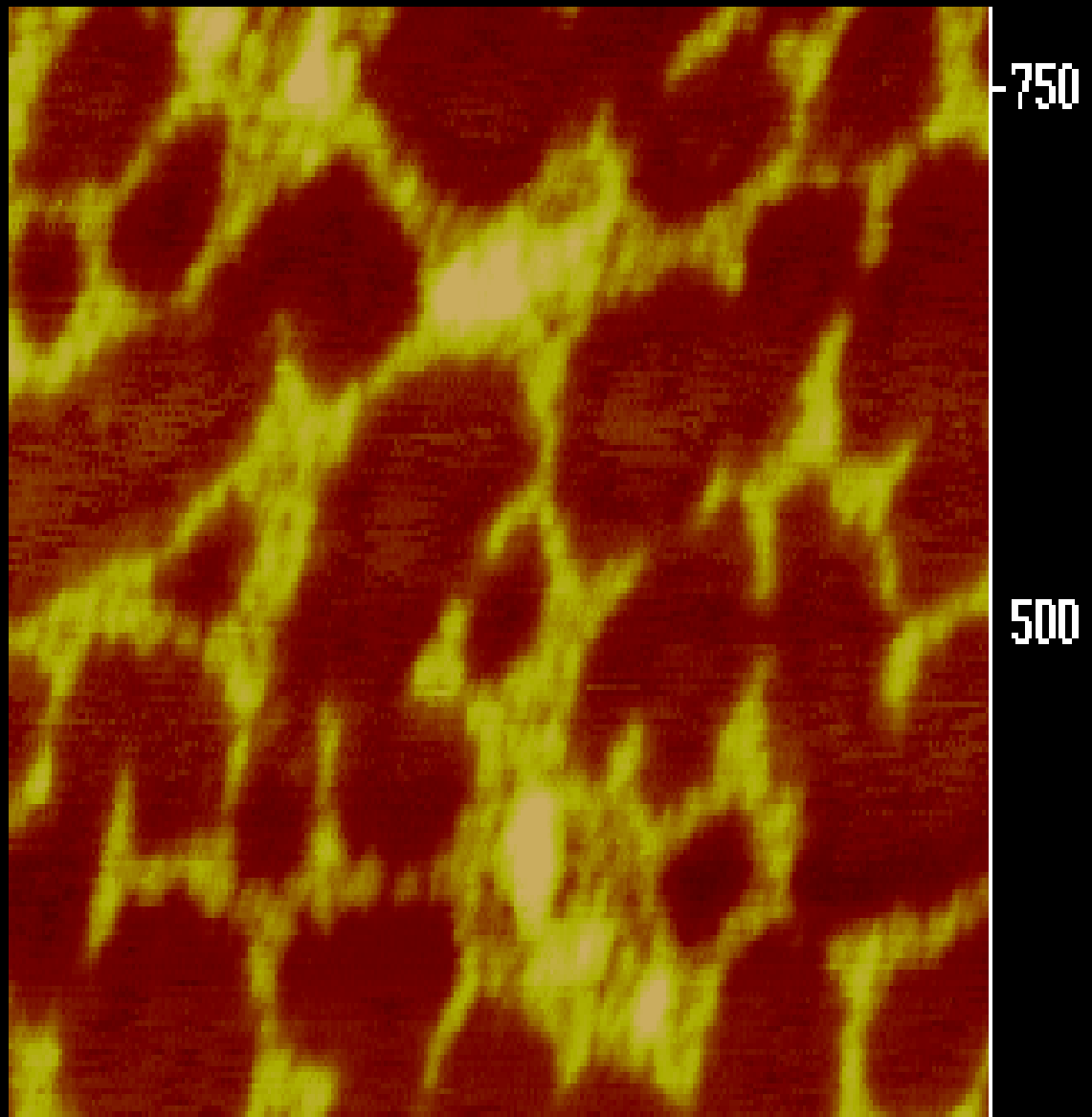
Higher Molecular Weight

Lower Molecular Weight

Picture 1: Oligonucleotides assembled with three strands per solution- triplets 1,2,3 & 4.

Picture 2: 10 microL of each of the four triplets mixed together three times to assemble film- heated at 37º, 47º, & 57ºC.

Height Angle Surface Normal Clear Calculator



750

500

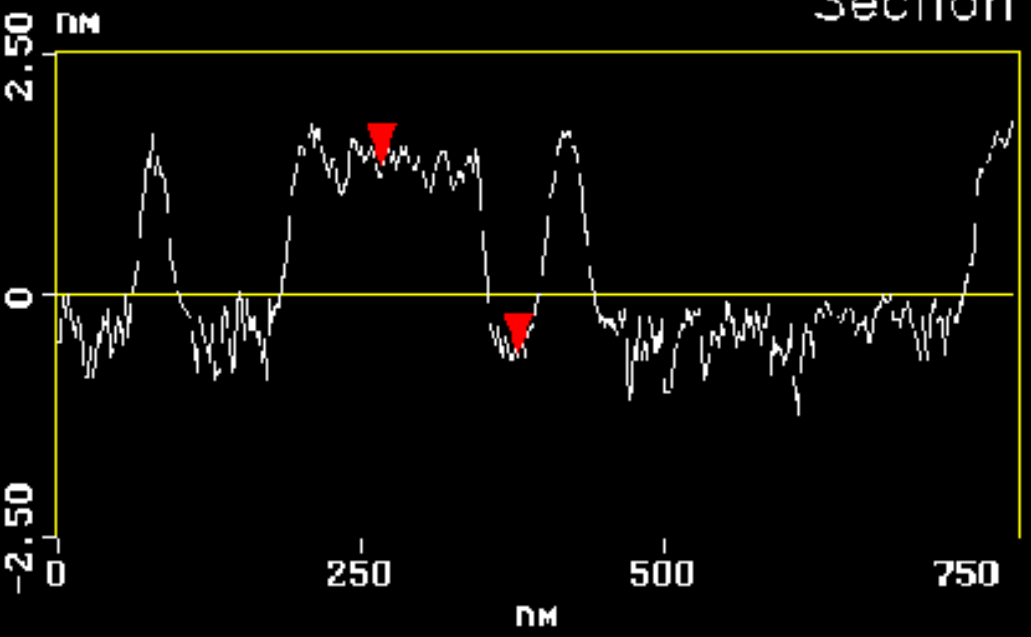
5.0 nm

2.5 nm

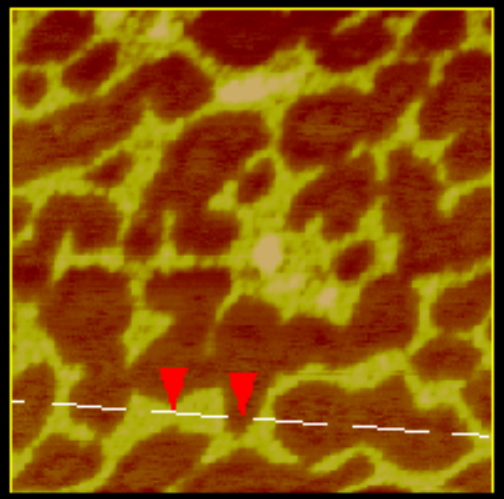
0.0 nm

Cursor Marker Spectrum Zoom Center Line Offset Clear

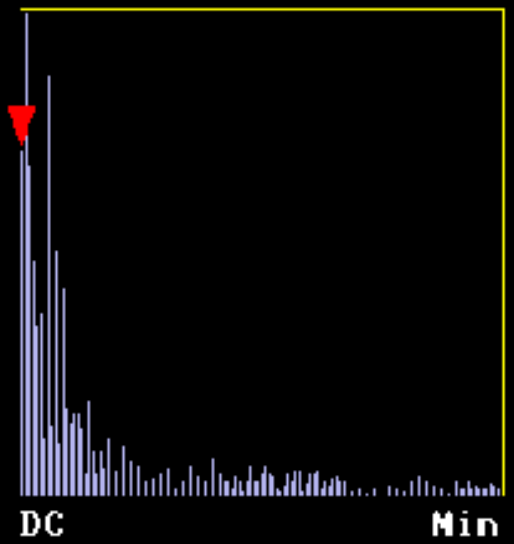
Section Analysis



L	112.72 nm
RMS	0.790 nm
lc	DC
Ra(lc)	0.400 nm
Rmax	1.705 nm
Rz	1.196 nm
Rz Cnt	4
Radius	802.95 nm
Sigma	0.388 nm



Spectrum



Surface distance	113.11 nm
Horiz distance(L)	112.72 nm
Vert distance	1.950 nm
Angle	0.991
Surface distance	
Horiz distance	
Vert distance	
Angle	
Surface distance	
Horiz distance	
Vert distance	
Angle	
Spectral period	DC
Spectral freq	0 Hz
Spectral RMS amp	0.0006 nm

07011606.002

Cursor: fixed Zoom: 2:1 Cen line: Off Offset: Off

In the Immediate Future

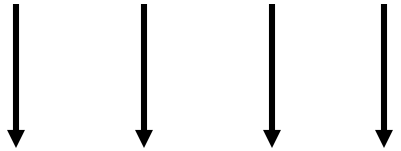
- Design a new set of oligonucleotides that are more specific in their interactions
- Assemble the oligonucleotides on a mica crystal surface

Acknowledgements

- Helen Hansma and Emin Oroudjev
- INSET

To Prevent Hairpins and Dimers

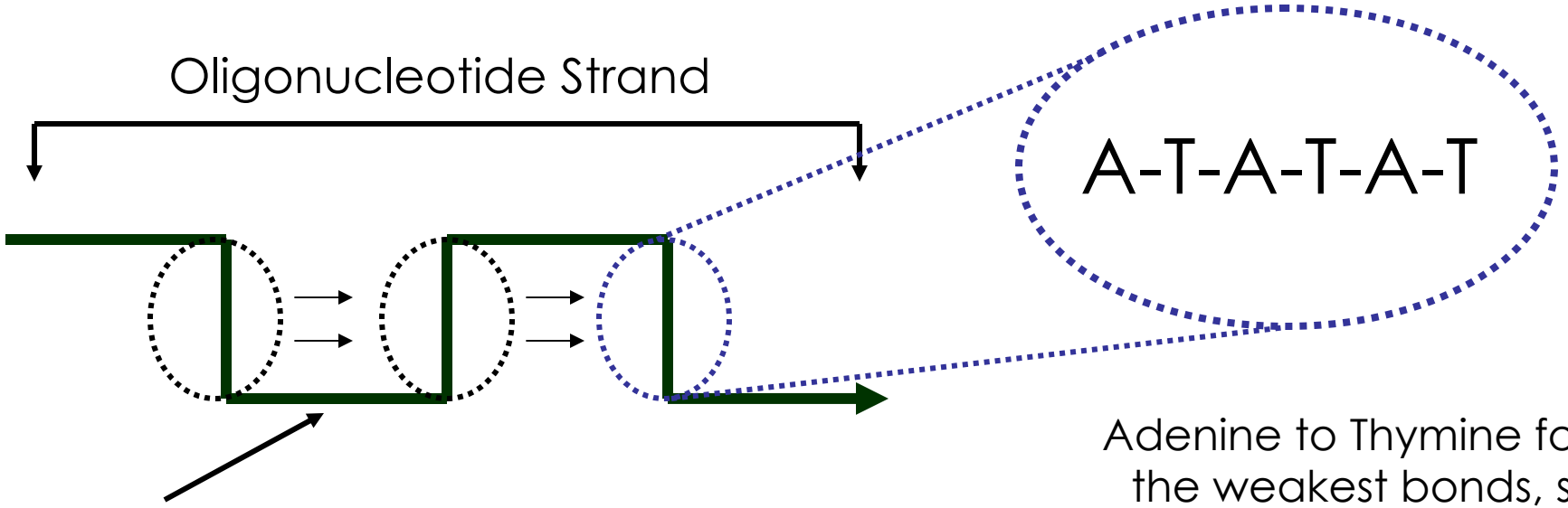
Desired interactions have highest melting point usually between 46°C and 58°C



Hairpin and dimer formations have a melting point between 36°C and 42°C

Heat the oligonucleotides up to 98°C and let cool for an hour and a half. This allows the correct interactions between the strands to occur while the hairpin and dimer interactions form and then melt again.

The Importance of Spacers



- How long should they be?
- What bases should they be composed of?
- Should they interact with a spacer on a different strand?

Agarose Gel Electrophoresis

- Will separate the structures that formed according to size
- Higher molecular weight structures stay closer to the gel
- Lower molecular weight structures migrate across the gel