I. What is shading? - The process of generating synthetic imagery.
   A. Every pixel in the final rendered image requires the following to be calculated:
      1. Surface Geometry
      2. Surface Attributes
      3. Surface Reflectivity
      4. Lighting

II. Render Nodes
   A. Along with shape nodes, transform nodes, and input nodes, render nodes are used to
      visualize renderable attributes of the modeling world.
      1. Can be Materials, textures, lighting, and atmospheric effects.
      2. Nodes appear in Hypergraph while using the Show Dependency mode.
   B. Shading Groups - A network of render nodes that include some or all of the following:
      1. Materials - Determine the surface properties of an object.
         i. Color and transparency.
         ii. Matte or shininess, reflectivity
         iii. Glow properties
         iv. Motion Blur
      2. Textures - determine surface color by applying images, or procedural textures
         to surfaces.
      3. Placement Nodes - are used to determine placement and orientation of textures
         on objects.
      4. Bump or Displacement Nodes - determine the bump or displacement attributes
         on a surface.
   C. Surface Material Render Nodes
      1. Anisotropic - used primarily for surfaces with microscopic grooves.
         i. Direction and orientation of the tiny grooves to the camera eye
            determines the way in which light reflects off the surface.
         ii. Examples - hair, cloth and brushed metal.
      2. Blinn - Used primarily for metallic surfaces which typically have soft specular
         highlights.
         i. Used instead of Phong for surfaces that have bump or displacement
            maps.
         ii. Softer highlights reduce flickering on thin highlights.
      3. Lambert - Used primarily for matte surfaces or other unpolished surfaces which
         have no specular highlights. Fastest to render.
      4. Phong / Phong E - Used primarily for glass and glossy plastic surfaces.
         i. Faster to render than Blinn and Anisotropic.
         ii. Phong E - slightly softer highlights and a simpler version of Phong.
         (Think E for economy.)
      5. Layered Shader - a single surface material or texture composed of several
         different surface material and textures.
         i. Require some level or portion of transparency on upper nodes to see
            lower nodes.
         ii. Allows user to share attributes between layers of the shader. Subtle
            characteristics can be shared, resulting in a very natural looking
            effect.
         i. Has only three input connections.
         ii. Surface Material should be linked to a Material node.
         iii. Displacement Material - connected to a material that will determine the
             displacement of the surfaces geometry.

III. Hypershade / Visor - Used to interactively create and graph dependency nodes of Shading
    Groups.
   A. Windows -> Visor - A visual outliner and file browser. Displays images of shading
      nodes you can create, of those already in your scene, and those in your project folder.
   B. Visor has three sections - they are:
      1. Rendering - displays the current scenes folders and their contents.
      2. Create -
         i. Displays the equivalent of Create Render Node window.
         ii. MMB drag from the Visor to Hypershade to create a new Render
            Node.
      3. Project Directory
         i. Displays the contents of your current project directory and its
            subdirectories.
ii. Drag images into the Hypershade to create new textures, or import from other projects.

C. **Windows -> Hypershade** - used to create and edit rendering nodes, and to view and edit rendering or shading networks.

1. Important menu options:
   i. **Options -> Clear before graphing** - clears the display before redisplaying a newly selected or created node.
   ii. **RMB -> Create -> x** - used to create render nodes such as materials, textures, lights, etc.

2. Connecting input and output nodes.

i. **MMB Drag** - one node to another. You will get a dialog that asks what you what to link to what.

3. Assigning Shader Groups to objects

   I. **MMB Drag** - a Shading Group onto an object in a modeling world.
   ii. Select a model in the world, then select a Shading Group node in the Hypershade. RMB over a render node, select **Assign material to Selection**.
   iii. **Assign material to selection** can also be used to connect a render node to another render node.

4. Hypershade icons -

   i. **Clear View** - a small icon that looks like an eraser.
   ii. **Graph material to selected objects** - looks like a small sphere and two boxes.
   iii. **Downstream graph** - shows render nodes that are inputs into the selected node.
   iv. **Upstream graph** - shows render nodes that are upstream of the selected node.
   v. **Downstream and upstream graph** - displays the entire dependency graph of the selected render node.

IV. Defining Material Properties - open up a Render Nodes' Attribute Editor

A. **Color** - Generally determined by three values representing the three primary colors Red, Green, and Blue.

1. HSV or RGB - The “color” of the color. (e.g. one red may have more blue in it than red)
2. Saturation - The amount of hue in a color.
   i. A color can go from dull to brilliant.
   ii. A fully desaturated color is a tone of gray.
   iii. Slider next to Gamut is used to determine saturation.
3. Luminance - The brightness of a color. (e.g. a color can be lighter or darker)

B. **Specular** - Cleverly referred to as "how light reflects off the surface"

1. Diffuse - The measure of how much light reflects overall from a surface.
   i. Darker objects reflect less light - lower diffusiveness.
   ii. Higher diffusiveness objects will be brighter then an object of the same color, though less diffuse.
   iii. An object with only the diffuse parameter renders as perfectly matte.
2. Specularity - The shiny spot on an object. (BLINN and PHONG)
   i. Specular Color - The color of the specular highlight.
   ii. Shininess / Eccentricity - effects the size of the highlight.
      1. Smaller highlights mean more shiny.
      2. Large highlights make light more scattered and less shiny.
3. Reflectivity - not all materials are equally reflective, use this to set reflectivity.

C. **Special Surface Effects**

1. Transparency - How much you can see through an object.
   i. Not all shading models support transparency.
   ii. Higher transparency values dim highlights, so adjustments should be made.
2. Refraction - How light bends as it passes through transparent objects.
   i. Generally only available in Raytracing/Radiosity rendering.
   ii. Refraction index - Air has an index of 1, light simply passes through without bending. Settings other then 1 create distortions as you look through the material.
3. Incandescence - Makes it appear that an object is emitting light.
   **Note:** This doesn't effect the lighting in the scene or other objects nearby.
4. Translucence - The way that light diffusely penetrates through translucent objects.