Here is some data about the growth of a bacteria population  
(bacteriology Lab, Dr. Linda Finke)

A culture of some (harmless) strain of bacteria is grown inside of a small beaker, which is filled with a liquid that supports life of the bacteria. Through light absorption measurements, it is possible to estimate the number of bacteria in the solution (per milliliter).

\[ t = \text{time in minutes after beginning of experiment} \quad A = \text{# of bacteria (per milliliter) in billions} \]

<table>
<thead>
<tr>
<th>( t )</th>
<th>0</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A )</td>
<td>4.6</td>
<td>6.0</td>
<td>7.6</td>
<td>10.8</td>
<td>15.1</td>
<td>21.5</td>
</tr>
</tbody>
</table>

(a) Would it be promising to try to imitate the above data with a Linear Model / Pattern? Would it be promising to try to imitate the above data with an Exponential Model / Pattern? How do you decide?

(b) Find a model, which tells us the approximate number of bacteria in the beaker at any time after the initial batch of bacteria was inserted to the solution. The beaker contains 95 milliliters of solution. (Assume that the growing bacteria population takes up no extra space.)

(c) Interpret the two numbers which appear in the model you found in (b).

(d) By what percentage does the population seem to grow every 15 minutes?  
   (i) according to the data? (How would you decide this - directly from the data!?)  
   (ii) according to the model? (How can you figure this out from the model?)
What will happen to the bacteria population in the long run? Can it continue to grow exponentially? The population will run out of space and nutrients!! So what will the later growth look like? Will the population grow exponentially until the test tube is "full"? And then what? The bacteria experiment continued...

Here is more data:

<table>
<thead>
<tr>
<th>time (minutes)</th>
<th>0</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>75</th>
<th>90</th>
<th>105</th>
<th>120</th>
<th>135</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td># bact. per ml (billions)</td>
<td>4.6</td>
<td>6.0</td>
<td>7.6</td>
<td>10.8</td>
<td>15.1</td>
<td>21.5</td>
<td>27.9</td>
<td>34.5</td>
<td>41.0</td>
<td>45.0</td>
<td>48.8</td>
</tr>
</tbody>
</table>

And here are some graphs to help with discussion:

Data only (all data)  
Data and exponential model which was fit to first six points  
Data and logistic model fit to the whole data set