1. **What is the prior probability of cancer?**
   Posterior distribution:
   probability ("Cancer") { //1 variable(s) and 2 values
   table
   0.5320600000000001 // p(true | evidence)
   0.46794; // p(false | evidence);
   }

2. **What is the probability of smoking given cancer?**
   Posterior distribution:
   probability ("Smoking") { //1 variable(s) and 2 values
   table
   0.4066458670074804 // p(true | evidence)
   0.5933541329925196; // p(false | evidence);
   }

3. **What is the probability of smoking given cancer and radiation?**
   Posterior distribution:
   probability ("Smoking") { //1 variable(s) and 2 values
   table
   0.39130434782608703 // p(true | evidence)
   0.6086956521739131; // p(false | evidence);
   }

4. By the concept of d-separation of common cause, the radiation and smoking are no longer independent of each other. This causes the radiation to affect smoking in a pronounced manner and subsequently reduces the effect of observing cancer on the probability of smoking.

5. The Markov Blanket of Yellow fingers includes "Smoking".
6. No, solar flares and using the microwave are not independent. Because they have a descendent ("Cancer") of their common effect ("Radiation") as an observed variable.

7. What is the probability of cancer if you never use a microwave?
   Posterior distribution:
   probability ("Cancer") { //1 variable(s) and 2 values
   table
   0.2554 // p(true | evidence)
   0.7446; // p(false | evidence);
   }
8. The model for predicting lung cancer should also incorporate the effect of Age as found in different sources. Another reason that can affect lung cancer is passive smoking that is inhaling

the smoke from other smokers. The other sources include Exposure to Radon, Exposure to Asbestos, Air Pollution, Tracing instances of lung cancer in family tree .

PROBLEM 2

Given that Louis had the disease the probabilities that all other mice are carriers (pd) of the disease is:

Alice: 0.020362684391958
Bob: 0.6241264848708957
Cindy: 0.38035713725489867
Dave: 0.018797572033354353
Ellen: 0.01800913197300494

Fred: 0.44898047861121004
Gwen: 0.8052217172230584
Henry: 0.38575306010385696
Iona: 0.6254948280717493

John: 1.0
Katherine: 1.0

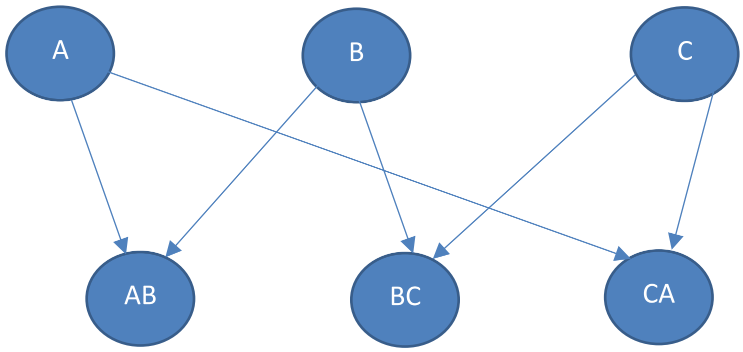
It is observed in the first generation that Bob has a higher probability of being a disease carrier because he is the parent of both lineages leading to Luis.

In the second generation Henry seems to have the least probability because his parents' probability of carrying the disease is less compared to other parents.

It is obvious about that John and Katherine are carriers of the disease because it is already observed that Louis, their immediate child is diseased which is only possible if the parents are both carriers of the disease.

PROBLEM 3:

1.



Here I have denoted the 1st set of nodes as the teams and the second set of nodes as outcomes. The reason for using these set of variables is that there are uncertainties in these variables. For example we do not know what is the probability that a particular node in the 1st layer namely A, B and C have as their quality. So we will have to create a prior on them in the Bayes Network. For the next set of variable like ***AB, BC and AC, we will have outcome of the teams A, B and C respectively*** distributed over wins, loses and draws. So we will get a Bayes network on that. Each such variable will have 16 conditional probability distribution since each node from the above layer has 4 possible outcomes. So a pair of teams can have 16 possible outcomes.

2.

Quality of Team A(B/C)	Probability
0	0.25
1	0.25
2	0.25
3	0.25

Team1	Team2	P(Team1Win)	P(Team1Loose)	P(Team1Draw)
0	0	0.3	0.3	0.4
0	1	0.2	0.5	0.3
0	2	0.1	0.7	0.2
0	3	0.0	0.9	0.1
1	0	0.5	0.2	0.3
1	1	0.3	0.3	0.4
1	2	0.2	0.5	0.3
1	3	0.1	0.7	0.2
2	0	0.7	0.1	0.2
2	1	0.5	0.2	0.3
2	2	0.3	0.3	0.4
2	3	0.2	0.5	0.3
3	0	0.9	0.0	0.1
3	1	0.7	0.1	0.2
3	2	0.5	0.2	0.3
3	3	0.3	0.3	0.4

Here Red represents that Team1 has a lower quality
Here Green represents that Team1 has a higher quality
Here Blue represents that Team1 and Team2 have same quality

3. Posterior distribution:

```
probability (  "BC" ) { //1 variable(s) and 3 values
	table
		0.36249999999999993  // p(win | evidence )
		0.36250000000000004  // p(loss | evidence )
		0.27499999999999997; // p(draw | evidence );
}
```

This answer does not make much sense because we have no information about which team is better beforehand. That is why the probability of winning and losing for B is same just like a prior with the only exception that there is a certain chance of a draw.

4. Posterior distribution:

```
probability (  "BC" ) { //1 variable(s) and 3 values
	table
		0.2853448275862069    // p(win | evidence )
		0.44051724137931036  // p(loss | evidence )
		0.2741379310344828;   // p(draw | evidence );
}
```

This result makes sense because if A beats B, it means that B is does not have a uniform prior over winning , losing and drawing. In fact B is probably weaker than C because B has been beaten by A. With the prior over A and C being same it hints that C has a better chance of beating B. Now, A is no longer d-separated from BC because node AB has been activated. So there is a path from A to BC through A>AB>B>BC.

5. Posterior distribution:

```
probability (  "BC" ) { //1 variable(s) and 3 values
	table
		0.2616352201257862    // p(win | evidence )
		0.46540880503144655  // p(loss | evidence )
		0.27295597484276735; // p(draw | evidence );
}
```

Yes, this data also makes sense because in that case it can be inferred that A and C are of similar quality and since A has beaten B, B is of a lower quality than A and hence C. This proves that in the game between B and C, B has even a lesser chance of winning compared to the case in the previous problem where the game between A and C was not observed.

6. Posterior distribution:
   ```
   probability (  "A" ) { //1 variable(s) and 4 values
       table
               0.09433962264150943  // p(0 | evidence )
               0.2075471698113208   // p(1 | evidence )
               0.3207547169811321   // p(2 | evidence )
               0.37735849056603776; // p(3 | evidence );
   }
   ```
   Posterior distribution:
   ```
   probability (  "B" ) { //1 variable(s) and 4 values
       table
               0.4150943396226416   // p(0 | evidence )
               0.2924528301886793   // p(1 | evidence )
               0.18867924528301888  // p(2 | evidence )
               0.1037735849056604;  // p(3 | evidence );
   }
   ```
   Posterior distribution:
   ```
   probability (  "C" ) { //1 variable(s) and 4 values
       table
               0.18081761006289312  // p(0 | evidence )
               0.2531446540880503   // p(1 | evidence )
               0.2908805031446541   // p(2 | evidence )
               0.27515723270440257; // p(3 | evidence );
   }
   ```

   The observed nodes AB and CA indicate that B is more of a team with lesser quality than either of A and C.
   The reason why A has better probability of being a higher quality than C is because it has already played two matches against B and C here one of the matches is a win .On the other hand C only has 1 draw out of 1 match. This causes A to have a higher probability of being better quality.

7. No numerical calculations are required because C will have a uniform distribution over its quality because C is d – separated from both A and B since node BC is not activated.
   Posterior distribution:
   ```
   probability (  "C" ) { //1 variable(s) and 4 values
       table
               0.25    // p(0 | evidence )
               0.25    // p(1 | evidence )
               0.25    // p(2 | evidence )
               0.25;   // p(3 | evidence );
   }
   ```

8. Posterior distribution:
   ```
   probability (  "AB" ) { //1 variable(s) and 3 values
   ```

```
    table
            0.275    // p(win | evidence )
            0.425    // p(loss | evidence )
            0.3;     // p(draw | evidence );
}
```

This distribution makes sense because we are considering the P(A=win) marginalized over all possible qualities of B each with a probability of 0.25. that is:

P(A=win) = P(A=w|B=0,A=1)P(B=0)+ P(A=w|B=1,A=1)P(B=1)+ P(A=w|B=2,A=1)P(B=2)+ P(A=w|B=3,A=1)P(B=3) = (0.25*0.5)+(0.25*0.3)+(0.25*0.2)+(0.25*0.1) = 0.275

Essentially it means that since A does not have a prior over its quality and A's quality is more on the lower side i.e. 1, it implies that a game between A and B will be more in favor of B. Hence the distribution.