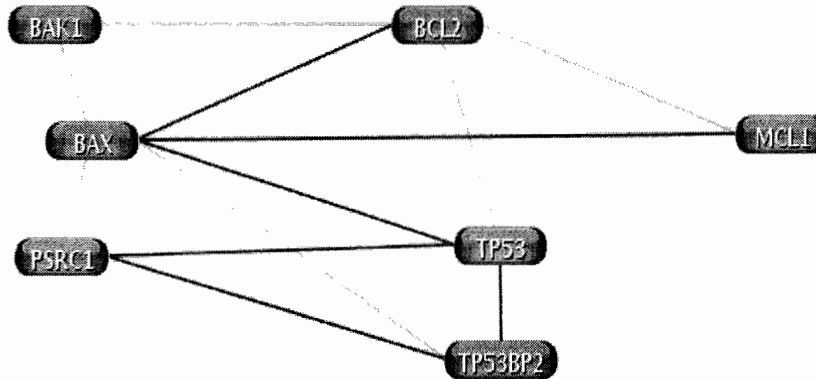


SCHOOL OF BIOLOGICAL SCIENCES  
MAJOR: 4<sup>TH</sup> MAY 2010 in WS-213 from 3:30 to 5:30 PM

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1. The figure below shows the interaction between different genes in *Homo sapiens* that play a role in apoptosis.
  - a) Prepare the adjacency and incidence matrix for these genes.
  - b) Define the terms walk, trail and path using one example from the figure below



**Fig 1.** Relationship between some of the apoptotic genes in *Homo sapiens*

(4+4+2+2+2 marks)

2. Discuss “real versus random networks”. Using the example of a transcription network in *E.coli*, having 424 vertices and 519 edges, prove that the *self edge* is a network motif. (5+5 marks)
3. Write down the equations describing the Coherent FFL with AND gate and discuss its role as a “persistence detector”. (5+5 marks)
4. Since FFL is a network motif, it is expected that all of the generalized structures should occur a significantly more number of times than random networks. However, only one of these generalizations is actually a motif. Why? (10 marks)
5. Discuss “robustness” in the context of pattern development. Use the *French Flag* model to describe how complex spatial patterns can form. (10 marks)
6. A morphogen is produced at both boundaries of a region of cells that ranges from  $x = 0$  to  $x = L$ . The morphogen diffuses into the region and is degraded at a rate  $a$ . What is the steady state concentration of the morphogen as a function of position? Assume the concentration at the boundaries is  $M(0) = M(L) = M_0$ . Under what conditions is the concentration of morphogen at the center of the region very small compared to  $M_0$ ? (6 marks)