COM3001, COM6003 Assignment 1

You will carry this out in teams – mostly of three.

The principle purpose is to take an existing FLAME model and top use it as the basis for some virtual experiments and to write this up as a scientific report. You will receive the FLAME code and some brief remarks about the background of the model and the sort of research questions being investigated.

You then have to do some background research into the scientific area involved, the sort of modelling that has been done before in this area and what discoveries – if any – that have been made using previous models.

There will be systems of the following types:

1) Molecular system – e.g. Oxygen in E. Coli; NFkappa-B system

2) Cellular and tissues systems – keratinocyte colonies etc.

3) Social insects – Pharaoh's ants

4) Economic systems – a Mall system.

Each group will be allowed to choose their preferred model.

The format of the report will be as follows:

Name of group – name of group's members.

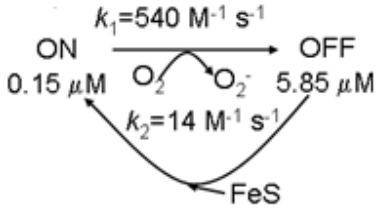
Title of investigation/model

E.coli Respiratory Adaptation Agent-Based Model

Background

The ability to sense and adapt to changes in oxygen concentration is critical to the survival of many organisms. In Escherichia Escherichia coli, the transcription factor FNR plays a central role in allowing the bacterium to adapt to changes in oxygen availability in its environment. When oxygen is limiting, FNR activates synthesis of many enzymes required to generate energy by anaerobic respiration and also represses synthesis of some enzymes involved in aerobic respiration. Since the levels of FNR do not significantly differ between aerobically and anaerobically grown cells, oxygen deprivation must modulate FNR dependent transcription by regulating the activity of FNR.
Concentration of FNR is similar in both aerobic and anaerobic condition; however its activity would change. Determining how oxygen regulates FNR activity should provide fundamental information regarding the strategies available to cells to sense changes in oxygen levels.

FNR contains an Fe–S cluster that is a redox sensor **(can sense oxygen directly)** and increases dimerization and DNA binding.



Most of *Mathematical Modelling* approaches have focused on describing biochemical, gene expression or signal transduction networks in terms of changes in cell-wide concentrations with time. Less attention has been paid to the fact that these processes are also occurring in space. In SUMO we will address how movement of molecules through the cell by applying *Agent-Based modelling technique.*

Each ***individual molecule*** represented as an ***autonomous agent*** that exists within the cellular environment and interacts with other molecules according to the biochemical situation. Molecules each have a location within the cell – some may be close to the membrane, others more uniformly distributed. Molecules can move through the cell and interact with each other when close enough and in a suitable state. The agent model consists of the following types of agents: oxygen, FNR and cell. Each agent communicates with the others via message passing. The binding of O_2 molecules has been modeled by interpreting the *k* rate suitably and dealing with FNR and the terminal oxidizes.

Contacts

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Section 1

Introduction to the subject area, the sort of modelling done previously – a brief literature survey, the sort of research questions examined and a defensible judgment on whether this modelling led to any new insights.

Section 2

An explanation of the main aspects of the supplied model – e.g. the agents involved, their messages and other key factors. The key parameters, distribution of agent types and so on.

Section 3

A new research question that could be explored using the model or a suitable adaptation of it. This could include questions relating to what happens if some parameters are changed, if the number of agents in the simulation is changed – how does that affect

things, or any other new agents that might be brought into the model. This should include a clear methods description – what has been changed and why.

Tasks:

i. Creating different 0.xmls for different oxygen availability based on values in the following tables.

Agent Name	Type	Number
cell	1	1
o2_mol	6	?
o2_comp	6	1
Fnr_mol	4	1500
Fnr_comp	4	1

#O2 level	conc DF dimerized (mole)	#DF dimerized (experiment)	conc Mfnr	#Mfnr (experiment)	# iterations to reach steady state	#Dfnr Agent Result
0	4.98173E-06	1500	0	0	?	?
150	4.48356E-06	1350	4.98173E-07	150	?	?
210	4.3175E-06	1300	6.64231E-07	200	?	?
600	3.07207E-06	925	1.90966E-06	575	?	?
3613	3.32116E-09	1	4.97841E-06	1499	?	?

ii: Changing kinetics parameters in **FnrFunctions.c** file**.**

```
22
23  float k_DFnr_o2=(223*3600);  //from on to off
24  float k_MFnr_o2=(0.01*3600);  //from off to on
```

Write your own research questions for exploring the model.

Section 4

Results of the simulation. A number of simulations should be run for each experiment – at least 10. the length of the simulation should be suitable – if it is too short interesting behaviour might be limited.

Section 5

Analysis of the results. Here simple statistics should be used – for example you could measure some parameters – e.g. relating to attributes of individual agents, or characteristics/properties of a population of agents etc. Express the results as graphs with error bars or other means to display the spread of results.

Section 6

Conclusions. The best way to do this is to define some hypotheses and to test them – can you accept or reject them to some suitable level of significance. Again a well argued statistical analysis is needed.

References

Group performance

A list of the contributions of each member of the group – their role – e.g. group leader (if there was one), statistical boffin, programmer, project planning, scientific literature research etc.

A signed statement as to how many hours each member contributed to the project.

Mark scheme. Out of 50.

Section	Marks
1	3
2	3
3	10
4	10
5	10
6	3
References	1
Group performance	10