Practice questions for CTO2 growth.

NB – these are not necessarily in the order of the lectures, so you should do the only after the last lecture and the computer workshop.

Feedback is given under each question – the questions are the same as in the document you just used.

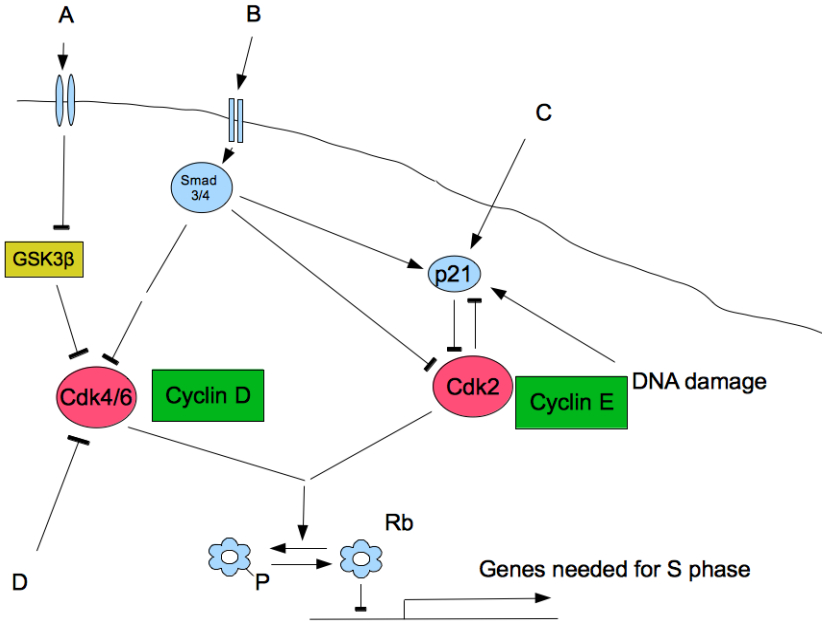
Q1 The healing of human wounds is a complex process involving many things. One important feature is stimulation of proliferation by cells that surround the wound, so that missing tissue can be replaced. One of the stimuli for skin (dermal) cell proliferation is the release of platelet-derived growth factor (PDGF) by platelets as they form a blood clot. In monkeys, there is a retrovirus that has picked up a copy of the simian PDGF gene, and incorporated it next to a strong viral gene promoter. When this virus infects cells and integrates into them (as retroviruses do), the PDGF gene of the retrovirus is therefore 'on' all the time. What would you expect to be the biological result of a monkey getting such an infection into its dermal cells?

a) Nothing
b) The monkey would be really good (fast) at healing wounds at or near the affected site
c) The monkey's platelets would be activated as they passed through the affected site
d) The monkey would develop a dermal sarcoma (a neoplasm of the dermis)
e) The monkey would develop platelet-type leukaemia (a neoplasm of the blood)

Feedback:

The correct answer is (d). As the question already told you, dermal cells are encouraged to divide if they receive PDGF, but they normally do this only when platelets release it (hence the name). If cells make it for themselves, they will be telling themselves to divide, whether there is any external need to or not. They will therefore grow as a tumour (neoplasm). (b) is a 'reasonable wrong answer' – but uncontrolled growth is not actually good at doing anything, compared to properly-regulated. Choosing (c) or (e) suggests a confusion – platelets are the source of PDGF: it does not act on them but on other cells. Platelet-type leukaemia is a made-up disease by the way – platelets have no nuclei and cannot divide.

Q2 The following diagram shows the influence of four factors (A-D) on progression through the G1-S transition of the cell cycle. The other named things are proteins we met in a very similar diagram in the lectures.



Factors A, B, C and D could each be things that are needed for entry to S phase to happen, or things that can block entry to S phase. By following the connections of the diagram, determine whether each factor encourages or inhibits entry to S phase, and choose the appropriate row from the tabel below.

	A	B	C	D
a	encourages	encourages	encourages	encourages
b	encourages	encourages	encourages	inhibits
c	encourages	inhibits	inhibits	encourages
d	inhibits	encourages	encourages	inhibits
e	inhibits	encourages	inhibits	inhibits
f	inhibits	encourages	encourages	encourages
g	inhibits	inhibits	encourages	encourages
h	encourages	encourages	inhibits	inhibits
i	encourages	inhibits	inhibits	inhibits

Feedback: The correct answer is 'i'. The genes will be on only if Rb is phosphporylated, and it will be only if either of the cdk complexes is active. Cdk2 is inhibited by p21, and C is shown activating p21, so c must be an inhibitor of S phase gene expression. D is shown directly inhibiting cdk4/6, and B does the same thing via Smad ¾. GSK3B does this too, but its inhibition is in turn inhibited by A, so A has the net effect of allowing S phase gene synthesis. Just follow the arrows... (to complete the biological picture, A = growth factors, B = TGFb, C = crowding, D = low ATP). You probably discovered that these questions are easier if you sort out the answer 1st and then find it in the table, than if you try to engage with a complex table before you have got the answer.

Q3: Condensation (aggregation together) of cells prior to making something new is a common feature of animal development. The accumulation of cells should last long enough for there to be enough cells to make the new thing, but not any longer or too many will be there. One way that cells might arrange this is by each secreting a small amount of a substance ('X') that diffuses poorly through tight aggregates of cells: cells move on to the next phase of development when the local concentration of substance X around the cells reaches a threshold. A researcher investigating a system she thinks works this way has identified X and has developed two drugs, drug M that mimics the action of X on cells, and drug I that inhibits the action of X. If she is right about cells judging when they have formed a large enough aggregate by the local concentration of X, what effect would these drugs have;

a) Both drugs would cause abnormally small aggregates of cells to attempt to move on to the next stage of development

b) Both drugs would cause over-large aggregates to form

c) Drug A would cause abnormally small aggregates to attempt to move on to the next stage, while drug M would cause abnormally large aggregates to form.

d) Drug M would cause abnormally small aggregates to attempt to move on to the next stage, while drug I would cause abnormally large aggregates to form.

e) Neither drug would have any effect on the system

Feedback: the correct answer is (d). Drug M would mimic X, so cells would think that they were in a large aggregate making lots of X, and drug I would 'deafen' even cells that really were in a large aggregate to X so they would never know and would just keep expanding the aggregate. (Once you understand this, you can quickly work out why the other answers were wrong).

Q4: A partonomic hierarchy of body components could be stated as follows:

body
organs
tissues
cells
molecules
atoms

If one compares large and small animals (for example a Great Dane dog and a terrier dog, or an adult Great Dane and a Great Dane puppy), it is clear that the body has 'scaled up'. It is also clear that the atoms of a large dog are the same size as those of a small dog, so not every part of the dog scales with the body. Where, in the above hierarchy, does the boundary between things that scale, and things that do not scale, lie?

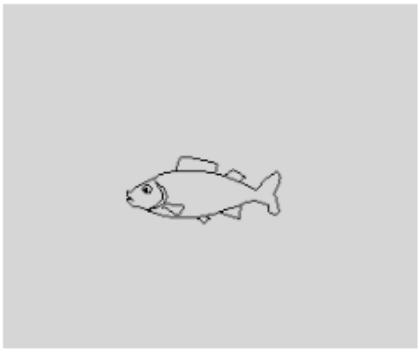
a) between organs and body
b) between tissues and organs
c) between cells and tissues
d) between molecules and cells
e) between atoms and molecules

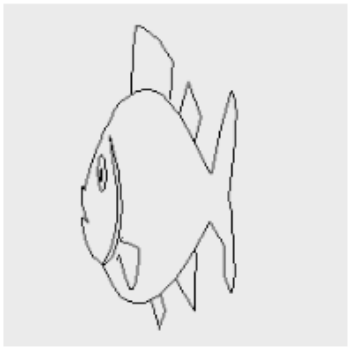
Feedback: The correct answer is c. Working from the bottom up, the sizes of atoms and molecules are set by their intrinsic properties and they do not scale. The size of cells are limited (as we considered at length in lecture one) by problems of diffusion and problems making enough proteins from just 2 copies of each gene (in a diploid animal like a dog). Therefore cells do not scale with body size either. Tissues and organs do, and they do so by larger tissues being larger by having more cells. If you got this wrong, was it because you did not understand the answer or because you did not understand the question? If the latter, good advice might be to slow down and make sure you understand every sentence before jumping in with the answers.

Q5: The left-hand image below shows the body of a grown fish, in which the rate of growth of a smaller ('starting') version of the fish, in the dorso-ventral plane, is given by the equation

growth = b + mx + e.exp(x) + s.sin(x) + r.y

(where y is the dorsoventral axis, x the cranio-caudal one, and all other letters are constants. To produce the fish on the left, b=1 and all other constants = 0).





The image on the right shows how the same initial fish turns out if ONE of the constants in the equation is increased (and the rest are the same) Which one must it be?

1) b is increased
2) m is increased
3) e is increased
4) s is increased
5) r is increased
6) x is increased

Feedback: The correct answer is (1) – constant b is increased. If you just look at the image, you will see it has been stretched linearly with all parts of the fish along the head-tail axis being affected equally much. Increasing either m or e would have made the effects weak at the head end and stronger towards the tail. Increasing s would produce some weird periodic effect. Increasing r would stretch things more the higher they already are, producing a fish with a very high fin and a comparatively flat ventral surface. If anyone suggested that x has changed, they should recognize that they really don't understand how equations work, and they need to revise basic maths quickly. Note also that this question came from the computer practical, which included a lot of material that also appears in the learning outcomes and is examinable. You may also realize that a lazy examiner can create very many questions of the type above, just by choosing to increase different constants and grabbing a screenshot.