Constructive teaching and biology

IJsbrand Kramer
IECB
i.kramer@iecb.u-bordeaux.fr

The constructivist theory

may be summarized, as follows:

1. Learning involves the active construction of a conceptual knowledge base

2. Learning is reflective and builds on, and consolidates, existing knowledge

3. Learning benefits from multiple views of a subject area

4. Learning is facilitated by authentic activity; authentic resources, experiences and sharing (here is where Internet comes into play)

Two sections:

- what we teach
- what we assess

1. Learning involves the active construction of a personal, conceptual knowledge base

What matters here are:

- Clear objectives of the course
- The provision of an “all embracing” context
- A story to tell (rather than a list to learn)

2. Learning is reflective and builds on (and consolidates) existing knowledge

What has been taught at school or in previous university courses?

- good contact between colleagues essential
- what are the objectives of the institution (curriculum and attitudes)
- charismatic leadership needed to overcome hurdles
- exercise of scoring definitions, scientific concepts, setting benchmarks (cross referencing)
- labor intensive procedure

What is being taught in parallel courses?

- similar conditions and drawback

2. Learning is reflective and builds on (and consolidates) existing knowledge

But what have students picked up from these courses?

- spot test essential
- provide time and means (precise referral to course documentation) for students to catch up (synchronization)
- repeat information that has been provided in previous courses (part of the consolidation process)

2. Learning is reflective and builds on (and consolidates) existing knowledge

Too often university teachers consider teaching as the art of “having mentioned it once in the lecture (with an acceleration towards the end), having shown it once in a slide or written it once in the handout”

Too often lecture course are designed to cover the “whole subject” in order to be “complete”

Too often university courses bear very little interrelationship in particular when it concerns mathematics, chemistry and physics

2. Learning is reflective and builds on (and consolidates) existing knowledge

Too often curricula are constructed on the basis that “you first need the bricks before you can build the house”. This concept is flawed because bricks do not evaporate whereas knowledge is lost without frequent repetition (and from multiple points of view) (point 3)

Basic subjects are hardly every conceived as relevant by the students and this makes the lecture courses unsatisfying for both teachers (the burnout syndrome) and the students

2. Learning is reflective and builds on (and consolidates) existing knowledge

Basic subjects are not always taught within a context that is relevant to the situation in which they will be applied later in the curriculum (if ever)

And finally, most, if not all, biology teachers would fail the exams of a number of “basic subjects” (so what is the importance?)

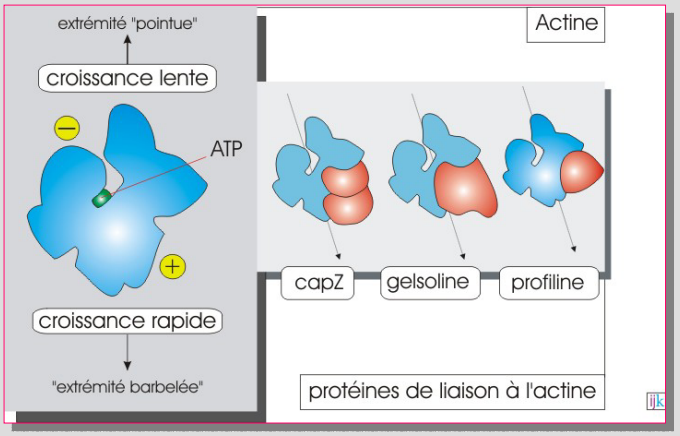
2. Learning is reflective and builds on (and consolidates) existing knowledge

Building on existing knowledge also applies within a lecture course and this is particularly true for examples chosen to illustrate certain principles or mechanisms of action.

For instance a basic course in cell biology: use the different chapters to return to proteins that have been treated before in the lecture course

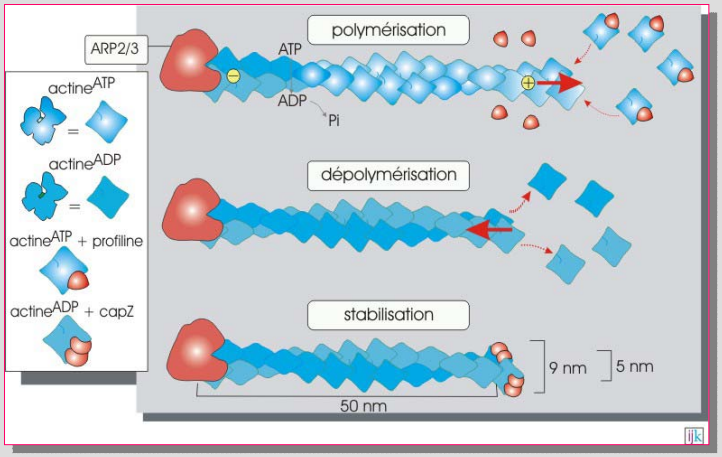
2. Learning is reflective and builds on (and consolidates) existing knowledge

Actin is an important component of the cytoskeleton



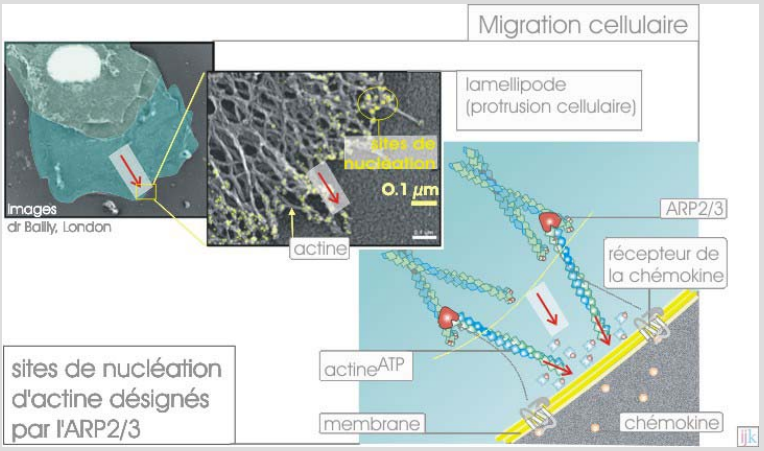
2. Learning is reflective and builds on (and consolidates) existing knowledge

Actin polymerizes (and textbooks explain it in a terrible theoretical way, with barbed ends, tread milling etc, but in real life there is always ARP2/3)



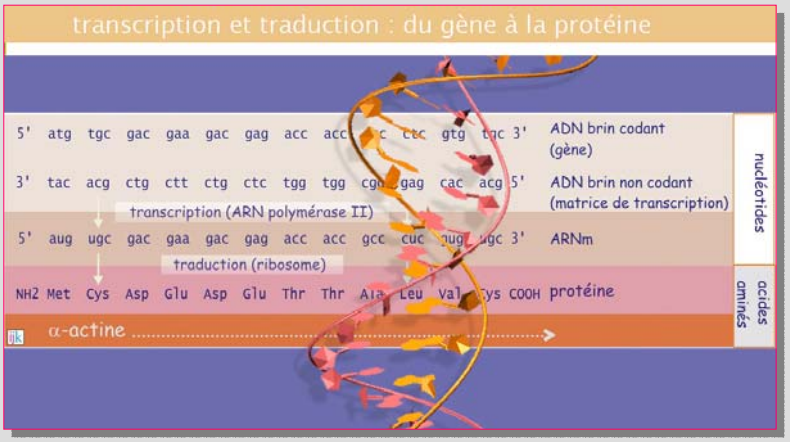
2. Learning is reflective and builds on (and consolidates) existing knowledge

Put the polymerisation of actin in a “real” context, for instance cell migration (relevant to the situation in which it will be applied)



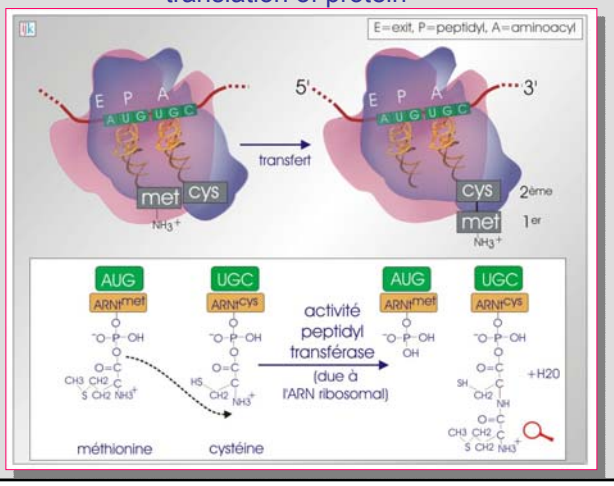
2. Learning is reflective and builds on (and consolidates) existing knowledge

If actin is so important, why not using it as an example to explain transcription and translation



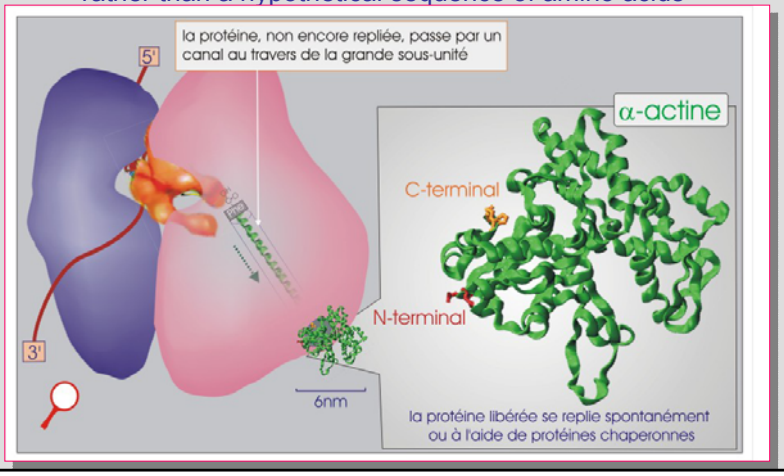
2. Learning is reflective and builds on (and consolidates) existing knowledge

And why not using the messenger of actin to illustrate translation of protein



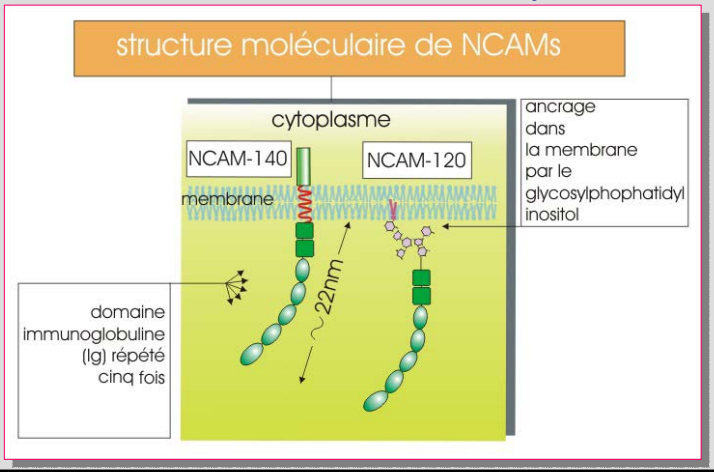
2. Learning is reflective and builds on (and consolidates) existing knowledge

And let the ribosome make actin, a real important protein rather than a hypothetical sequence of amino acids



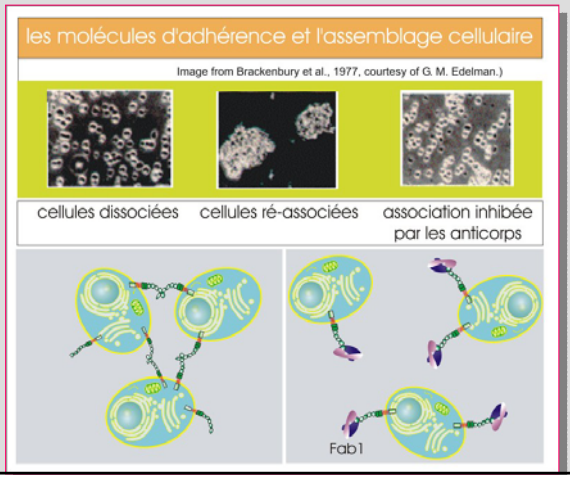
2. Learning is reflective and builds on (and consolidates) existing knowledge

Cell adhesion molecules are also important and much of current research deals with this subject



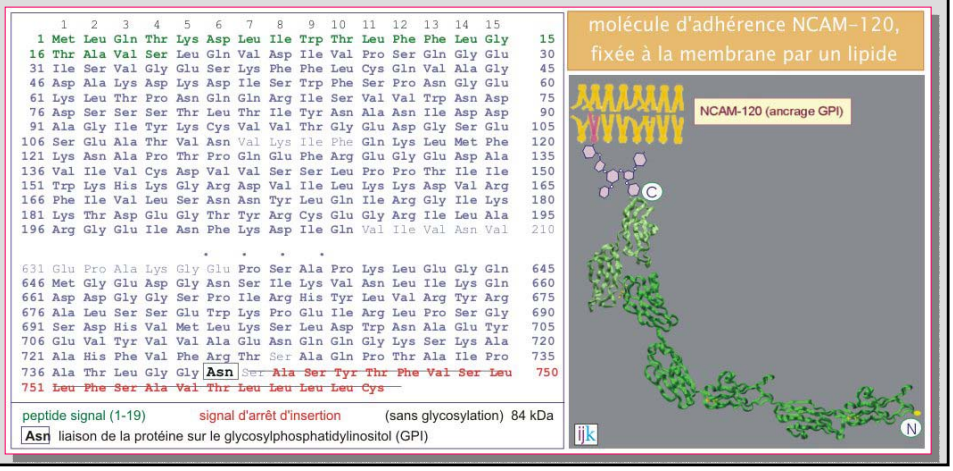
2. Learning is reflective and builds on (and consolidates) existing knowledge

Make sure to give it a (historical) context, for instance discovery of adhesion molecules in embryological development



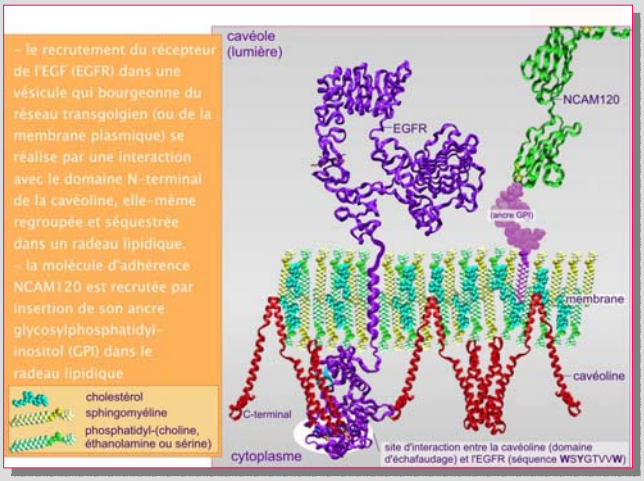
2. Learning is reflective and builds on (and consolidates) existing knowledge

And let the NCAM-120 come back when we talk about glycophosphatidyl inositol anchoring into the membrane



2. Learning is reflective and builds on (and consolidates) existing knowledge

And give NCAM-120 one more change when it comes to lipid rafts and the sequestration of protein into caveolin-coated vesicles

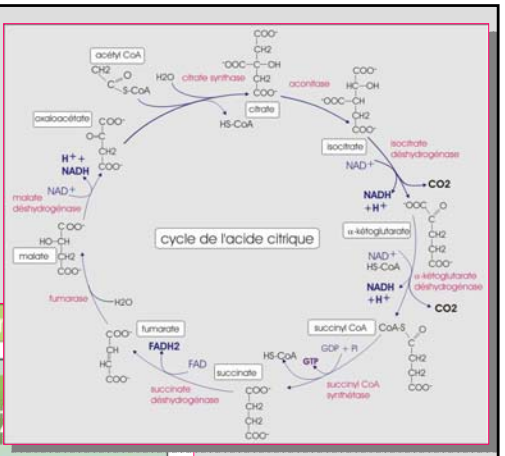


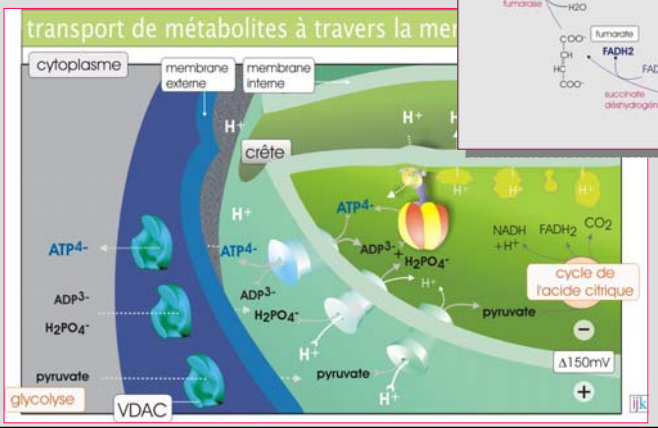
2. Learning is reflective and builds on (and consolidates) existing knowledge

Lastly, if students were taught the biochemistry of glucose metabolism or of the chemistry of macromolecular interactions (van der Waals forces, Pi-stacking or hydrogen bonds) return **explicitly** to these subjects when dealing with for instance insulin, mitochondria or the folding of DNA/RNA.

2. Learning is reflective and builds on (and consolidates) existing knowledge

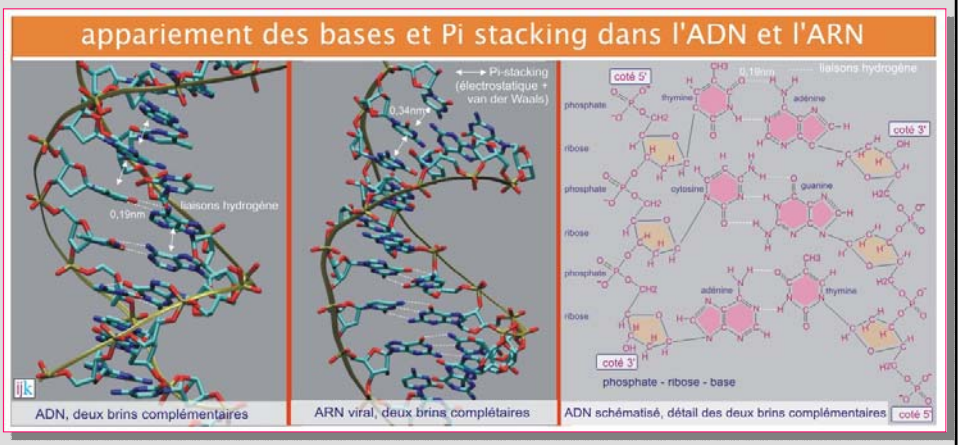
Repeat the (bio)chemistry courses when dealing with mitochondria and the production of ATP





2. Learning is reflective and builds on (and consolidates) existing knowledge

Repeat the (bio)chemistry courses when dealing with DNA or RNA



3. Learning benefits from multiple views of a subject area

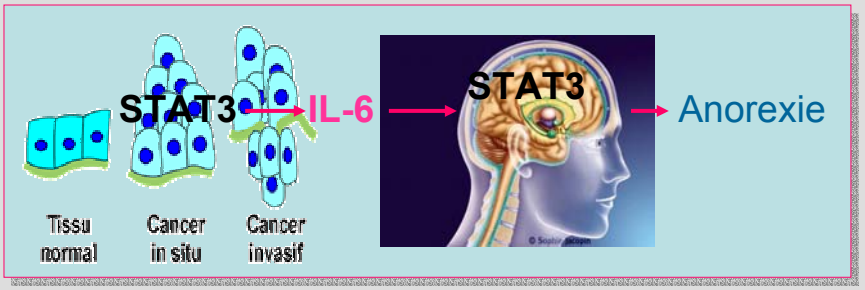
An integrated approach, which can be interpreted in two ways:

1. Treat the formation of NADH from a chemical point of view, based on reaction processes of the citric acid cycle, and from a biological point of view, based on the need to feed the electron transport chain with electrons in order to generate ATP

2. Treat cell transformation from a cell biology, signal transduction, pathology and chemotherapy point of view (more about this in the presentation of my “signal transduction” module)

3. Learning benefits from multiple views of a subject area

The advantage of an integrated approach is that it provides students an instant “story to tell”; the acquisition of knowledge makes sense (for the majority). It allows you to explain to an ill person why mutations cause cell transformation (although we still know little) and how this transformation causes cancer and why anorexia is one of the symptoms.



3. Learning benefits from multiple views of a subject area

Integrated or interdisciplinary approaches have drawbacks:

- it is more difficult to set standards for assessment
- students have a tendency, for reasons of efficacy, to ignore certain aspects entirely (they have their own agenda and this agenda is not always based on the interest in the subject, regardless how you present it).

4. Learning is facilitated by authentic activity

-Authentic activities have real-world relevance

-They are ill-defined (the students must define the tasks)

-They comprise complex tasks

-They offer the opportunity to examine the problem from a variety of -perspectives (and encourage an interdisciplinary approach)

- They offer the opportunity to collaborate

4. Learning is facilitated by authentic activity

-They are seamlessly integrated with assessment (real world assessment relevant to the nature of the task) (I will return to this in the assessment section)

-They culminate in the creation of a whole product rather than an exercise in preparation of something else (“in five years time you will understand why you had to learn all this”)

-They allow a range of outcomes rather than a single correct response (here is where the assessment trouble starts)

4. Learning is facilitated by authentic activity

a central component of course design consists of the design of complex activities and I hope that Betty Collis will enlighten us about this (in particular how to implement all this in “mass” teaching)

Two sections:

- what we teach
- what we assess

Important in assessment (evaluation) is standard setting:

- Content standards; what should students know and be able to do
- Performance standards; minimal requirement in order to pass (level of mastery)

Important is also that assessment resembles teaching and not a punishment, every form of assessment must have some “reward” (for both student and teacher)

What we want students to learn is not determined by what we teach but by what we assess

- Over the last 20 years I have not met a single university teachers who has put into question the methods of assessment
- Too often teachers give mixed messages to students, they teach one thing and assess another (lots of information serves as mere “decoration” of teaching courses.
- Assessment is time consuming and can be a discouraging exercise (in particular when the student numbers increase)

At a more macroscopic scale, meaning the level of a course curriculum, assessment should be linked to “benchmarks”

- These are statements of what students should know and be able to do at a specified time in the curriculum.

- Benchmarks are used to measure student’s progress towards meeting the competence standard

Evidence based teaching

Although we apply strict rules of experimental rigour to our scientific activities, when it comes to teaching we merely copy habits of our predecessors without much experimental validation

An important reason for this is that scientific output and quality are measured and rewarded by our institutions (and society), whereas teaching is not (impact factors and citation indexes do not exist).