Molecular methods and bioanalytics:

Introduction to the field and didactic approaches for Bachelor and Master level

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Ganz nah. Weit voraus.

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Estland
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Nordsee
Litauen
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Konya
Athen
Griechen-land
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Zypern
Beirut
Libanon
Syrien
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Chabarovsk
R u s s l a n d
1 Ungarn
2 Serbien
3 Slowenien
4 Bosnien-Herzegowina
5 Montenegro
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8 Liechtenstein
Astana
K a s a c h s t a n
Almaty
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Usbekistan
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Herat
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Lahore
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Karachi
Ulan-Bator
Mongolei
Wladiwostok
Sapporo
Nord Korea
P'yongyang
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Nepal
Thimphu
Bhutan
Bangla Desh
Dhaka
New Delhi
Jaipur
Agra
Indien
Kolkata (Calcutta)
Myanmar (Birma)
Mandalay
Nay Pyi Taw
Yangon (Rangoon)
Thailand
Bangkok
Vietnam
Kam-bodscha
Phnom Penh
Saigon
Golf von Bengalen
Mumbai (Bombay)
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Panaji (Goa)
Bengaluru (Bangalore)
Chennai (Madras)
Kochi (Cochin)
Sri Lanka
Colombo
Sri Jayawardenpura (Kotte)
Male
Malediven
Südchinesisches Meer
Manila
Philippinen
Cebu
Guam (US)
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Palau
Melekeok
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Denpasar
Ujung Pandang (Makassar)
Jayapura
Papua N
Dili
Kupang
Timor-Leste
Port Mo
Darwin
Broome
Cairns
Alice Springs
A u s t r a l i e n
Perth
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Al-Basrah
Bandar Abbas
Bahrain
Al-Manamah
Qatar
Doha
Dubai
V.A.E
Abu Dhabi
Masqat (Muscat)
Oman
Salalah
Ar-Riyad (Riyad)
Saudi Arabien
Makkah
Jemen
San'a
Aden
Arabisches Meer
Tunis
Valetta
Malta
Tunesien
El Djazair (Algier)
Gibraltar(GB)
Rabat
Casablanca
Marokko
Mittel-meer
Tripoli
Benghazi
Libyen
Kairo
Suez
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Ägypten
Luxor
Assuan
Algerien
Kanarische Inseln (Sp.)
El-Aaiún
West-Sahara
Mauretanien
Nouakchott
Mali
Timbuktu
Niger
Tschad
Sudan
Bur Sudan
Rotes Meer
Al-Khartum (Khartum)
Asmara
Eritrea
Djibouti
Senegal
Dakar
Gambia
Banjul
Bissau
Guinea
Bamako
Burkina Faso
Niamey
Ouagadougou
Nigeria
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Conakry
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Golf von Guinea
Kamerun
Malabo
Jaunde
Äquatorial-guinea
Zentral-afrikanische Rep.
Bangui
Südsudan
Juba
Äthiopien
Addis Abeba
Somalia
Uganda
Kampala
Kenia
Nairobi
Lodwar
Muqdisho (Mogadishu)
São Tomé
São Tomé & Principe
Libreville
Gabun
Kongo
Demokr. Rep. Kongo
Brazzaville
Kinshasa
Cabinda (Ang.)
Ruanda
Kigali
Burundi
Bujumbura
Dodoma
Tansania
Mombasa
Zanzibar
Dar Es Salaam
Seychellen
Victoria
Äquator
Komoren
Moroni
Luanda
Angola
Sambia
Lusaka
Malawi
Lilongwe
Harare
Simbabwe
Beira
Mosambik
Madagaskar
Antananarivo
Mauritius
Port Louis
Réunion (Fr.)
Namibia
Windhuk
Botsuana
Gaborone
Tshwane/ Pretoria
Johannesburg
Maputo
Mbabane
Swaziland
Maseru
Lesotho
Durban
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molecular methods and bioanlytics

What are molecular methods?

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- used in molecular biology, biochemistry, genetics and biophysics which generally involve manipulation and analysis of DNA, RNA and proteins
- Application fields: diagnostics, ecology, strain development, basic biological research, …

Method types

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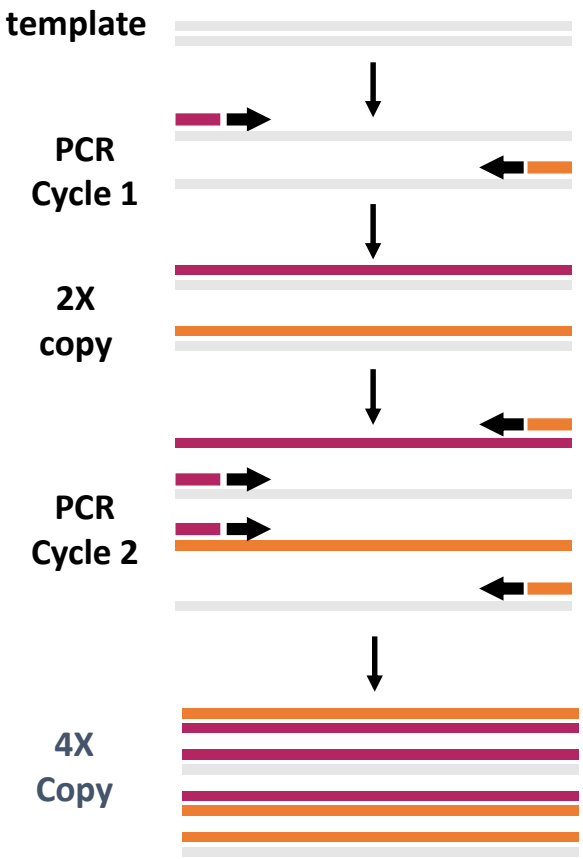
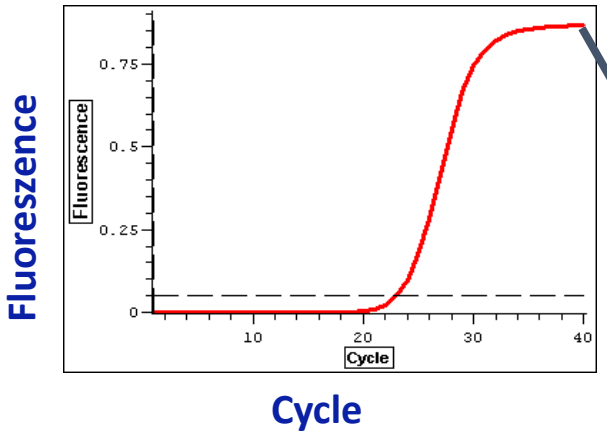
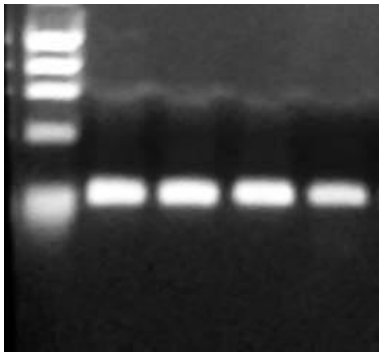
- Amplification techniques – PCR and its modifications
- Blot hybridisation techniques – Southern blot, Dot blot, RFLP Northern blot Western blot
- Hybridization techniques – In situ hybridization FISH and its modifications, Microarray
- (Immunological methods)

PCR: principle







Agarose gel

20-40 reaction cycles

Amplification: PCR based methods

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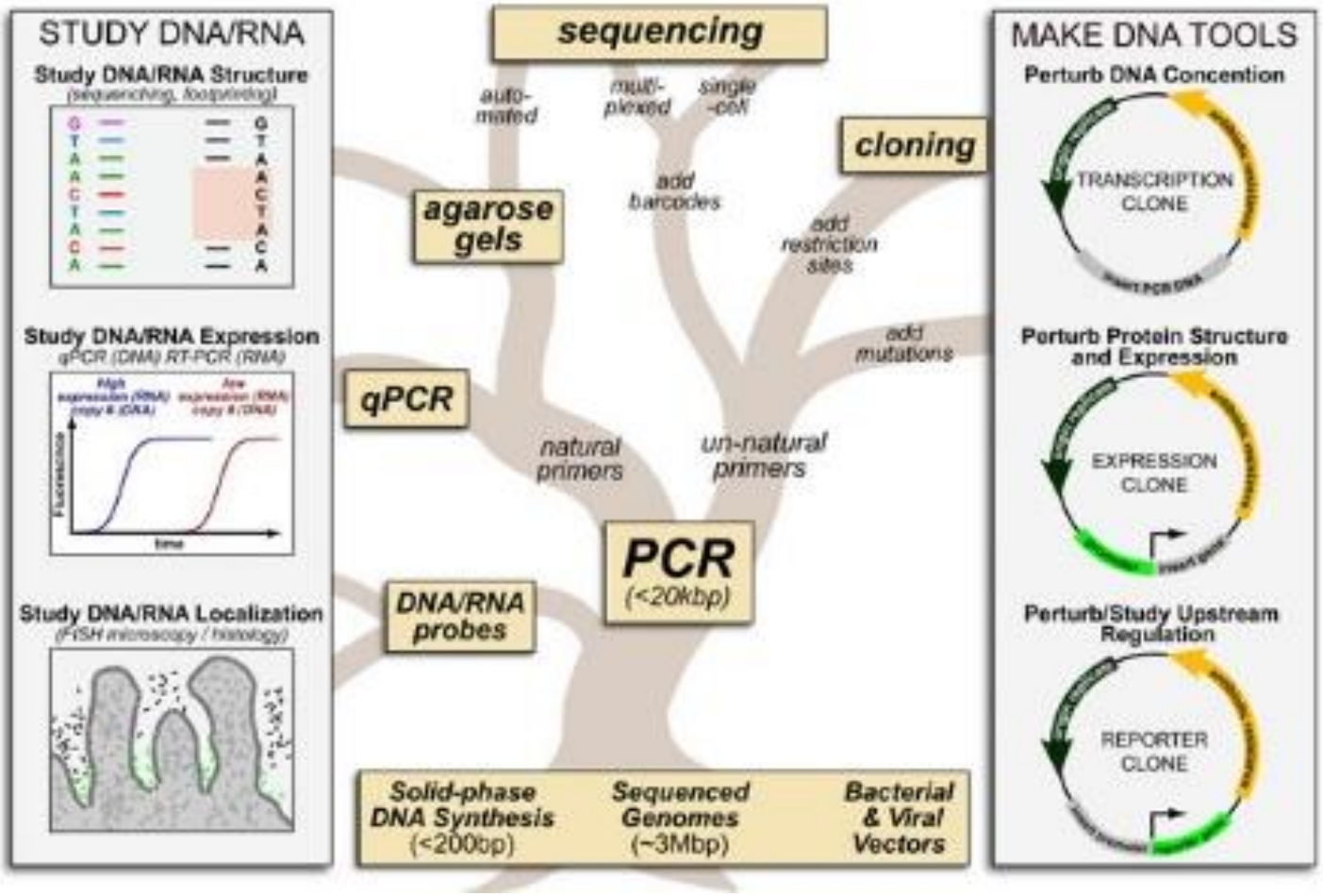
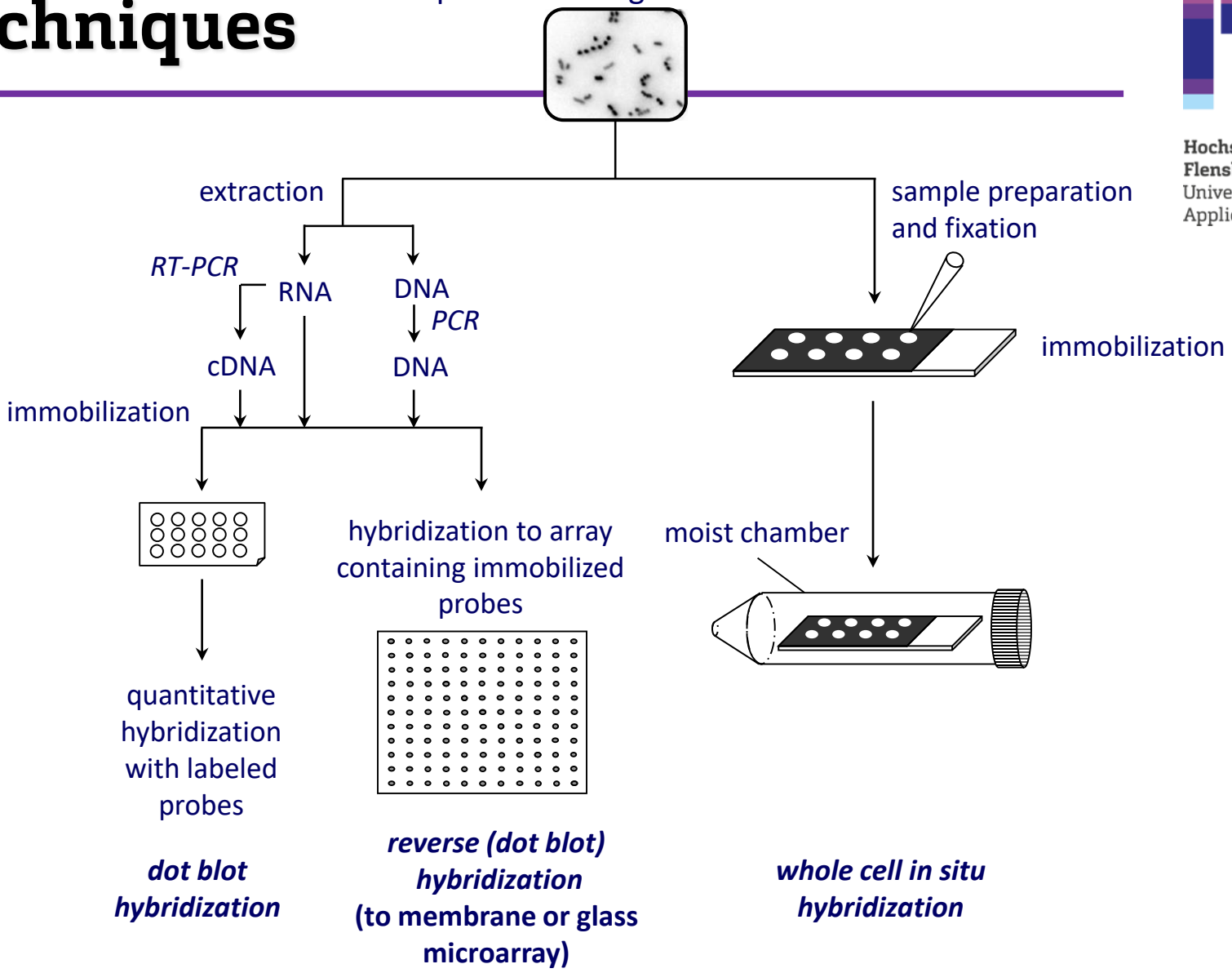


Hybridisation techniques



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Source: Lipski, A., U. Friedrich, and K. Altendorf. 2001. Appl Microbiol Biotechnol **56:**40-57.

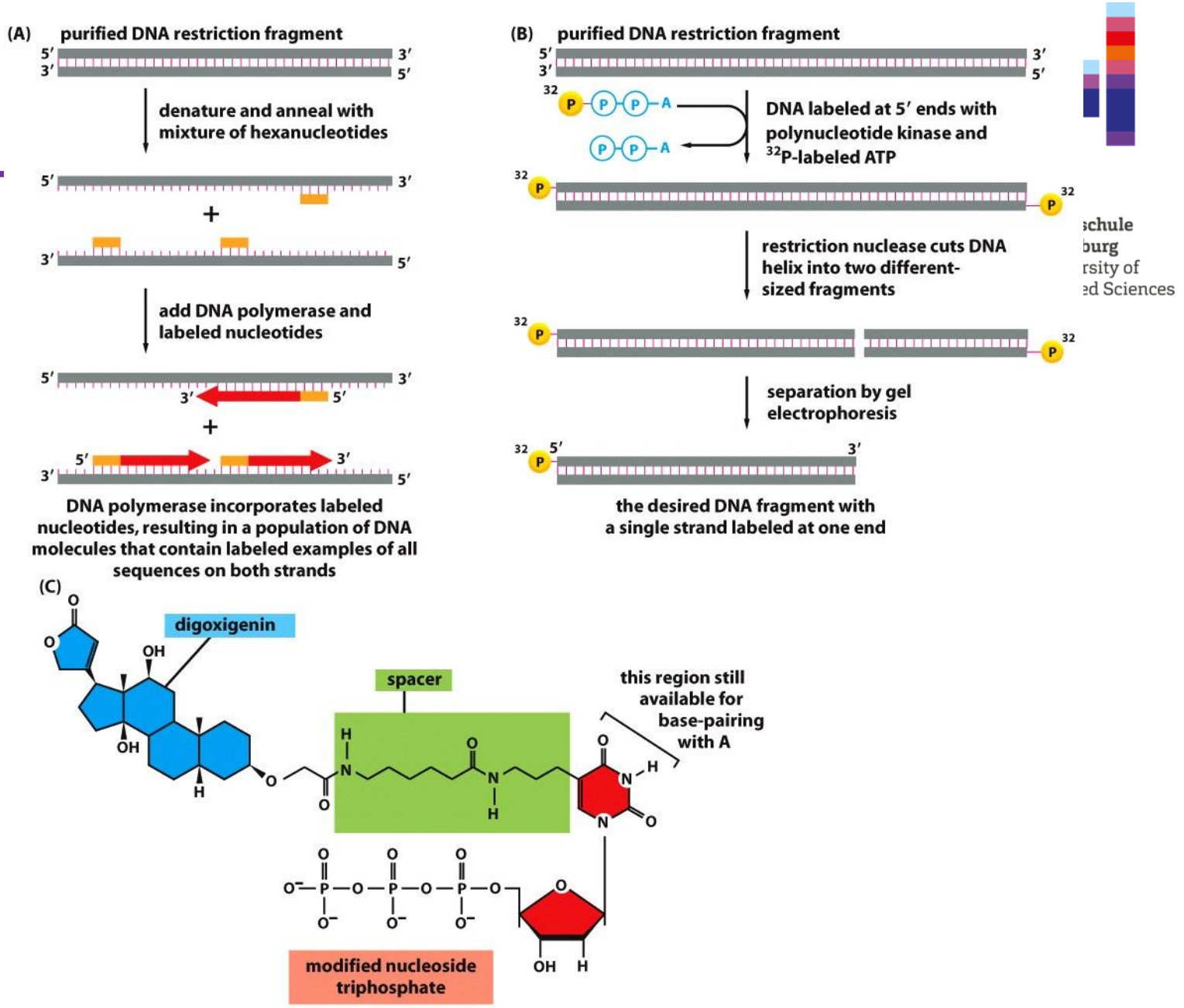
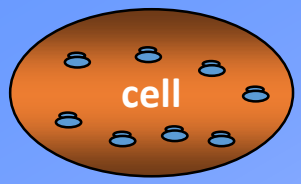
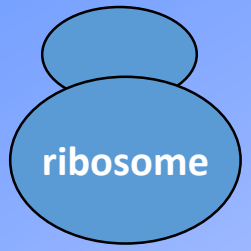
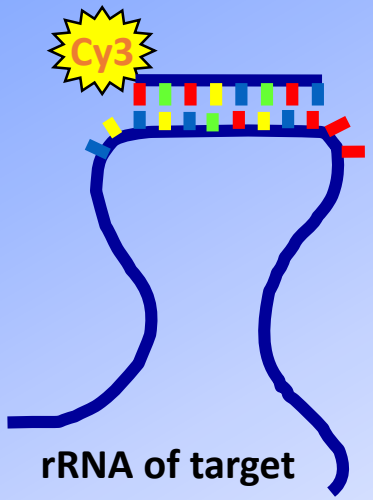


Figure 8-34 *Molecular Biology of the Cell* (© Garland Science 2008)

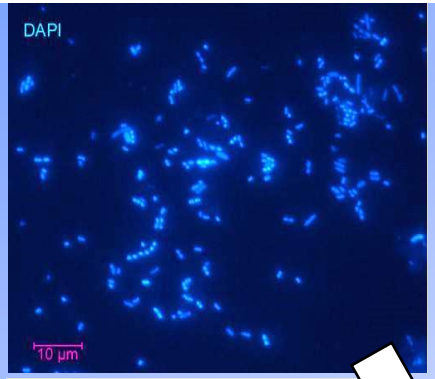
FISH (Fluorescence in situ hybridisation)

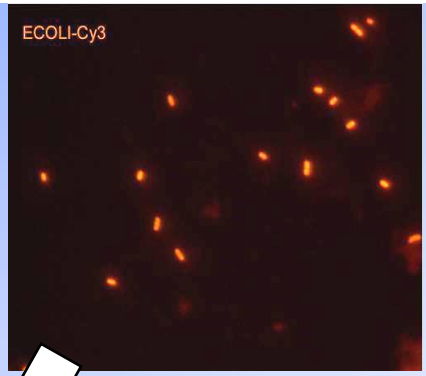


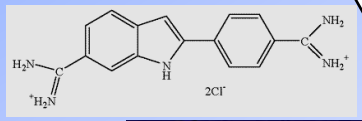




rRNA of target organism







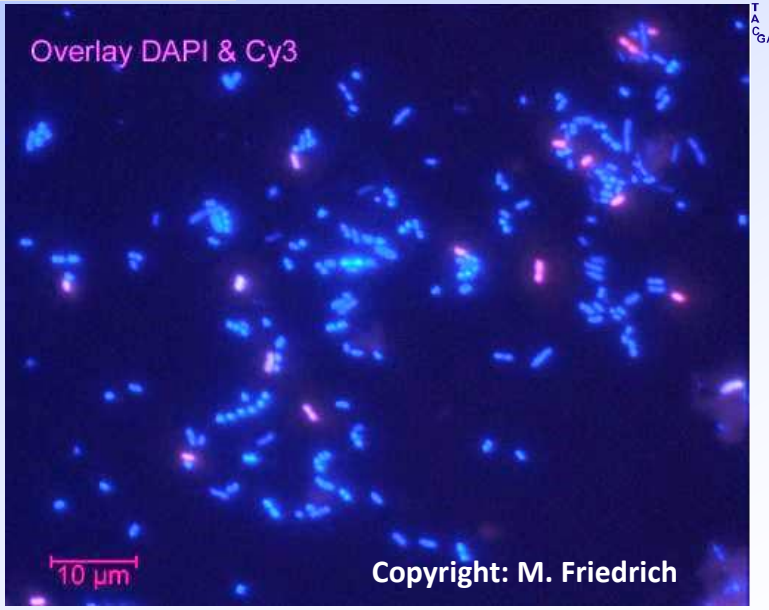


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Figure 8-35 *Molecular Biology of the Cell* (© Garland Science 2008)

Combinations

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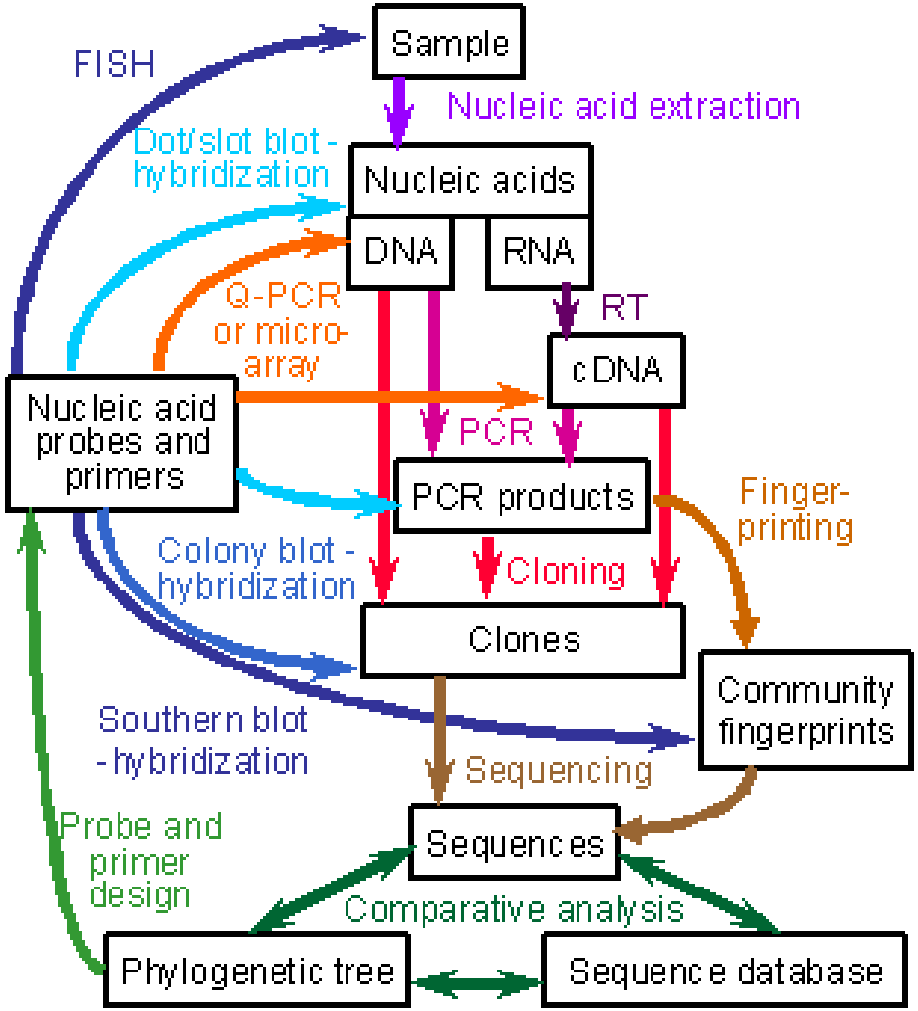

Example: functional microbiom description

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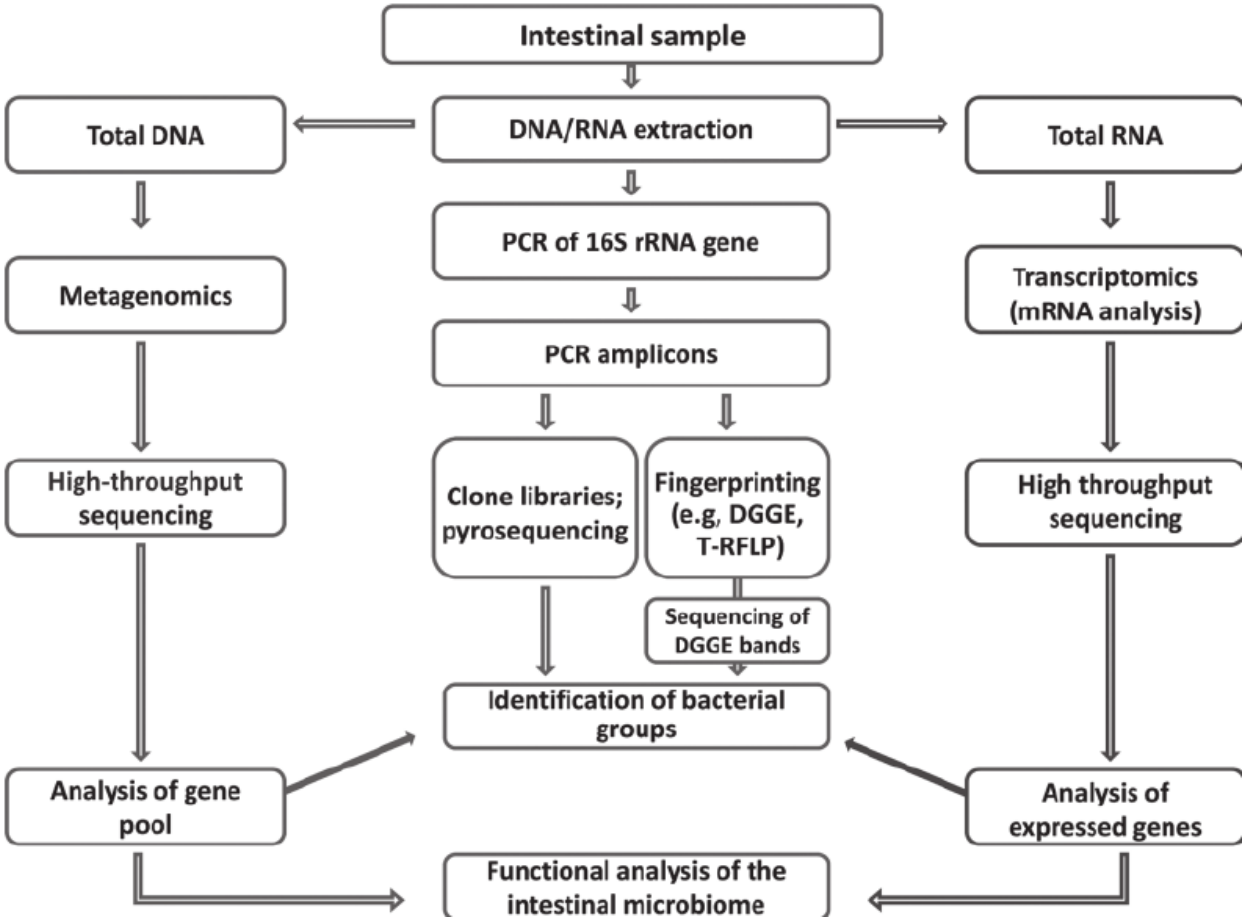

Advantages & disadvantages

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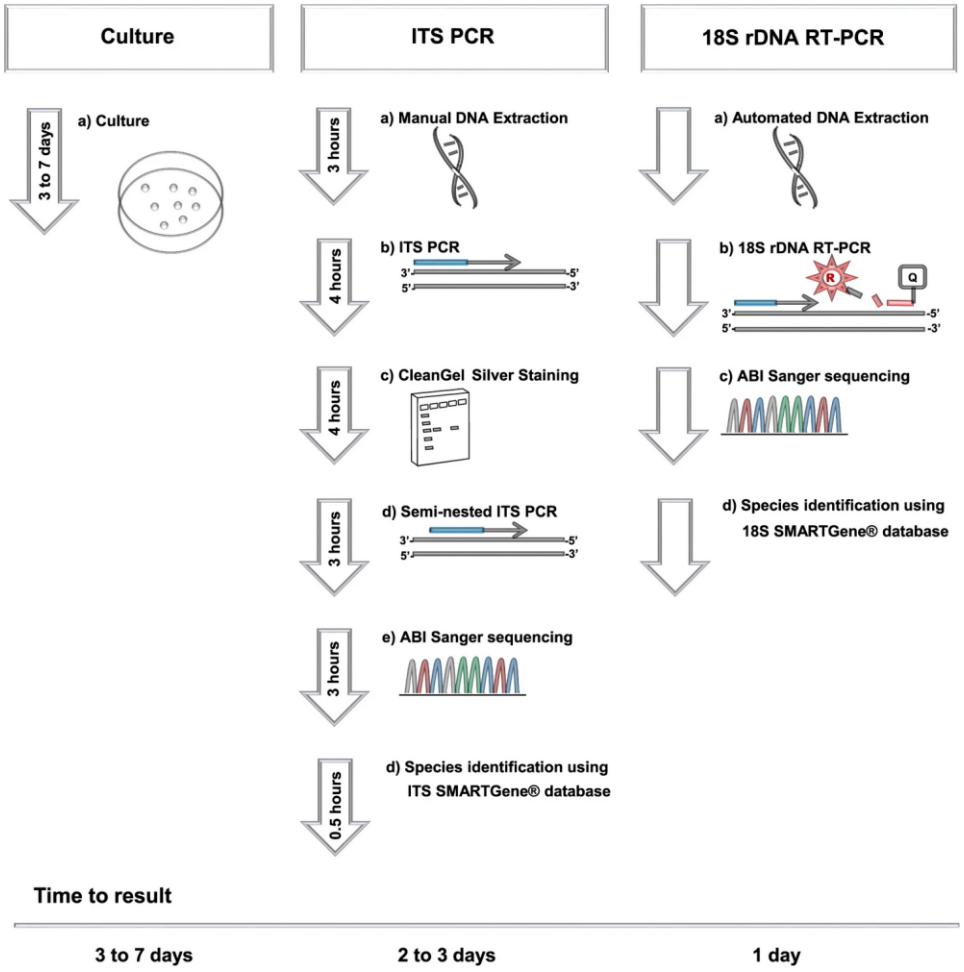

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Teaching molecular methods

Teacher vs. Student oriented aims

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Why teaching molecular methods?

- What shall students know?
- What are their competences?
- What is of importance to understand?

Why learning molecular methods?

- What is the benefit of knowing it?
- What will I need for my job?
- How can I use it?

Aligning Teaching and Learning Methods with Intended Learning Outcomes

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- When selecting any teaching and learning method it is obviously important to ensure that the method will enable the students to achieve what are intended as learning outcomes. There are different kinds of methods available. Some of them are more effective in building up subject knowledge while some make more contribution to developing generic skills.

- Q: From your point of view, what are the needs in molecular methods?

B. Sc. Study Programme
Bio-, Food and Process Engineering

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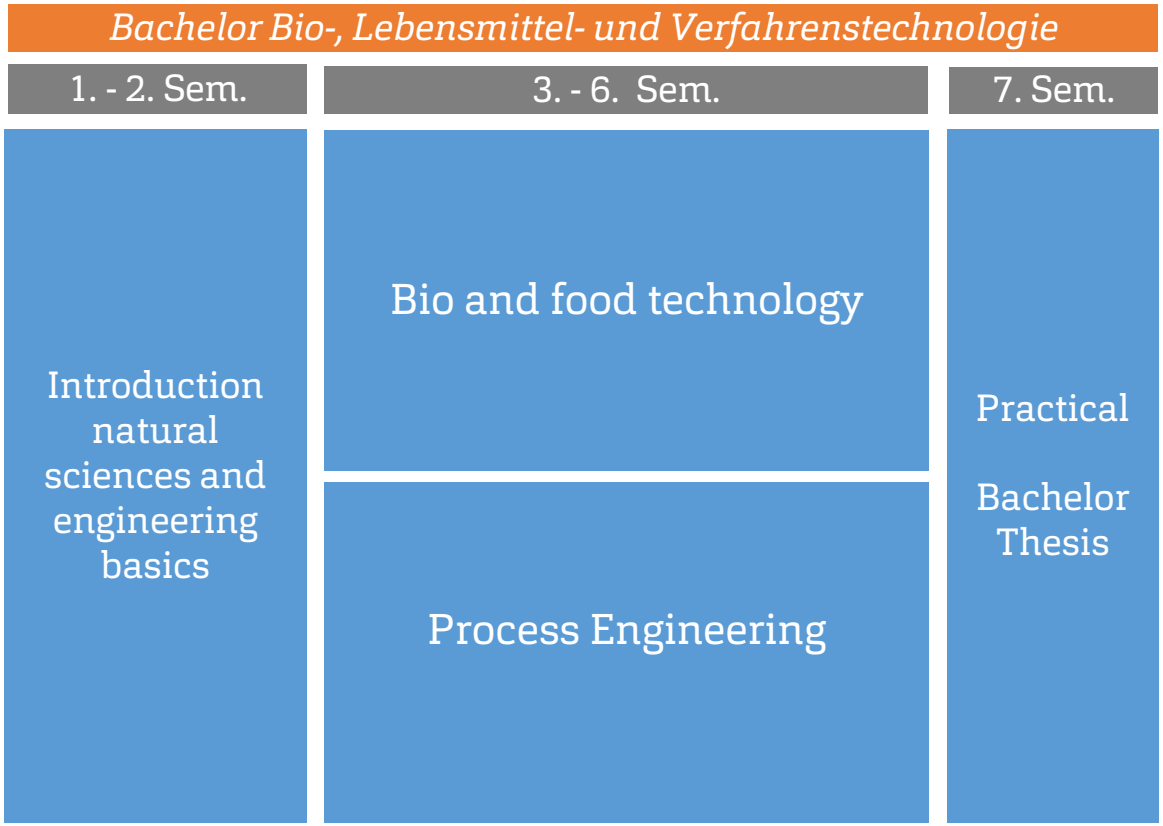

- 80 students
- Full time (210 CP)
- Specific study lines:
  - Bio- & Food technology
  - Process Engineering
- BSc thesis in cooparation with companies of the region (appr. 90%)

Study programme Applied Bio and Food Sciences (Master)

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Master Applied Bio and Food Sciences

1. Semester	2. Semester	3. Semester
Theorie-betonung Advanced Process Engineering, Industrial Food Processing, Production Organisms, Product Innovations, Elective Course	Projekt-arbeit Research Proposal, Project Theory, Team Project, Scientific Conference	Master-Thesis

- Natural Sciences and Technology
- Sectors: Food, Pharma, Cosmetics
- German/English/ Integration of international students in 2nd Semester
- Full time or dual
- 90 CP

Pharma

Cosmetics

Food

Application field	Product development, innovation	Quality management	Process	Research
Topics	Cell cultures, aquaculture, proteins, genetic modification	Applied product analytics, microbial risks	Fermentation, cell culture, bio process eng., HACCP,	New assay systems, metabolic pathways and their regulation
Skills	Project management, creativity	Data curation, management, compliance	Analyse processes, LCA	Analytical thinking, scientific writing and presentations

Teaching molecular methods

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- Big ideas
  Holistic systems biology
  Interaction of molecules as the basis for functionality

- Experimental approaches
  - Handling bio molecules
  - Sequencing
  - Instrumental analytics

- Current controverses
  - No technique fits all

- Non-solved questions
  - Systems complexicity
  - Data handling

Proportion knowledge/competencies

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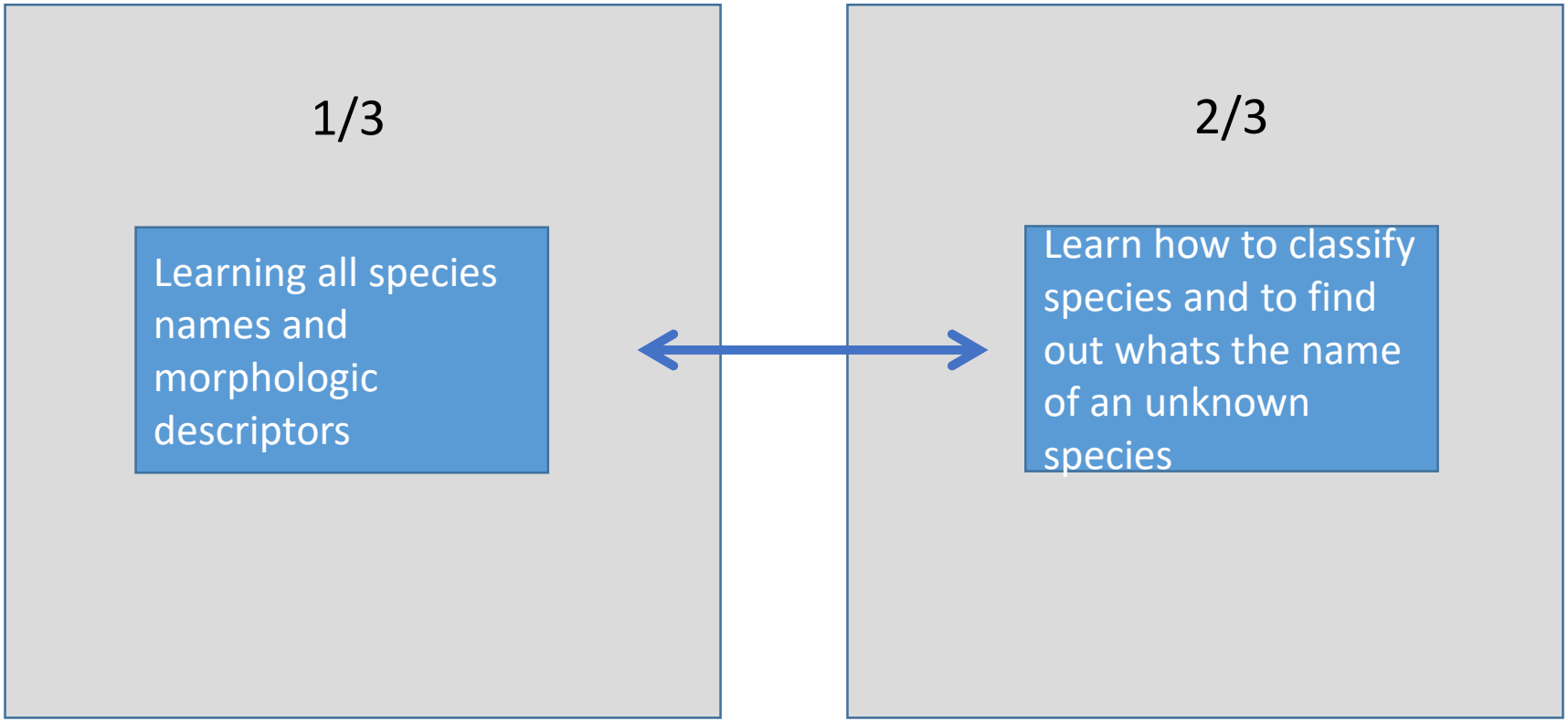

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Given a fish, one can eat for a day; taught to fish, one can eat for a lifetime.

- Think of effective science teaching as teaching learners to fish. Once learners come to understand and use scientific thinking to learn more about the world around them, they have become fishers with a lifetime thirst for knowledge and the skills to seek and learn on their own.

Competence depends on….

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- Declarative Knowledge – know
- Procedural Knowledge - do
- Conditional Knowledge – control
- Conceptual Knowledge – react and change

- **Q: part of each knowledge field in your learning outcomes and subsequently in your courses?**

How do I see competence in a student?

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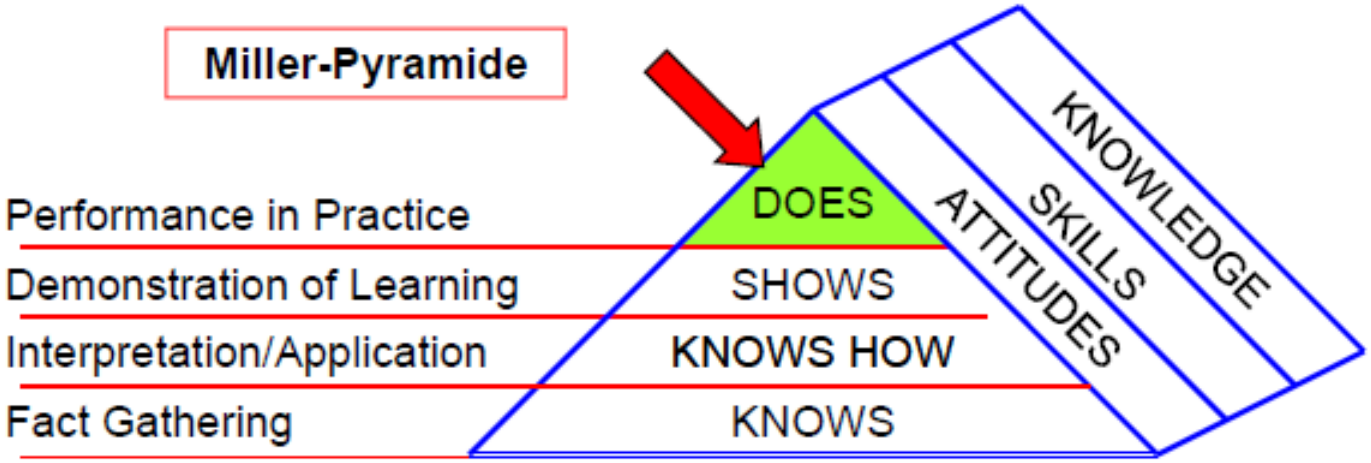
Competence: Doing the right thing at the right time in the right way in complex situations



Lab

Classroom

A Competency-based Program Includes…

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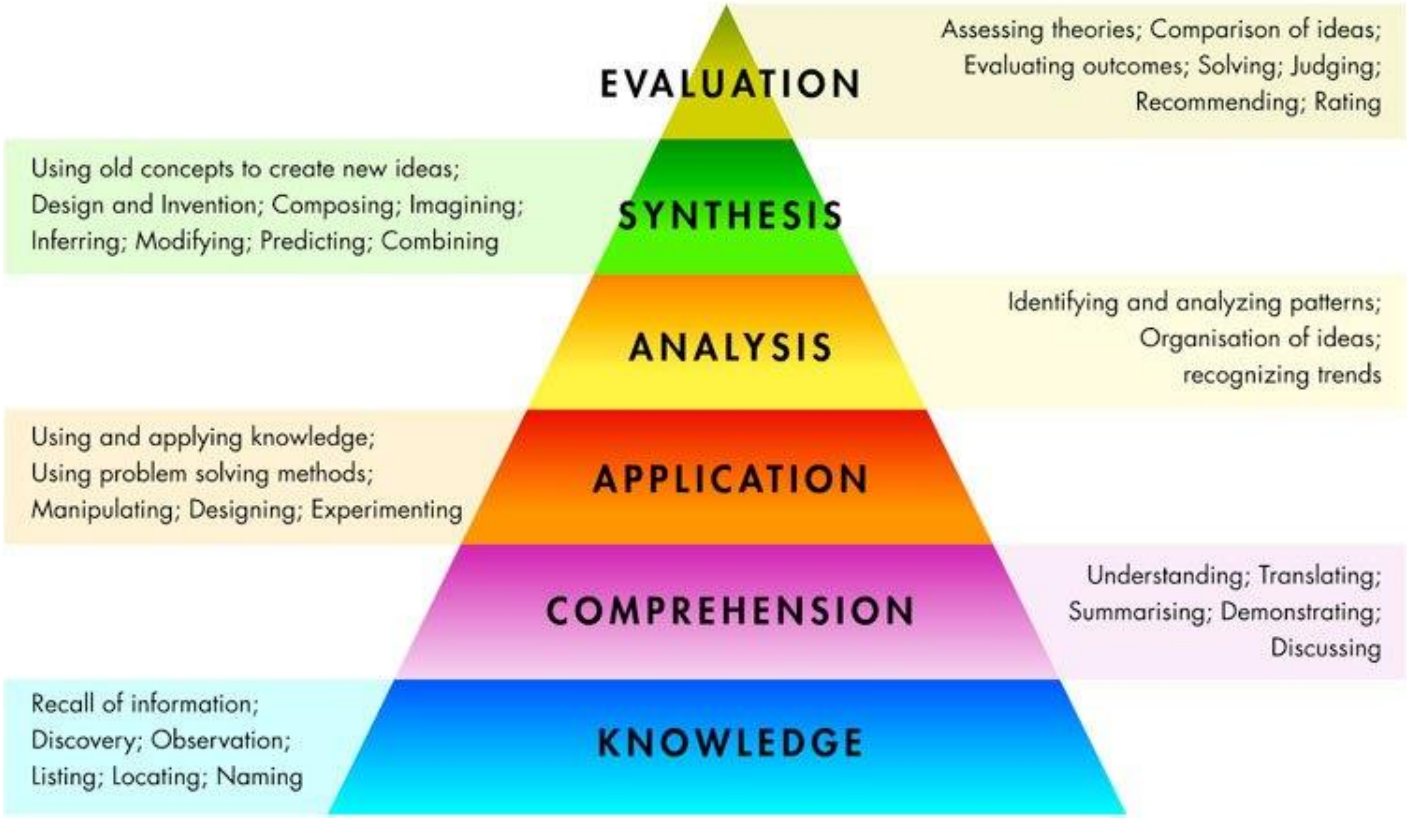
- Defining program outcomes: expected competencies of the graduate
- Providing relevant learning opportunities: through a curriculum that allows for the development of the competencies
- Assessing residents for competence: assessment of competencies as a component of the training program

BLOOMS TAXONOMY



How to define the goals?

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	Knowledge	Skills	profiency
Specific field competence			
Social competence			
Self competence			

Entwurf Studienplan **Bachelor Bio-, Lebensmittel- und Verfahrenstechnologie** Bearbeitungsstand: 19.09.2017b

Schwerpunkte im 3. - 6. Semester

SWS / Zyklus	1. Sem. WS	2. Sem. SS	3. Sem. BLT WS	3. Sem. VT WS	4. Sem. BLT SS	4. Sem. VT SS	5. Sem. BLT WS	5. Sem. VT WS	6. Sem. BLT SS	6. Sem. VT SS	7. Sem. WS
1	**EBTLTVT**	**Informatik**	**LMA**	**PCH**	**LMIBI**	**Messtechnik/IA**	**PTL**	**Studienarbeit**	**MOBI**	**TVT2**	**Berufs-**
	Arbeiten in Teams		4) Verfassen qualifizierter Berichte		3) Risiken bewerten				5) ethische Fragen stellen		**praktikum**
	1) Grundfertigkeiten Labor		3) Versuche nach Vorschrift				5) Theorie Bericht				
	1) Ethik, Nachhaltigkeit und Sicherheitsfragen		4) Prüfungsversuch								
	1) Vorbereitung auf den Arbeitsmarkt		2) Regeln befolgen								
4	2) Branchenüberblick		3) Auswertung von Daten								
5	1) Theorie Laborbericht	**MIBI**	**PPL**		**ABC**	**Umwelttechnik**	**QM**	**CVT1**	**PES**	**CVT2**	**Vorbereitung BP**
	2) einfachen Bericht schreiben	2) Versuche nach Anleitung	3) Wissenschaftliche Präsentation		5) Eigenständige Versuchsplanung und -durchführung		2) Rückmeldungen erhalten und geben		3) Anleiten von anderen Studierenden		3) Bewerbung
	1) Theorie Litrecherche	1) Planung Labor	3) Auswertung von Daten		4) Literaturmanagementsoftware		4) Ausgewogene Diskussionen führen		4) Gruppenprozesse reflektieren		4) Vorstellungsgespräch
	2) Bibliothek	3) Vollständigen und eigenständigen Laborbericht	4) Verfassen qualifizierter Berichte		5) Qualität von Quellen beurteilen				6) Theorie Hausarbeit		
	2) Einfache Präsentationen halten	2) Protokollieren/Laborbuch			4) Statistische Auswertung				7) Hausarbeit		
	1) Theorie Präsentationen	3) Vertiefung Theorie Laborbericht							2) Projektplanungsinstrumente		
8		2) englische Fachliteratur									
9	**Mechanik**	**Thermodynamik**	**BVT1**	**BVT1**	BVT2	**WPF NT**	**MSIM-BLT**	**MVT1/TVT1-L**	**VP/LMR**	**MVT2**	
			3) Auswertung von Daten (Graphiken und Tabellen)		3) Durchführung Literaturrecherche		**EDV Programmierung**				
			4) Verfassen qualifizierter Berichte		5) Darstellung von Ergebnissen		1) Zeitmanagementtechniken				
12											
13	**Chem**	**NaBLT**	**WärmeStoff**		**MRT**		**MVT1/TVT1**		**BVT3**	**PAT2**	
		1) Glossar							4) Elektronische Zeitmanagementtools		
		1) dt. Fachartikel									
		1) Fachvokabular									
16											**Bachelor-**
17	**Mathe 1**	**Mathe 2**	**Mathe 3**		**Konstruktion/CAE**		**PAT1**		**WPF NT**	**MoSim-VT**	**Thesis**
20											
21	**WT**	**Physik**	**Strömungslehre**		**BWL/Recht**		**WPF T1**		**WPF T2**		
					3) Risiken bewerten						
					1) Erennen, Analysieren und Lösen von Problemen						
24											

Check Questions for Teaching and Learning Plan

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When selecting teaching and learning methods, keep asking yourself these 3 check questions:

- How active is it?
- How related is it to real life?
- What outcomes does it promote?

Teaching: Methods

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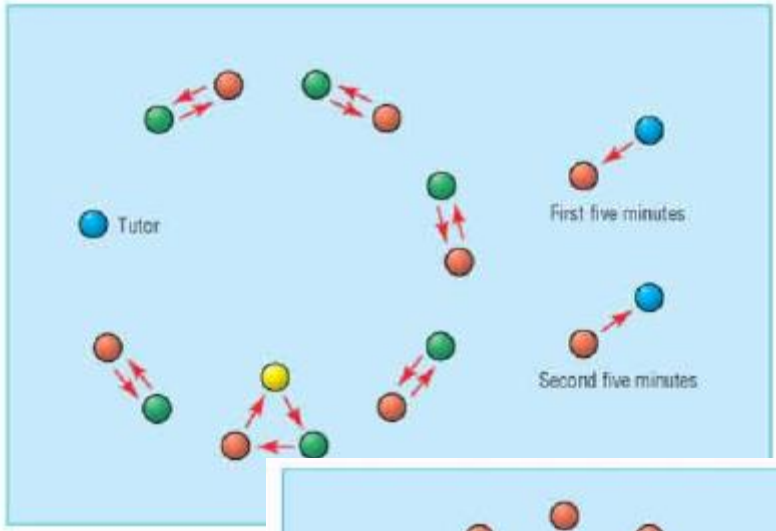
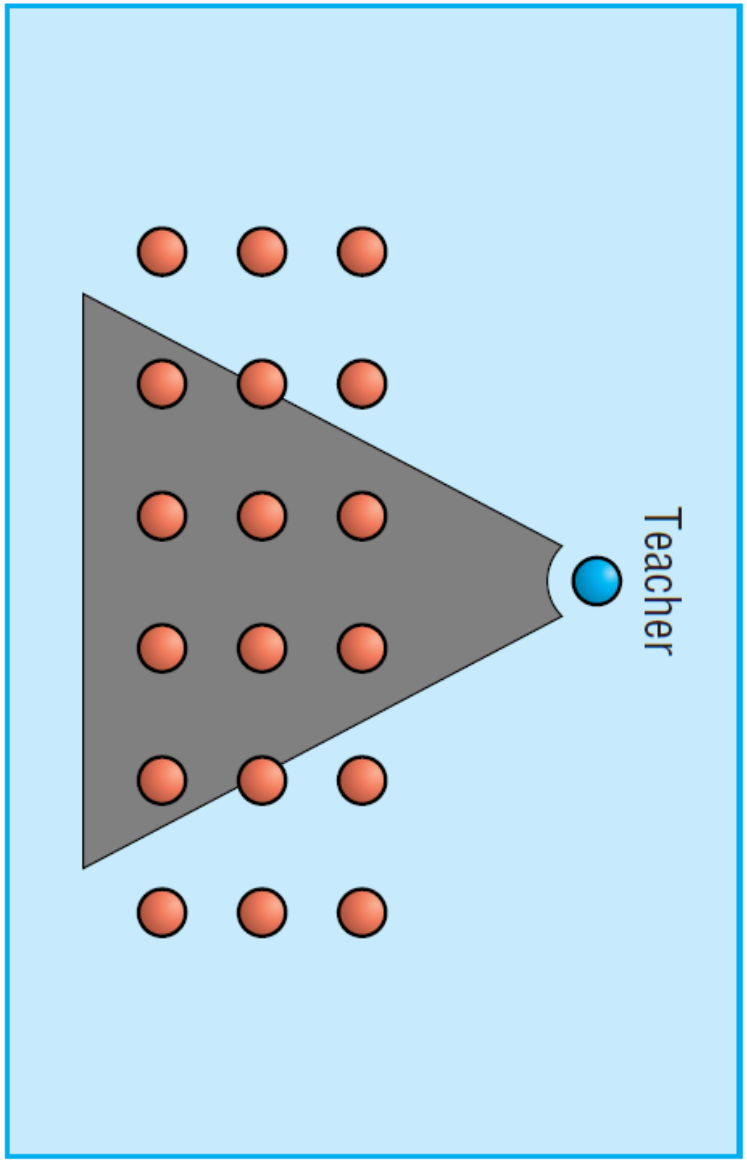
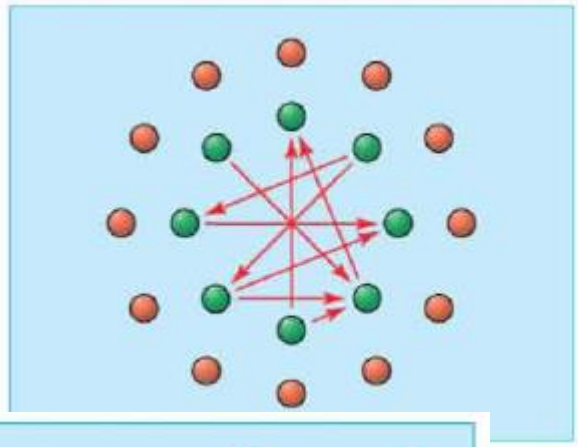
- Bachelor
- Master

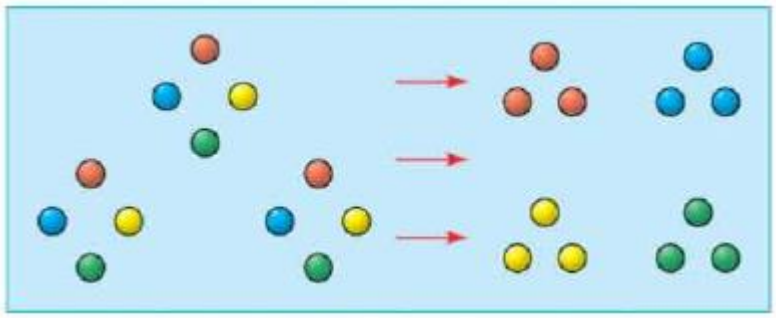
  - Media and methods:
    - Blackboard
    - Powerpoint
    - Video
    - Flipped classroom
    - Laboratory
    - voluntary homeworks, feedback included
    - Problem based learning



VS







Problem Solving vs Problem Based Learning

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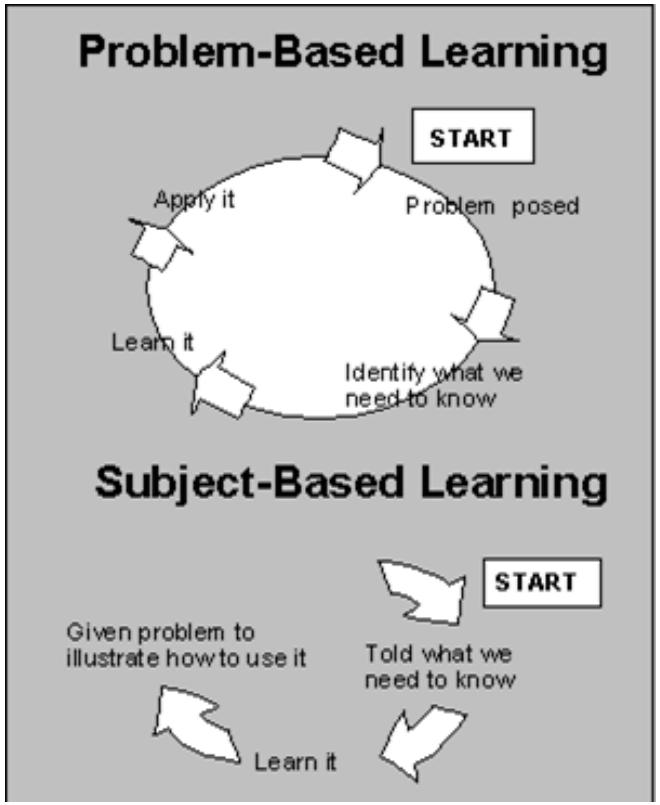
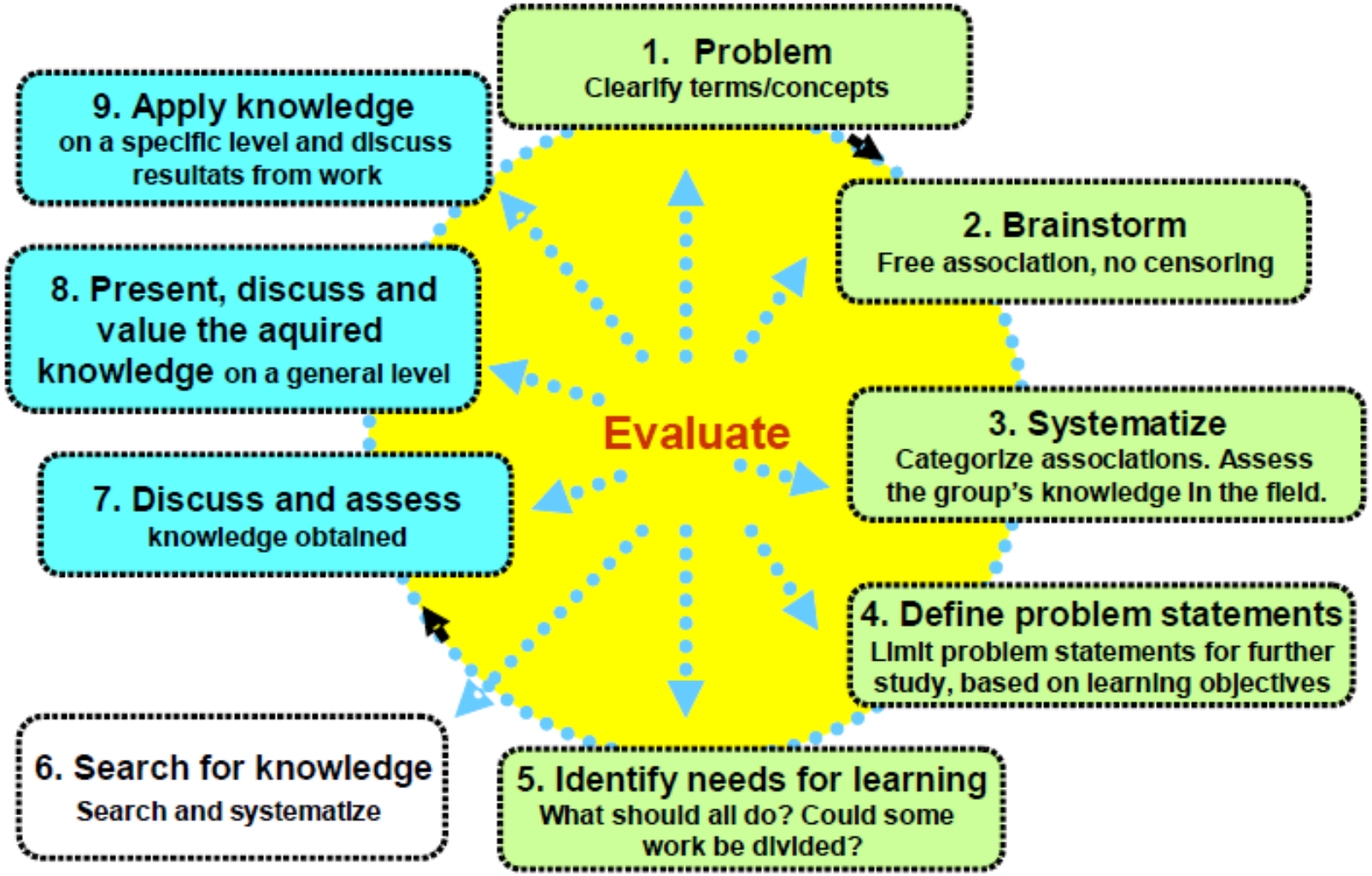
- Problem Solving: Arriving at decisions based on prior knowledge and reasoning

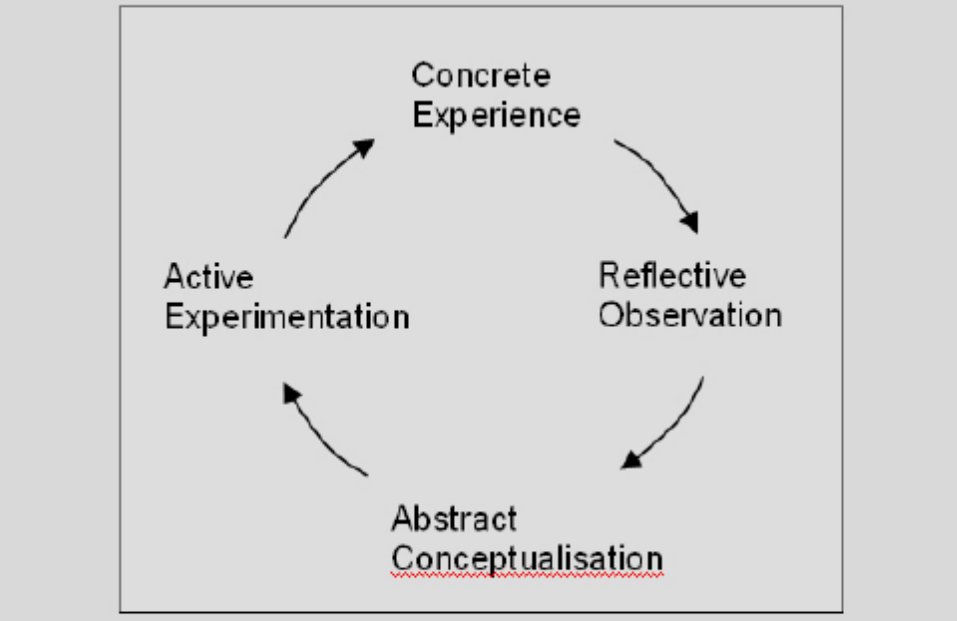
- Problem Based Learning: The process of acquiring new knowledge based on recognition of a need to learn.



The Seven Step Model (Wood, 2003)



Doing things practically



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Differences at learning levels

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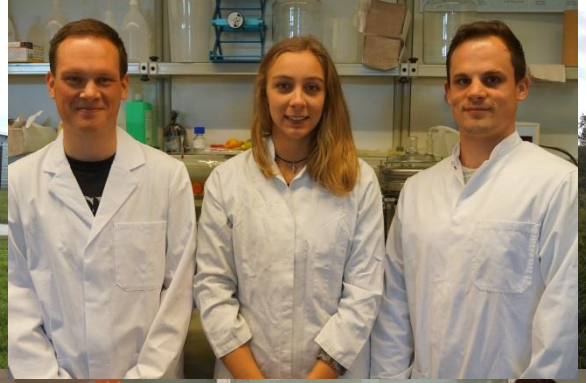
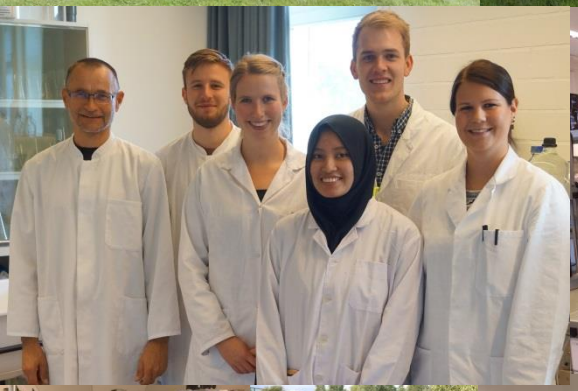
	Students	Graduates	Practising Scientists
To train students in making deductions from measurements and interpretation of data	✓	✓	✓
To familiarize students with important apparatus and measurement techniques	✓	✓	✓
To teach basic practical skills	✓	✓	✓
To train students in observation		✓	✓
To foster critical awareness		✓	✓
To illustrate material taught in lectures	✓		
To help bridge theory and practice	✓		

Table 1: The five top aims ranked highest by each response group (After Boud, Dunn, Kennedy and Thorley, 1980)



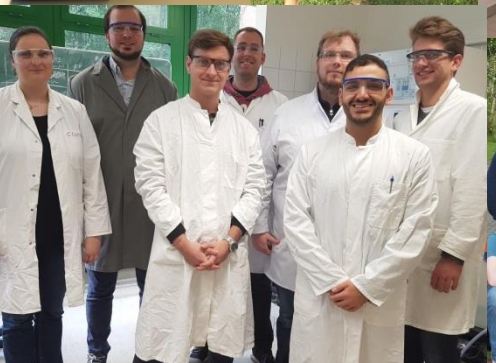


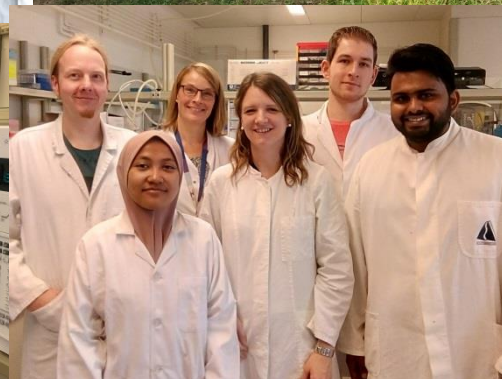








Useful links

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- http://www.scienceprofonline.com/instructors-corner/instructors-corner-main.html
- https://www.goconqr.com/en/examtime/blog/how-to-study-biology/
- https://www.aibs.org/education/teaching_resources.html
- http://www.didactics.eu/index.php?id=170&L=0%27%60%28%5B%7B%5E~
- http://www.liberatingstructures.com/
- http://www.edu-nova.com/teaching-techniques-for-science-teachers.html
- https://undsci.berkeley.edu/teaching/
- Burgess, H., Taylor, I (2001) 'From University Teacher to Learning Coordinator: Faculty Roles in Problem-Based Learning' *Journal of Excellence in College Teaching*, special issue on Problem-Based Learning