Sweet biochips

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Do we live „La dolce vita“ („The sweet life“)?

Sugars:

1. Energy source (glucose)
2. Building blocks (cellulose and chitin)
3. Storage (starch and glycogen)
4. Glycoproteins, glycolipids

DNA: ≈ 25 000 – 40 000 genes

Proteins: ?

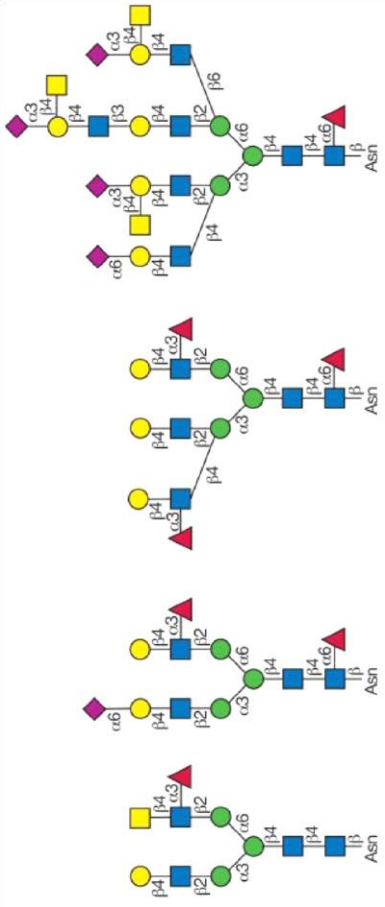
Glycoproteins/glycolipids: ≈ 1 million

Fig. 1: Original movie poster: *http://en.wikipedia.org/wiki/La_Dolce_Vita*

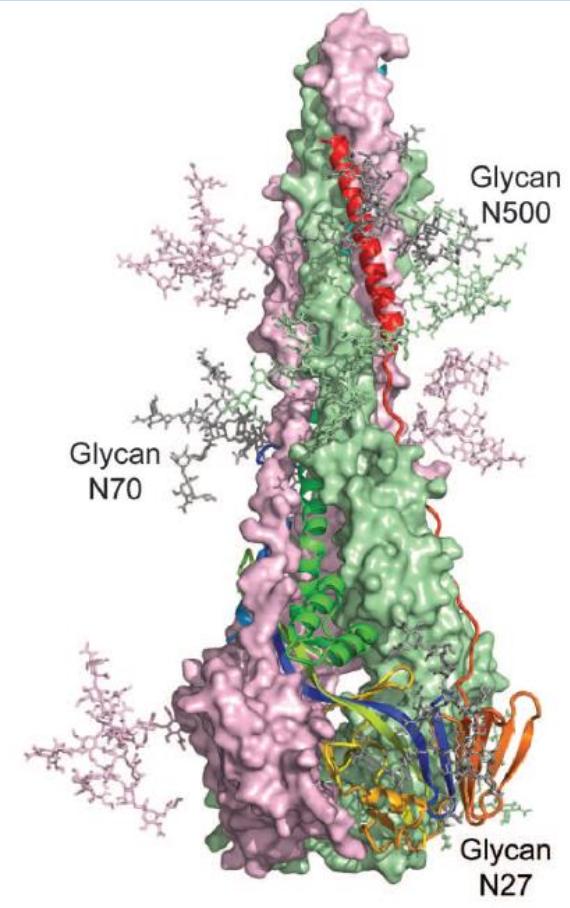
Glycans

Complex sugars attached to proteins/lipids

≈ 7 000 glycans



≈ 70-80% of proteins are glycosylated



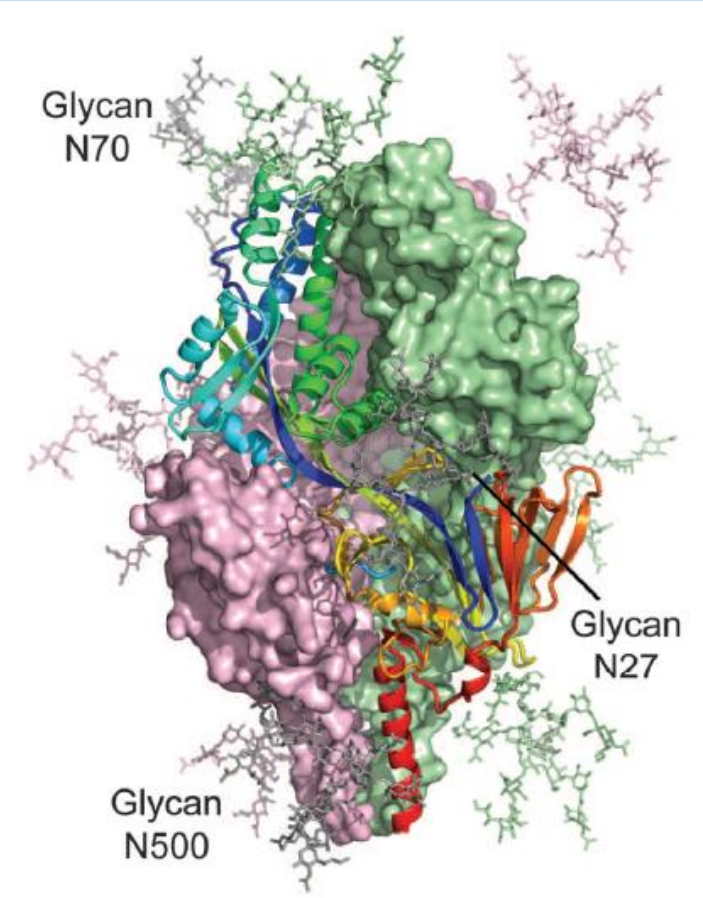
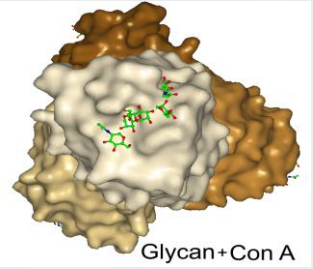


Fig. 2: Glycans: http://www.ncbi.nlm.nih.gov/books/NBK1908 and glycoproteins: *Science (2013) 1113*

Lectins

Proteins recognising glycans



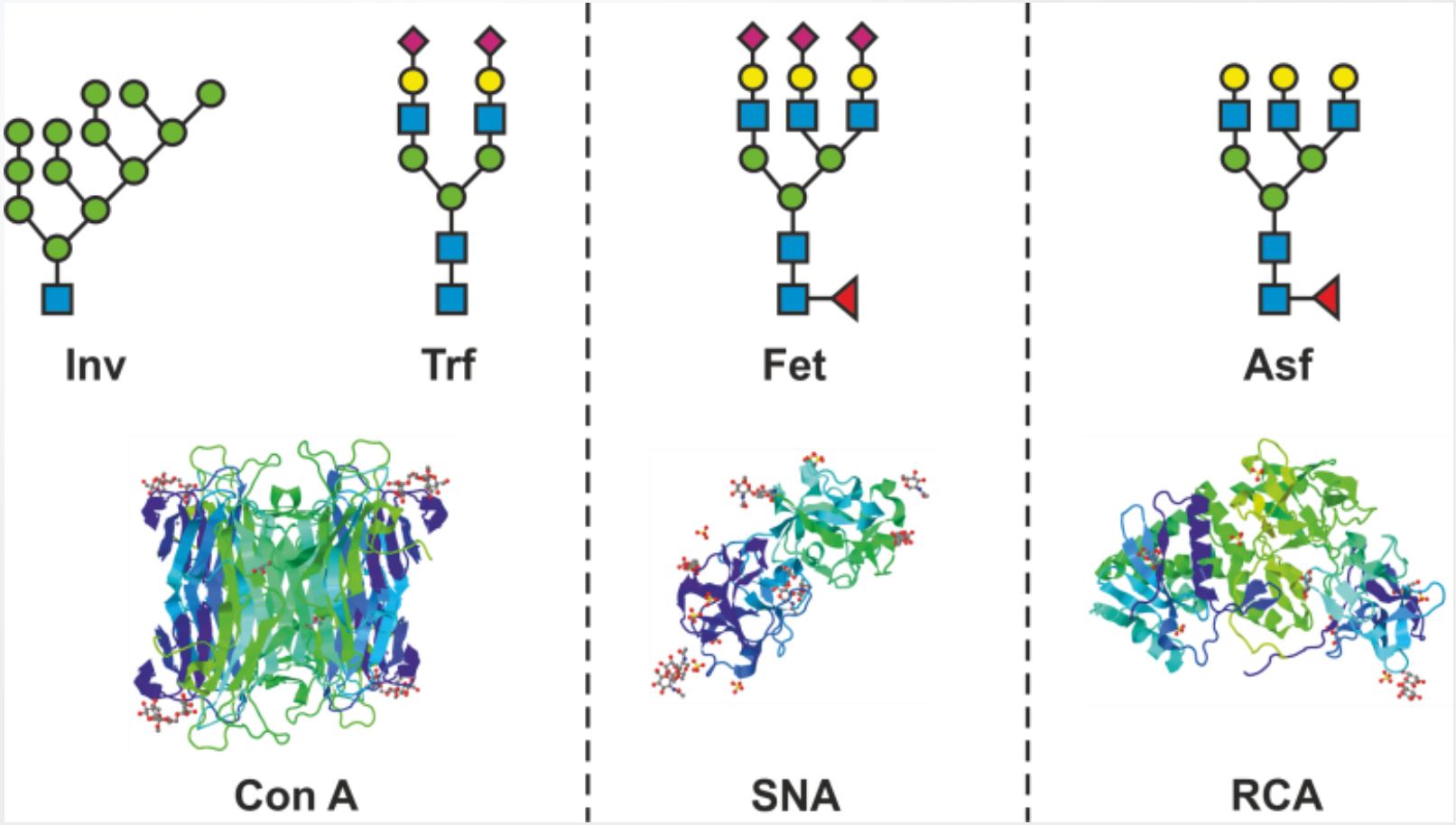
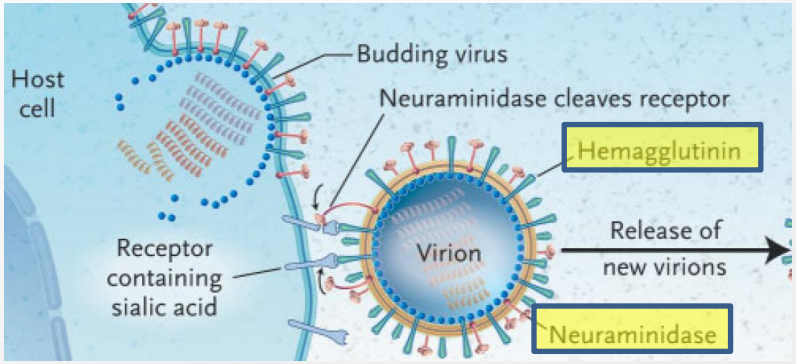


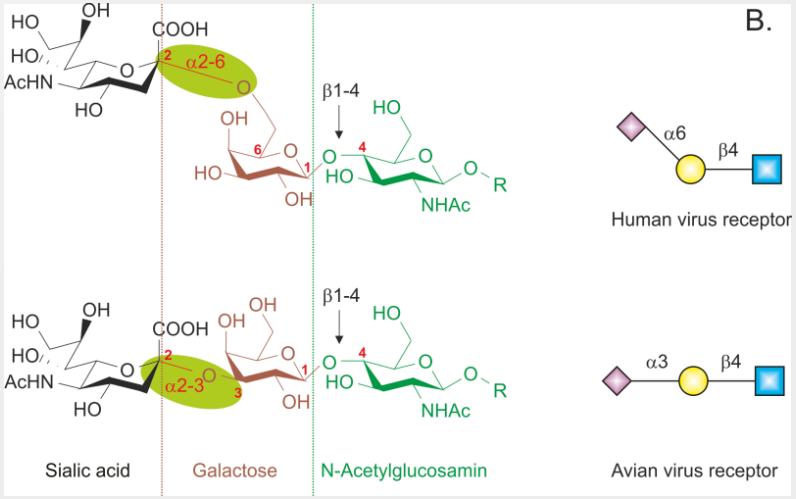
Fig. 3: Structure of selected lectins and their specificity

Role of glycans

Pathology *vs.* physiology

Viral infection (i.e. H1N5)





Blood group types

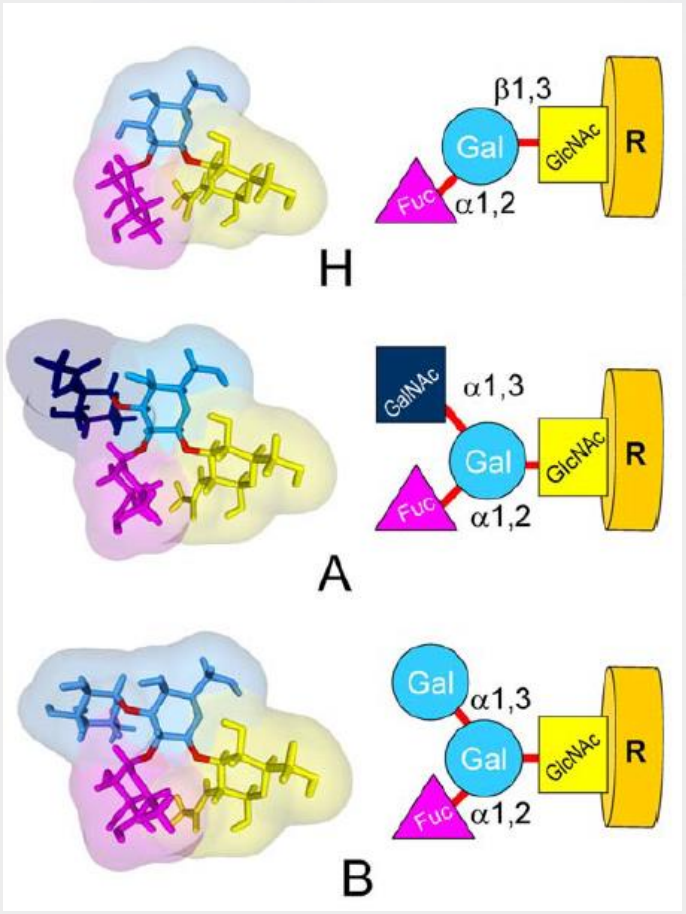


Fig. 4: Glycans in physiology: *Biologia 64 (2009) 1* and pathology: N. *Engl. J. Med. 353 (2005) 1363*

Analysis of glycans

Trying to find a needle in a haystack?

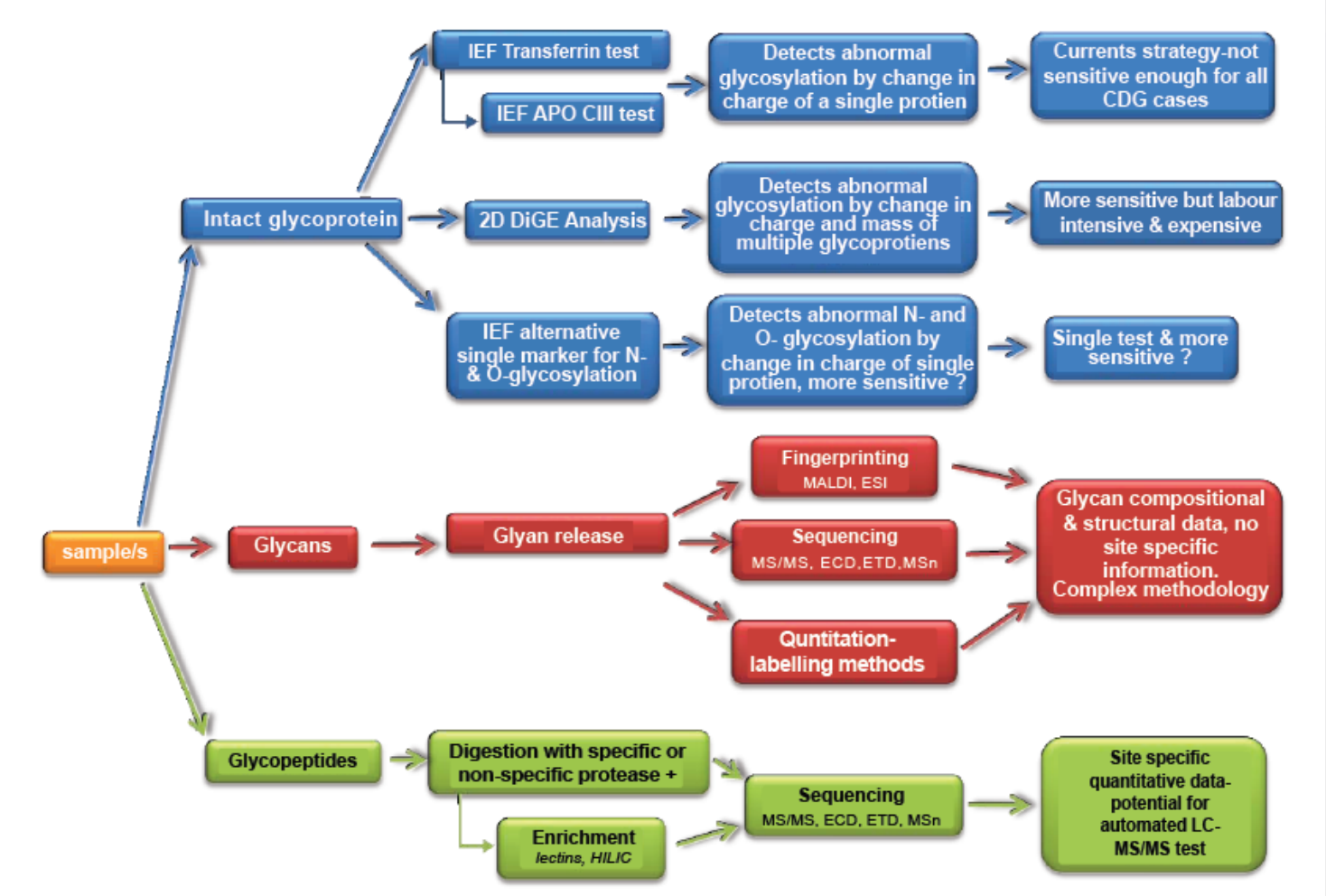


Fig. 5: Analytical approched for glycan analysis: *Pediatr. Therapeut. S3 (2012) 003*

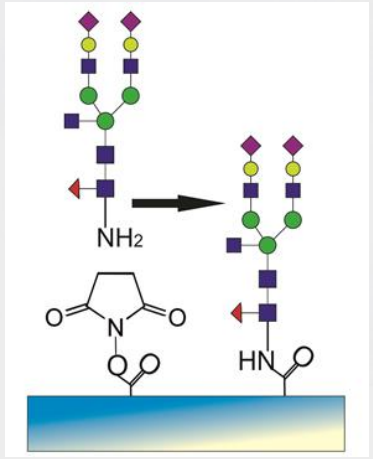
Application of sweet biochips?

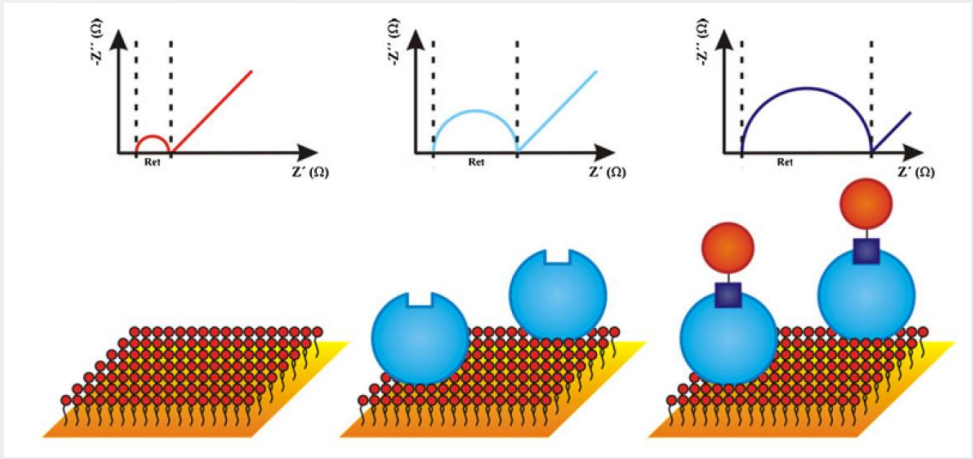
Really these ones?

Fig. 6: Biochips: http://www.herbolariosonline.es/es/34-biochips-con-amaranto-75g.html

Application of sweet biochips?

Really these ones!





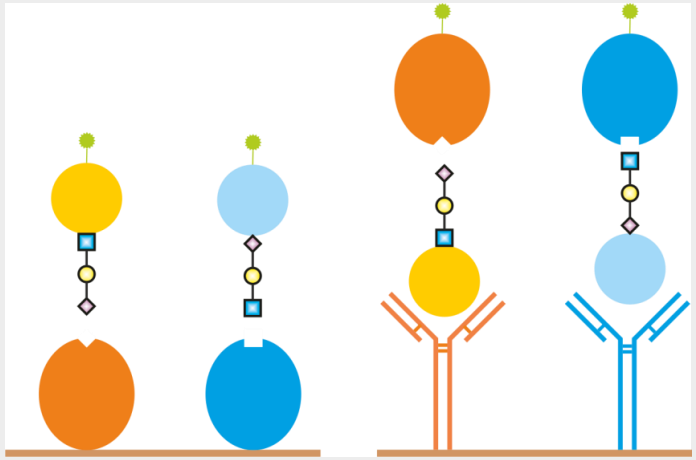


Fig. 7: Biochips: http://www.dropsens.com

Immobilisation: control at nanoscale

2-D *vs.* 3-D immobilisation

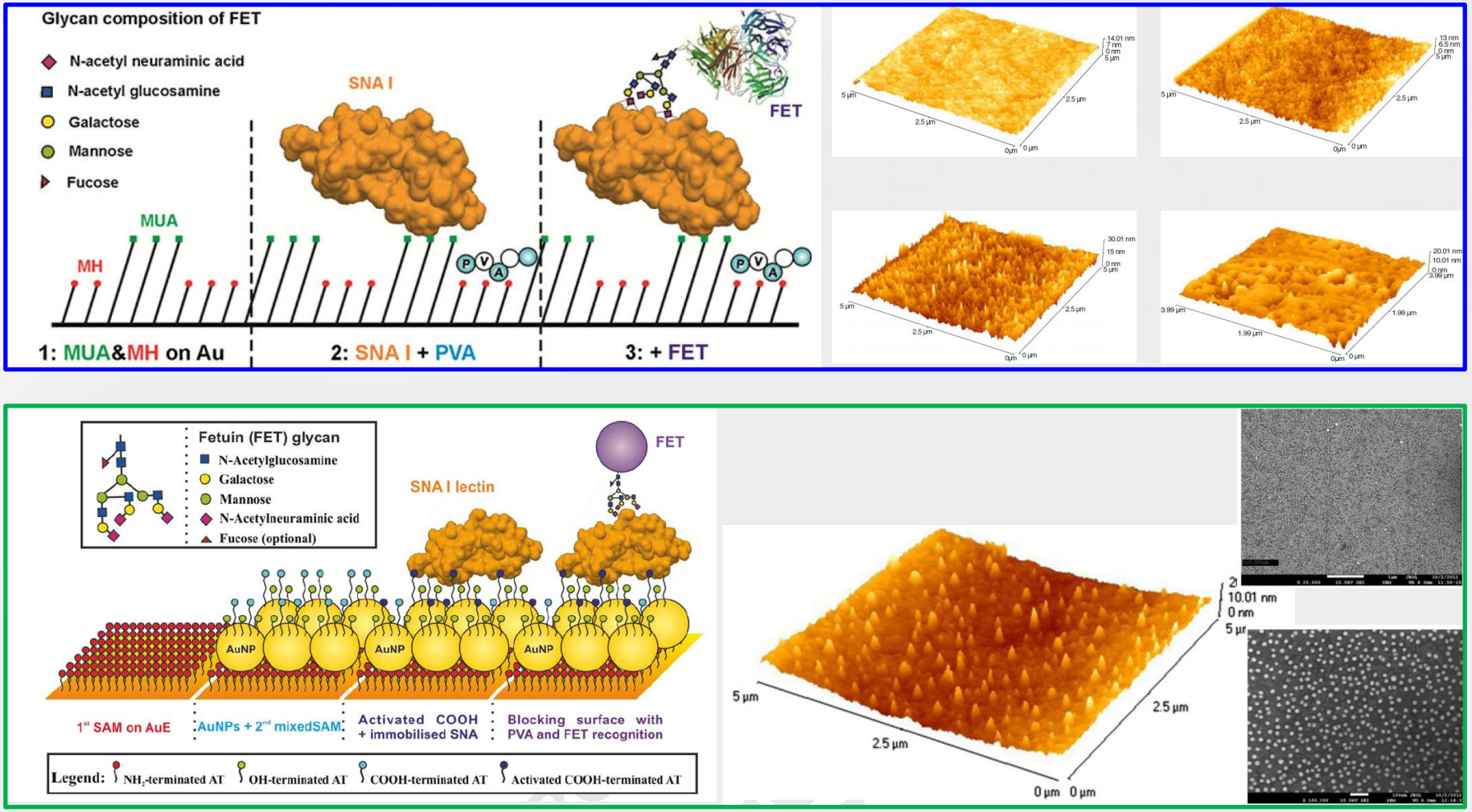
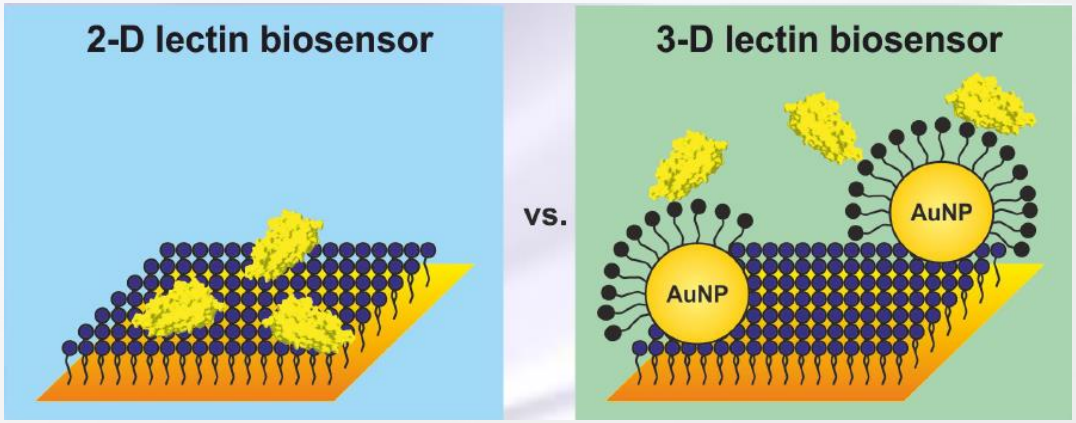
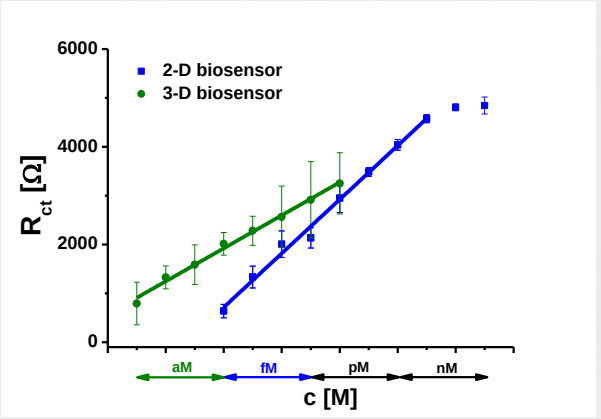


Fig. 8: Immobilisation of lectins: All images are taken from our publications

Performance of the E-biochips

2-D *vs.* 3-D immobilisation





2-D E-biochips

- DL: 0.3 fM (FET), 0.5 fM (ASF)
- LR: 7 orders of magnitude
- Non-specific signal: 24%

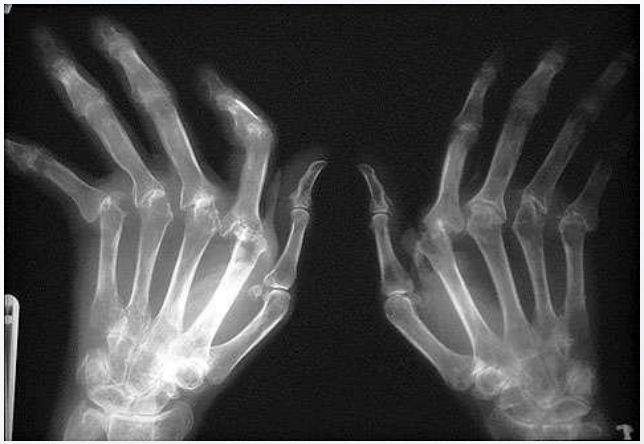
3-D E-biochips

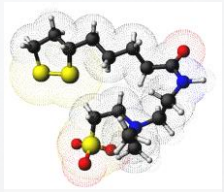
- DL: 0.5 aM (FET), 0.8 fM (ASF)
- LR: 7 orders of magnitude
- Non-specific signal: 23%

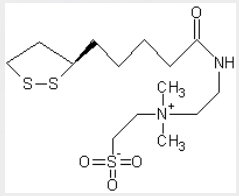
Fig. 9: Comparison of the performance of the E-biochips

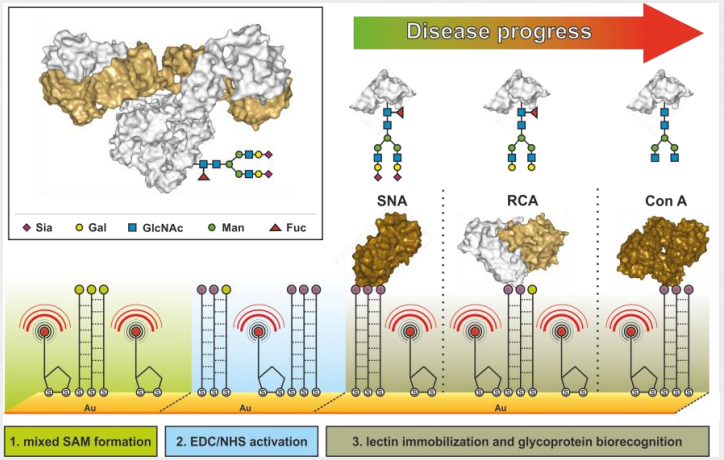
2-D betaine E-biochips

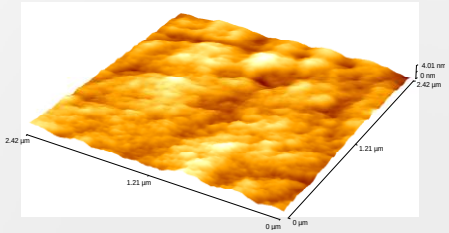
Analysis of rheumatoid arthritis (RA)

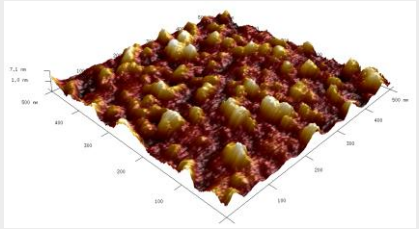












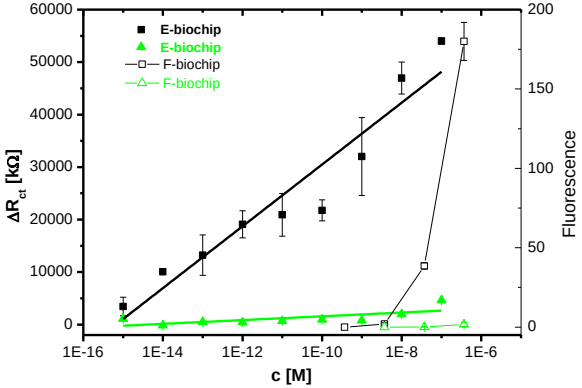
Con A betaine E-biochip

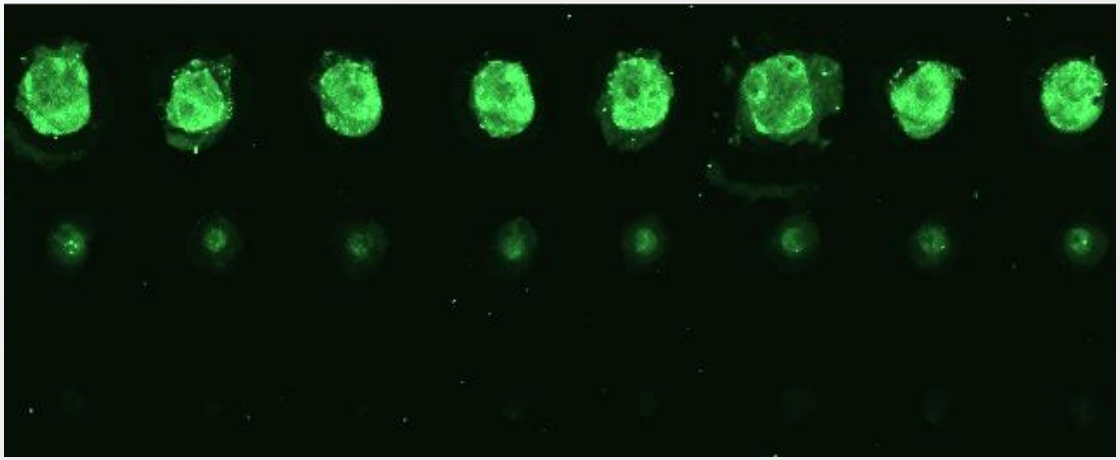
- DL: 1 fM (INV), 1 aM (INV sandwich)
- LR: 8 orders of magnitude
- Non-specific signal: 6%

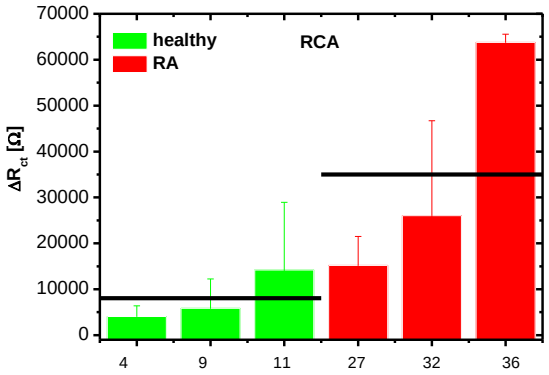
Fig. 10: Hands of RA patient, betaine structure, change in glycans – RA, bare and lectin modified gold

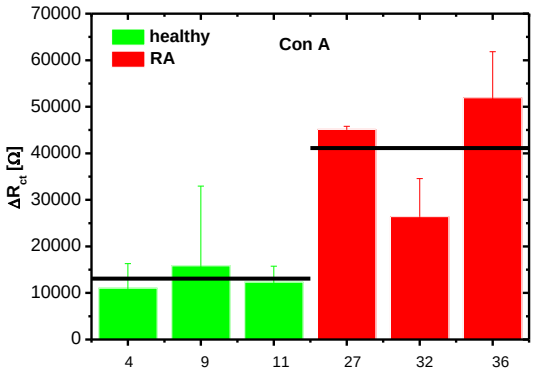
E-biochips *vs.* F-biochips

Analysis of RA samples









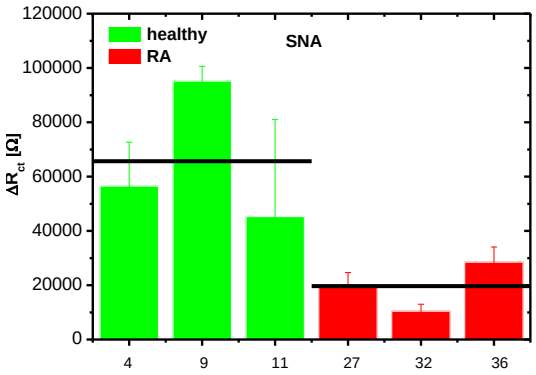


Fig. 11: Comparison of F-biochips with E-biochip spots and analysis of RA samples

Protein level in the blood *vs.* biochips performance

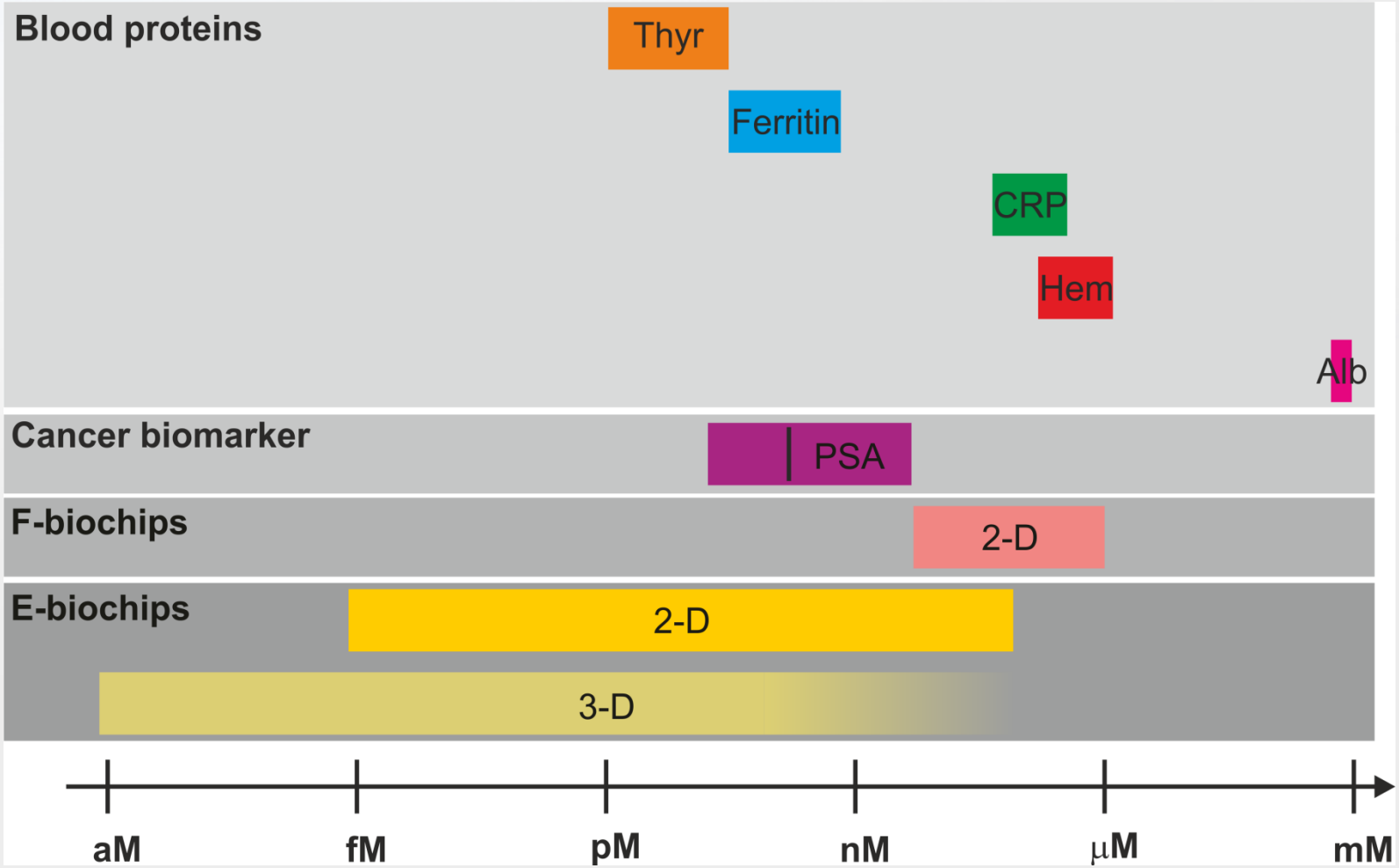


Fig. 12: Comparison of practical utility of biochips for analysis of serum proteins

Application of graphene

Nobel prize 2010: Konstantin Novoselov - ERC Starting grantee

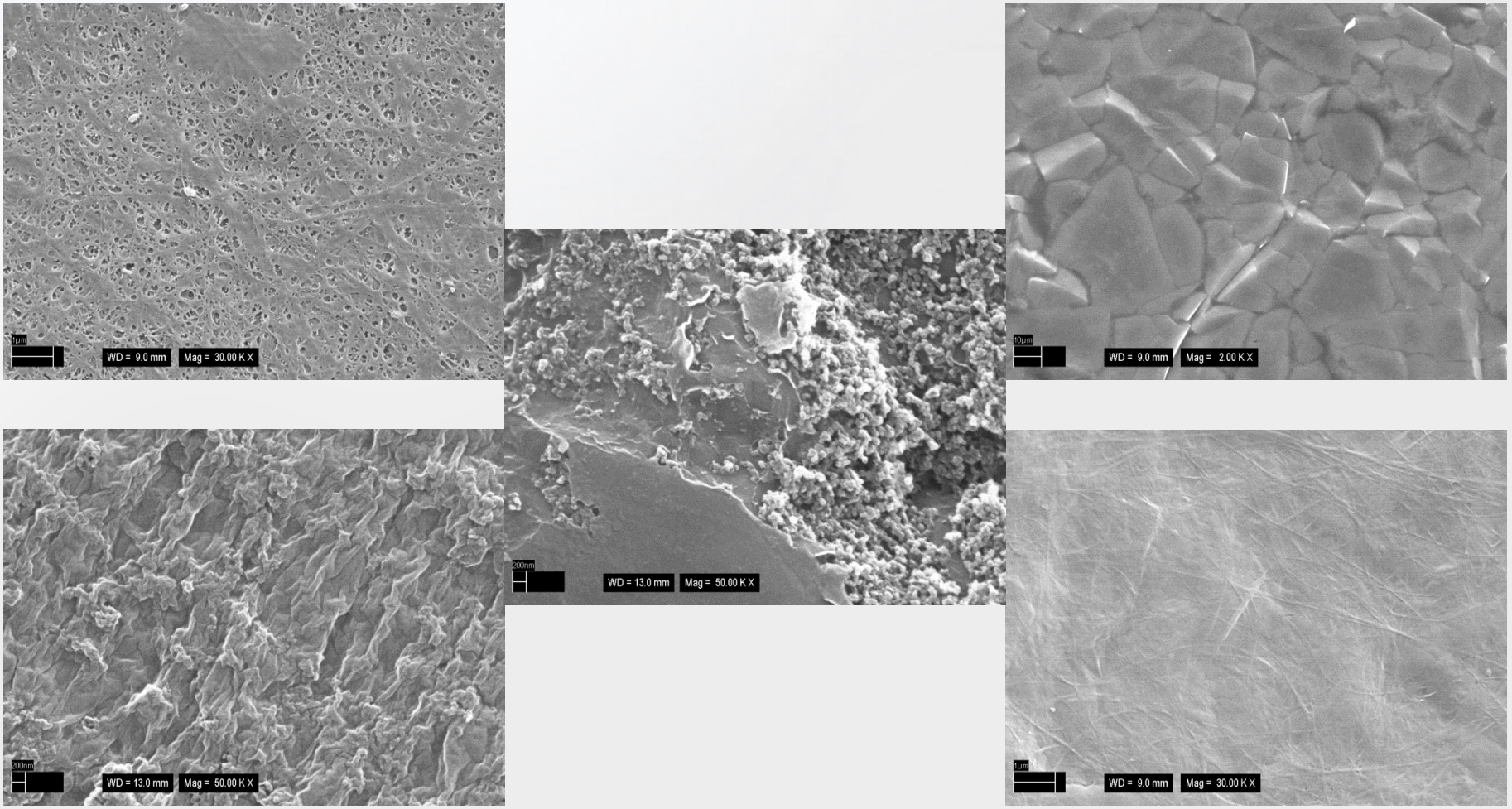


Fig. 13: Various ways of preparing graphene

Planned activities

Lectin biochips

- betaine lectin biochips: more lectins, cancer samples/cells, other diseases
- graphene-based lectin biochips: completely novel
- possible application in diagnostics and biomarker discovery

Glycan biochips

- betaine glycan biochips with control at nanoscale: completely novel
- graphene-based glycan biochips: novel
- possible application in enzyme activity assays – inhibitors (vaccines), inflammatory factors, antibodies

Outcomes so far

Start of the project on January 1st, 2013

Papers published

1. Bertok T, Sediva A, Katrlik J, Gemeiner P, Mikula M, Nosko M, **Tkac J**: *Talanta* 108, 11-18, 2013.
2. Bertok T, Gemeiner P, Mikula M, Gemeiner P, **Tkac J**: *Microchimica Acta* 180, 151-159, 2013.
3. Bertok T, Katrlik J, Gemeiner P, **Tkac J**: *Microchimica Acta* 180, 1-13, 2013.

Papers submitted

1. Bertok T, Klukova L, Sediva A, Kasak P, Semak V, Micusik M, Omastova M, Chovanová L, Vlček M, Imrich R, Vikartovska A, **Tkac J**: *Analytical Chemistry*, after revision, 2013.
2. Klukova L, Bertok T, **Tkac J**: *Chemicke Listy*, submitted, 2013.
3. Klukova L, Bertok T, **Tkac J**: *Chemicke Listy*, submitted, 2013.
4. Hushegyi A, Bertok T, **Tkac J**: *Chemicke Listy*, submitted, 2013.
5. Hushegyi A, Bertok T, **Tkac J**: *Chemicke Listy*, submitted, 2013.

Invited book chapter

1. **Tkac J**, Nahalka J, Gemeiner P. Prospective of glycomics *via* lectin engineering. LECTINS, in preparation

Invited presentations

1. **Tkac J**, Bertok T: European Biotechnology Congress, 16-18. 5. 2013, **chairman Nanobiotechnology.**
2. **Tkac J**, Klukova L, Bertok T: XIII. Meeting of physical chemists and electrochemists, 29-30. 5. 2013.

My way for getting ERC Starting grant

Time prior submission of the ERC project proposal (2010)

- **broaden horizons** (3 postdoc stays = 3 different projects)

- new challenges: periods **without success** = the best school

- choice of **top universities** (Nobel prize laureates, collaborators - ITN)

- **application for fellowships** (Marie Curie – 3rd succesfull)

- **other activities** – start-up (business plan competition - Nanochallenge)

- **project submissions** (university, unsuccesfull 3 FP7 and 1 domestic)

- **ERC Starting grant** – complementary to Structural funds

Writing ERC Starting grant

- 3 steps, submission of **B1** (5 p), **B2** (15 p) forms and **interview**

- **B2**: state-of-the-art, gaps identification, detailed solutions, prelim. data

- **B2**: try to find an application for the knowledge acquired

- **B1**: it is more important than **B2** for the 1st round

- **interview**: extremely challenging – 10 min

- **1st submission**: 4 weeks, only some preliminary data

- **2nd submision**: 8 weeks (large budget = long time), preliminary data

Why ERC Starting grant?

- **no consortium** needed

- **any scientific background**, high risk-high gain projects (venture capital)

- purely on **research excellence** (2 Nobel prize laureates in 6 years)

- to establish a group, to get **independent career**

- **the best finances** to individuals, **budget freedom** (budget categories)

- **low level of bureaucracy** (5 years: 4 financial and 2 scientific reports)

- **precious feedback** after submission

- a **very good deal**: few months of work = 5 year prestigeous grant

THANK YOU FOR YOUR ATTENTION