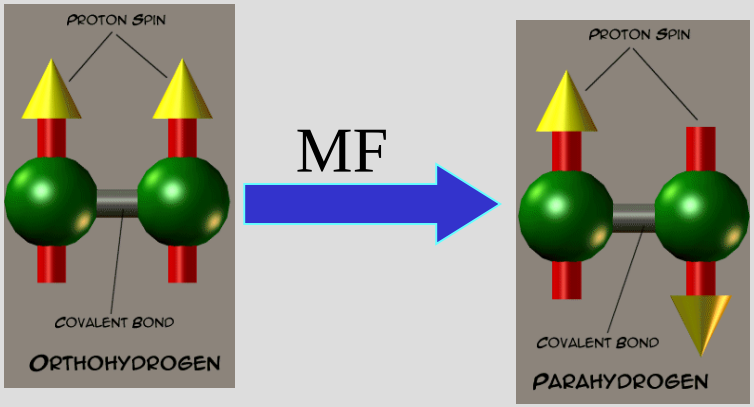
# Influence of magnetic fields on interfacial phenomena

**Malinowska I., Studziński M., Malinowski H*.**

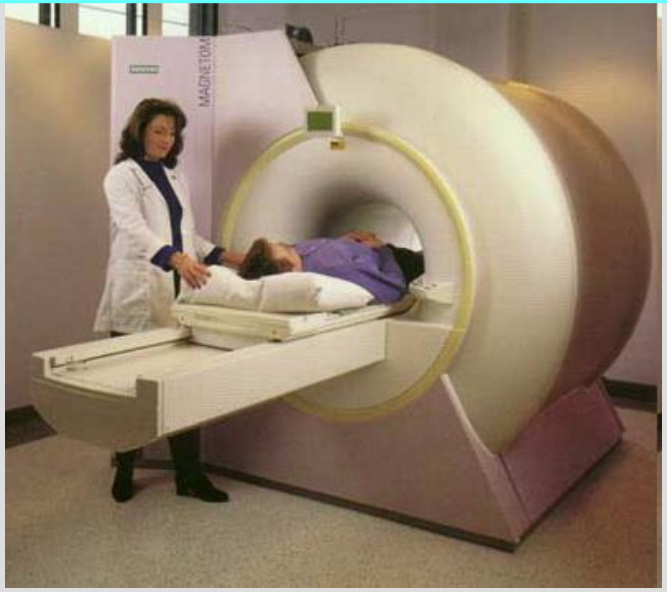
Faculty of Chemistry, Department of Planar Chromatography, M. Curie-Skłodowska University, M. Curie-Skłodowska Sq. 3, 20-031 Lublin , Poland, irena.malinowska@poczta.umcs.lublin.pl

Joint Institute for Nuclear Research, Veksler and Baldin Laboratory of High Energy Physics, Dubna, Russia

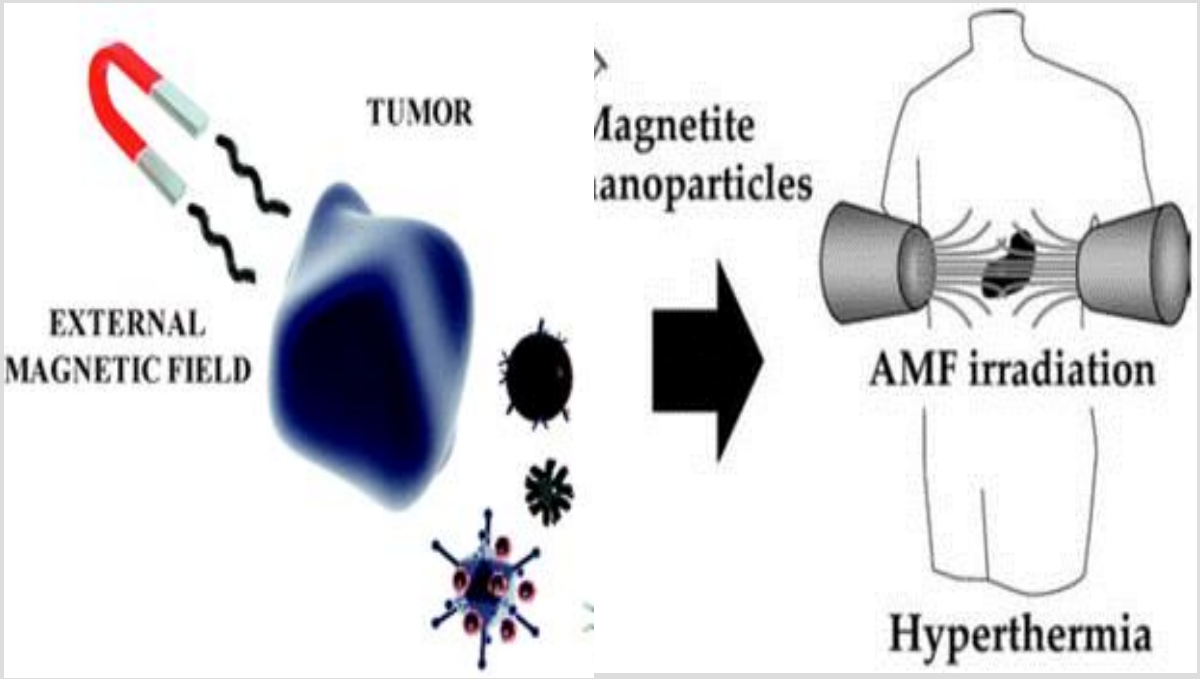
# Why this topic?



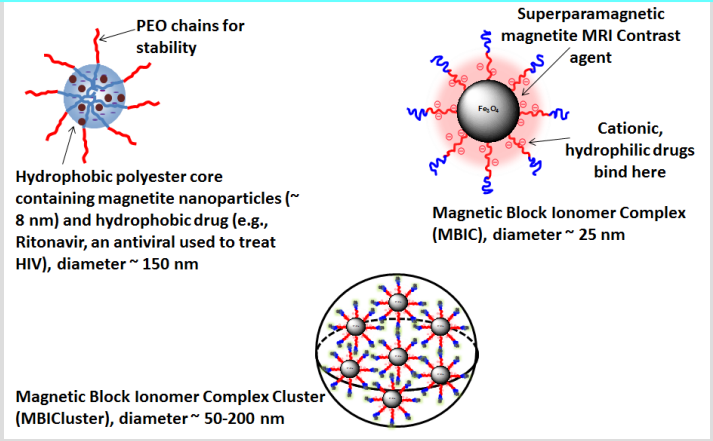

# magnetic field in medicine

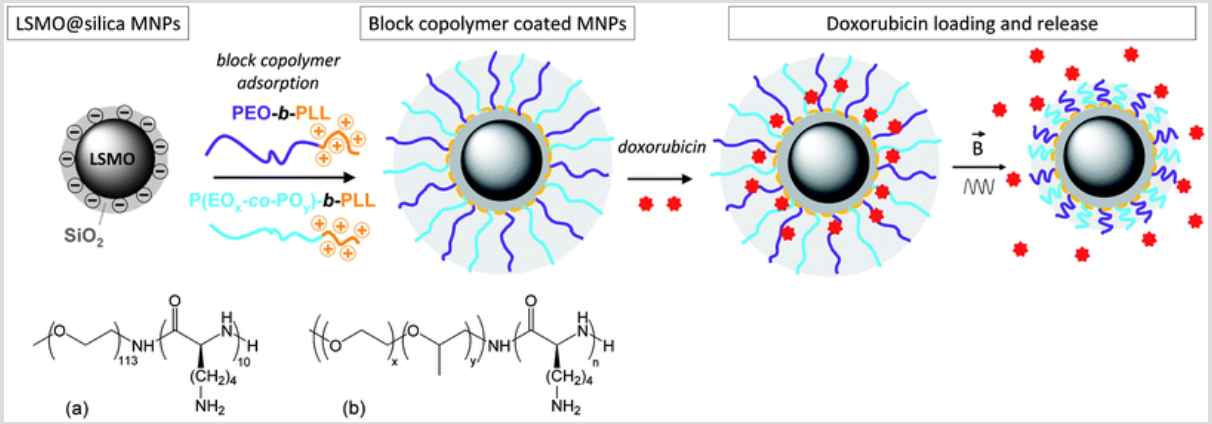


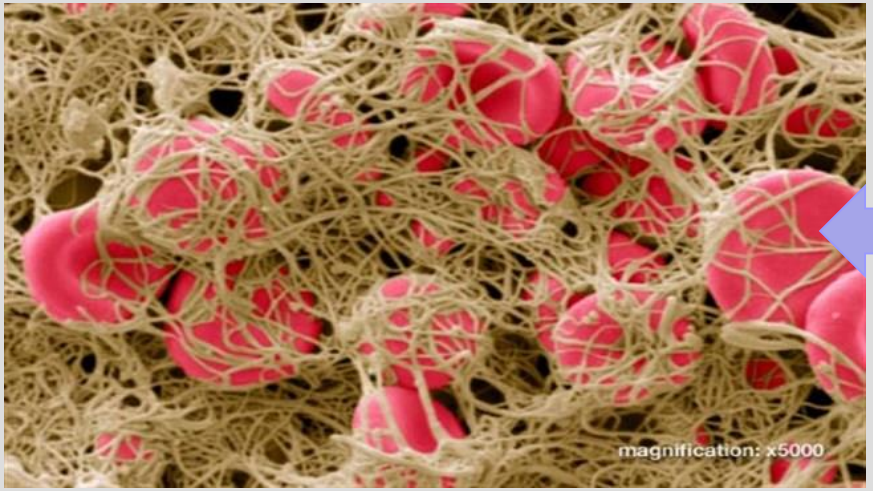
# magnetic field and magnetic nanoparticles

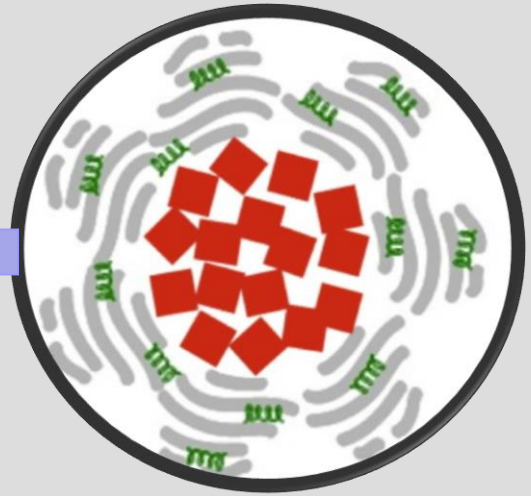


# magnetic filed and magnetic nanoparticles





Magnetic nanoparticle could stop blood clot caused strokes

*Nanotechnology News ID:112441Publish Date: Tue, 24 Feb 2015 15:37:49 GMTService: Healt*

# How magnetic field influence interfacial phenomena

## CHROMATOGRAPHY

# Why chromatography?

Chromatography:

Method based on different interactions of the solutes with stationary phase surface and components of the mobile phase

The different interactions are caused by different properties of the solutes

physical – GPC/SEC

chemical

structure

presence of functional groups

acid/base properties

interactions

- hydrophilic (HILIC)
- hydrophobic (HIC)
- electrostatic – ICC,
- witch metal cations - chiral chromatography,argentation chromatography
- with stationary phase - NP, RP chromatography

Chromatography in magnetic field can give us some information about influencing of magnetic fields interphacial phenomena.

# chromatography in magnetic field- magnetochromatography

analytical

Does magnetic field influence the solute retention and efficiency of chromatographic systems?

Separation results?

Fundamental research

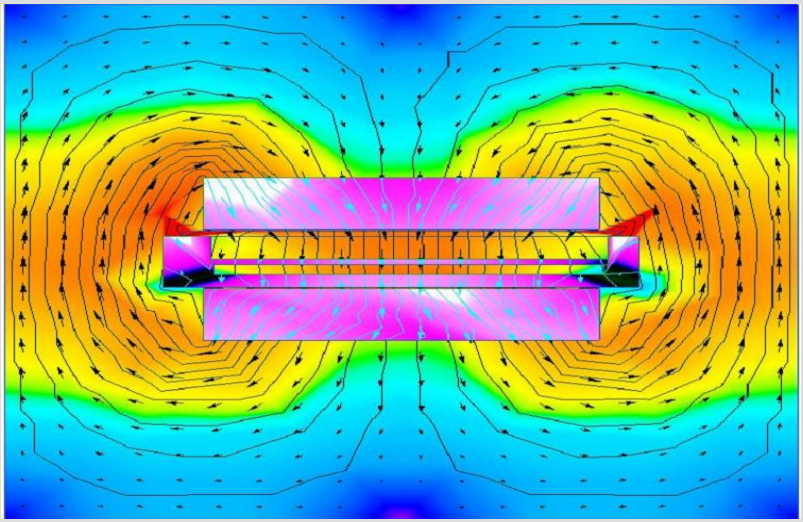
Does magnetic field influence interphacial phenomena?

Does magnetic field influence properies of solutes?

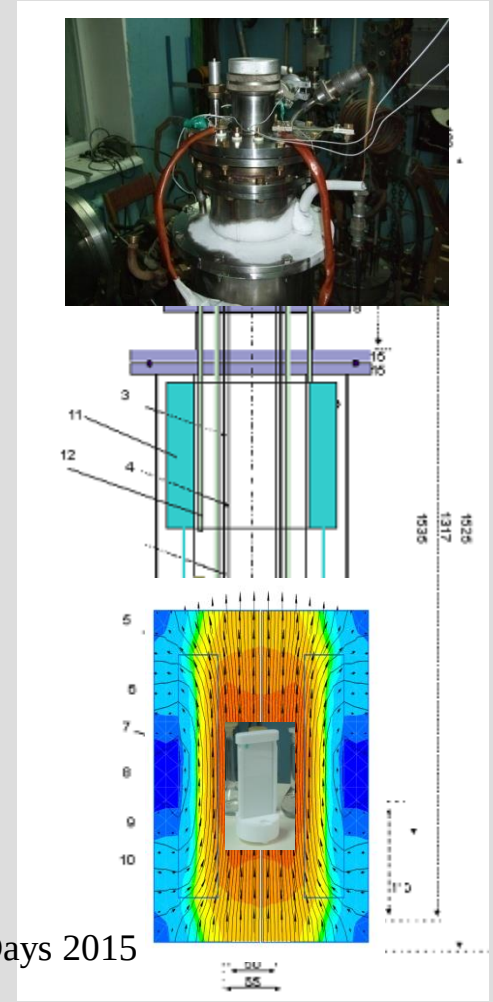
# Chromatography in magnetic field

## sources of magnetic field

neodymium magnet



B= 0.48 T

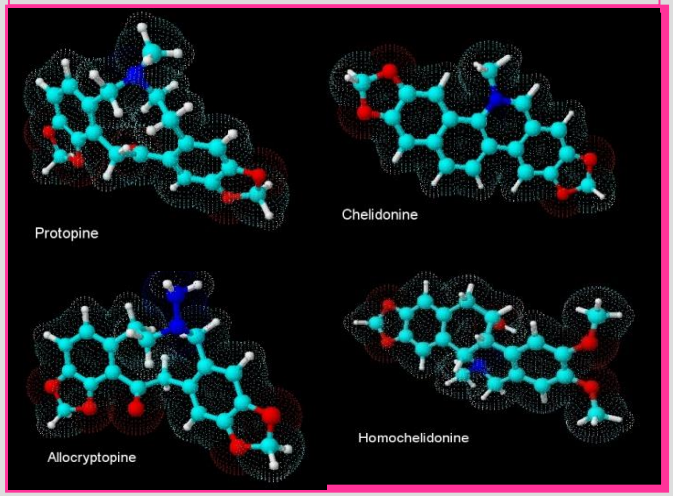


superconducting magnet

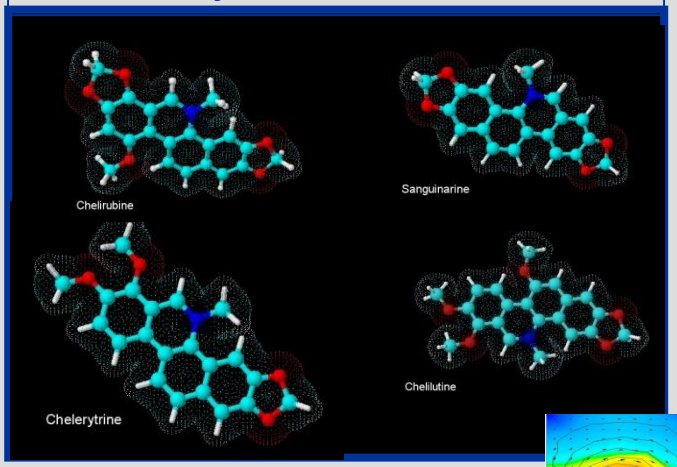
B: 0.5-3.5 T

# *Chelidonium maius L.*

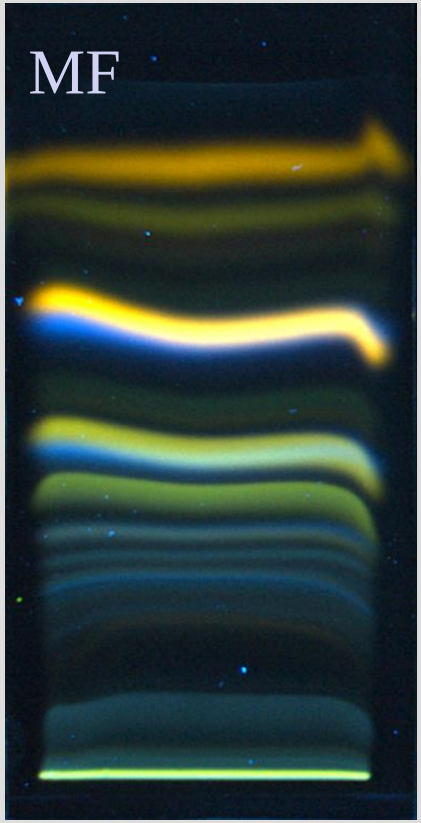
**Tertiary alkaliods**

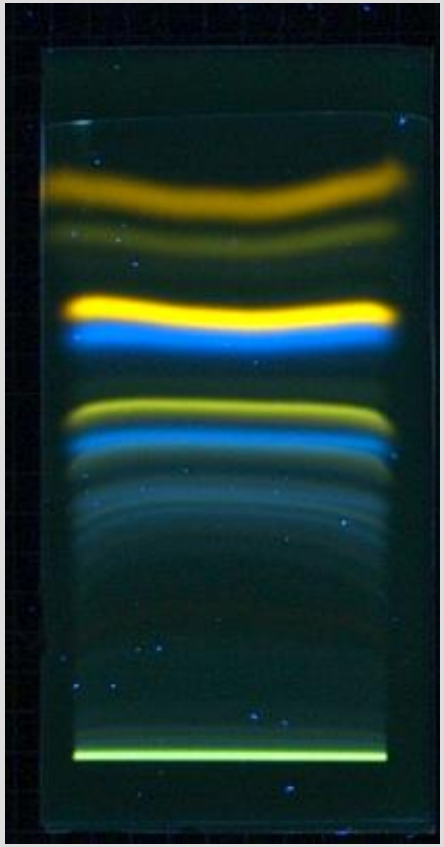


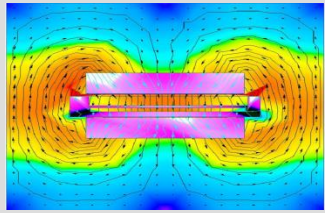

**Quaternary alkaloids**



# extract of tertiary alkaloids

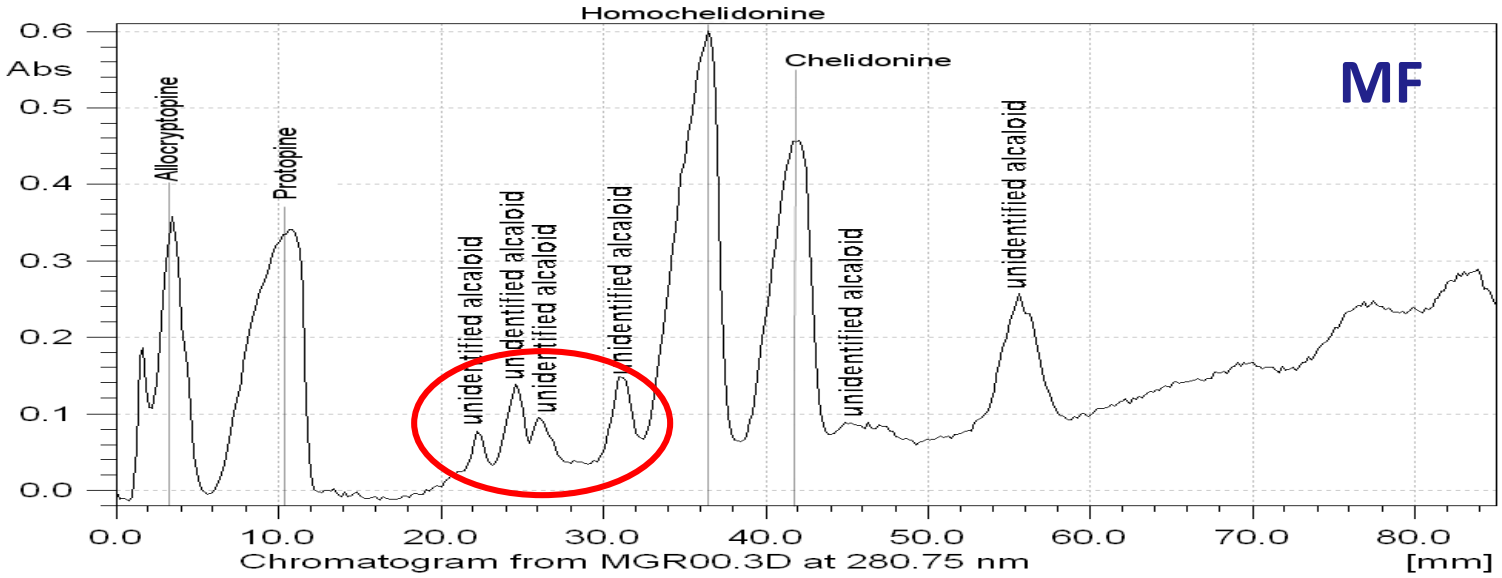


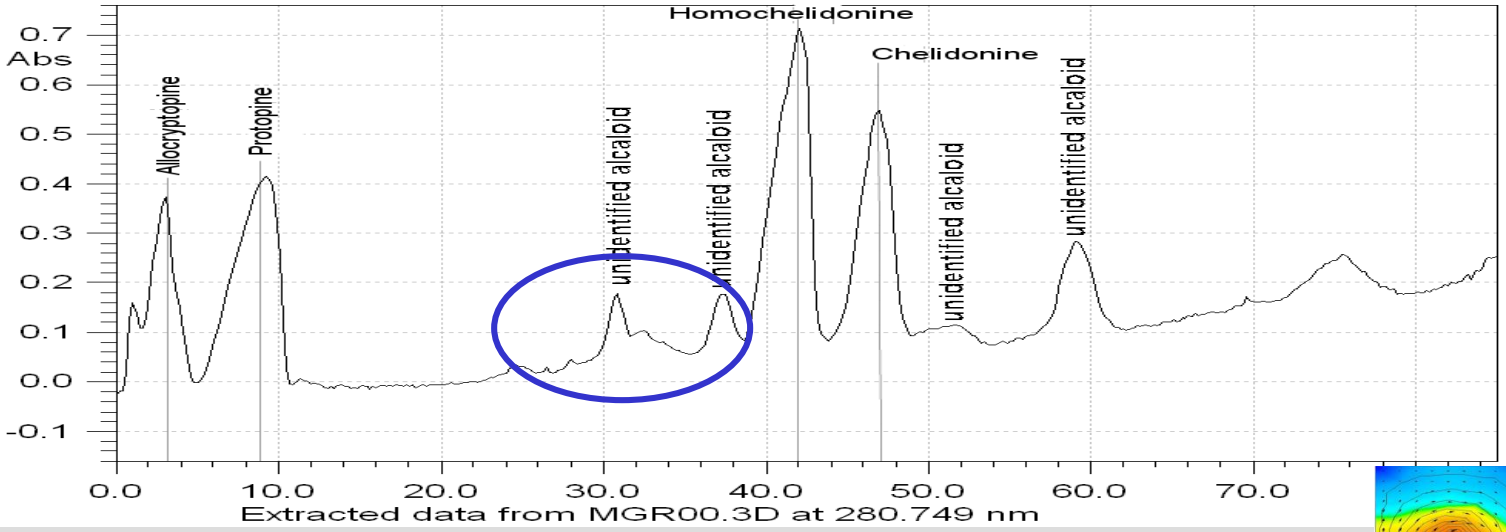



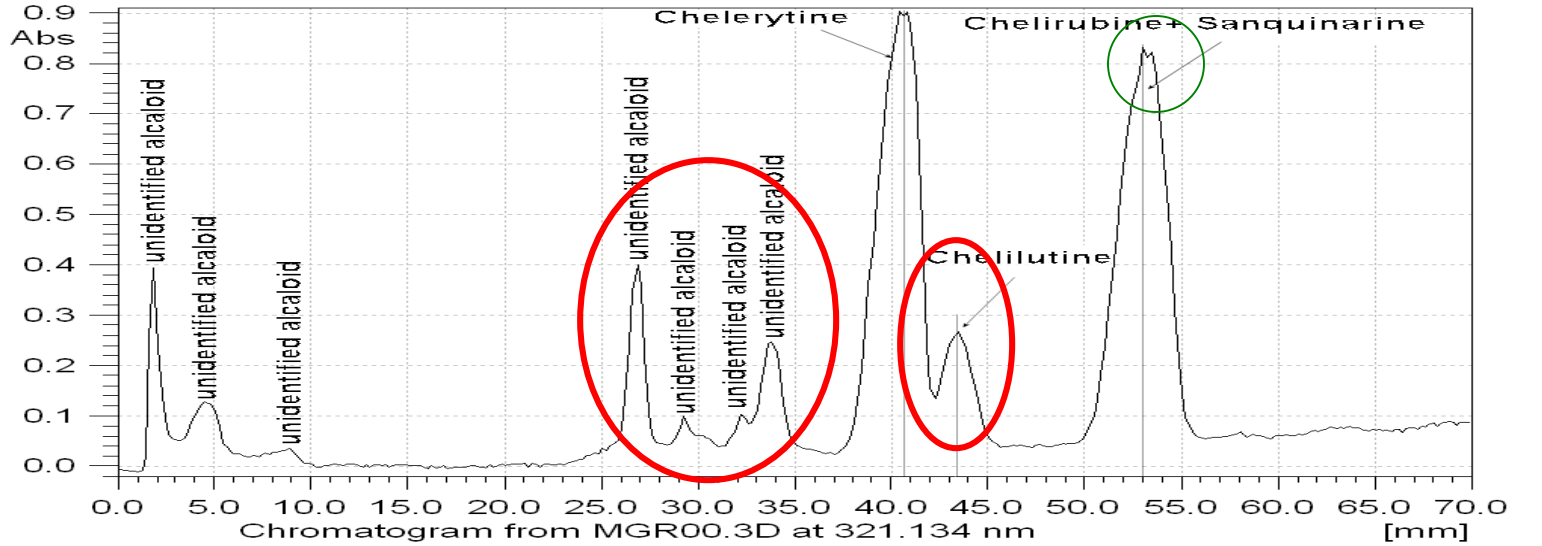


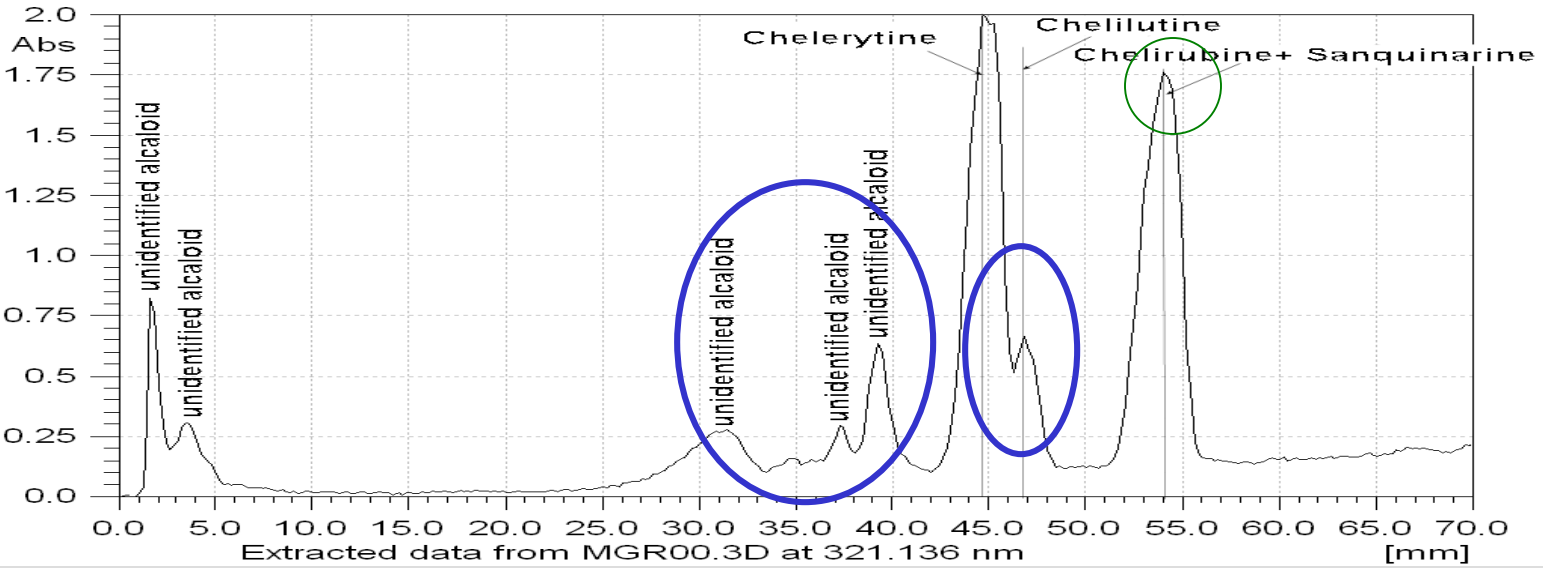
**Stationary phase $SiO_2$**

**Mobile phae: toluene/ethyl acetate /methanol 70/15/15 v/v/v**


Homochelidonine
Chelidonine
MF
Allocryptopine
Protopine
unidentified alcaloid
unidentified alcaloid
unidentified alcaloid
unidentified alcaloid
unidentified alcaloid
unidentified alcaloid
Abs
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
[mm]
Chromatogram from MGR00.3D at 280.75 nm


Homochelidonine
Chelidonine
Allocryptopine
Protopine
unidentified alcaloid
unidentified alcaloid
unidentified alcaloid
unidentified alcaloid
Abs
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Extracted data from MGR00.3D at 280.749 nm

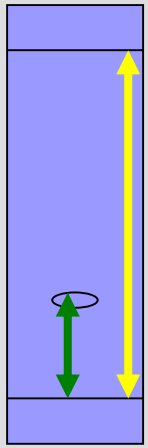


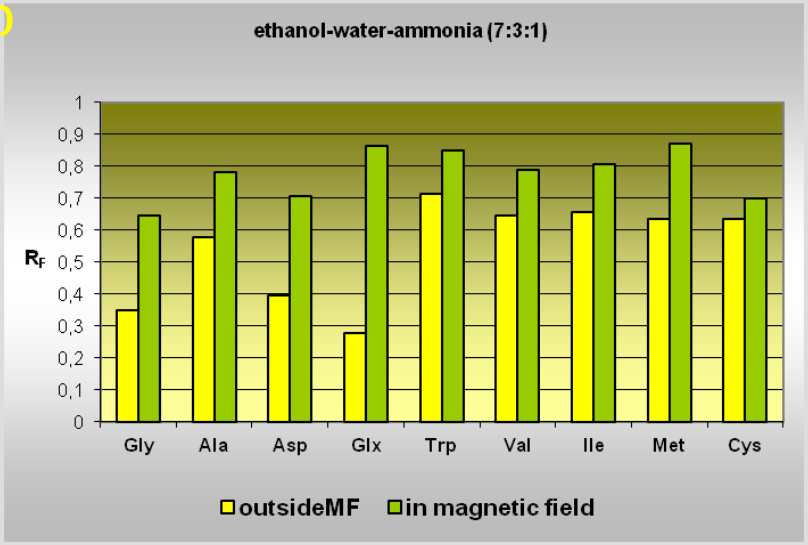



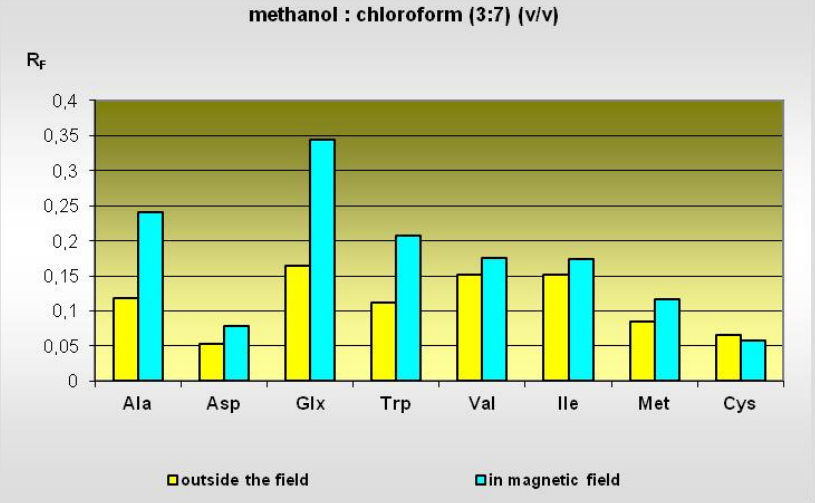

# Quaternary alkaloid extract.

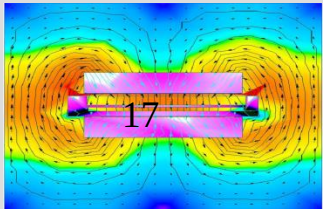
# amino acids in magnetic field

$R_F = a/b$

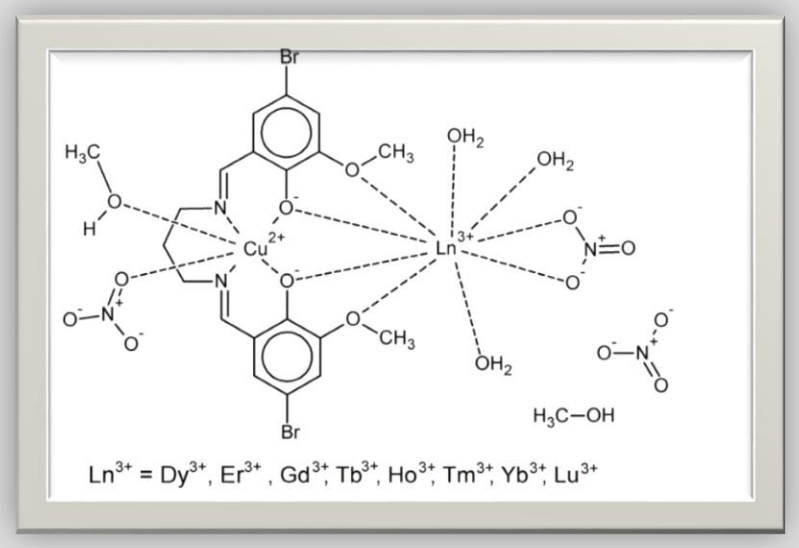


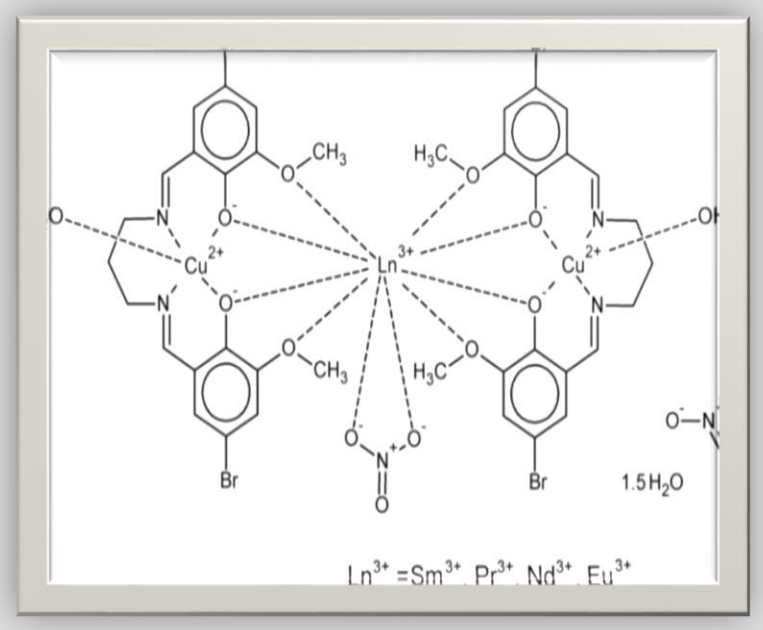


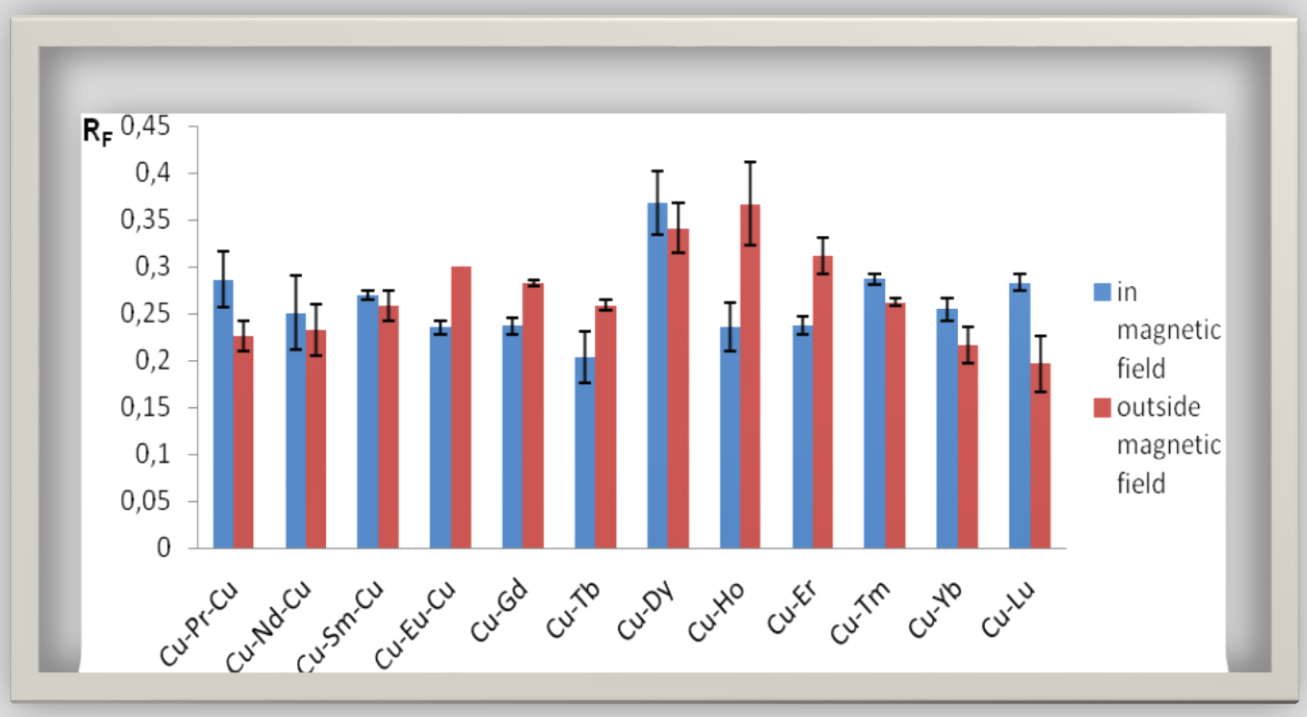
# Investigated compounds – heteronuclear complexes



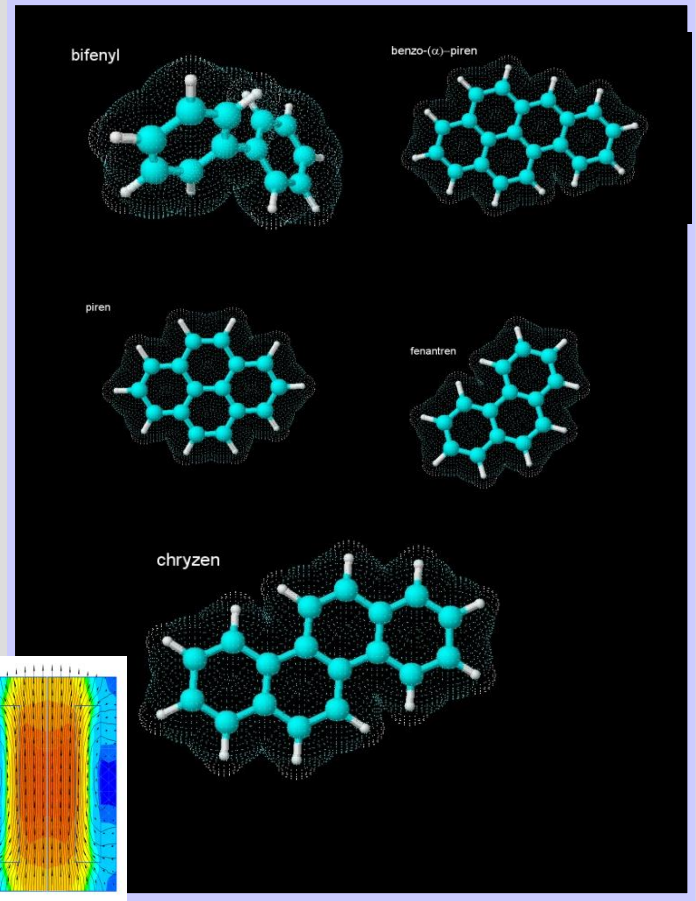



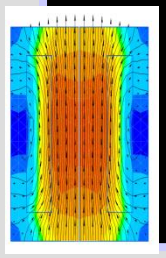

**f-electron elements**

# Heteronuclear complexes in magnetic filed

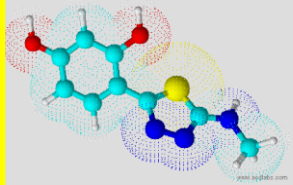


# PAH

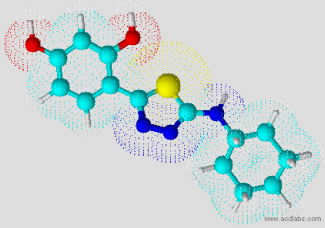


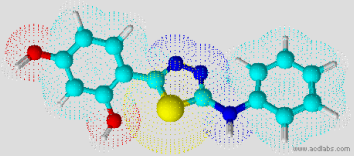
# resorcynothiadiazole derivatives



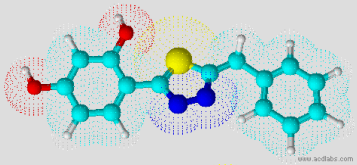
4-(5-amino-1,3,4-thiadiazol-2-yl)benzene-1,3-diol



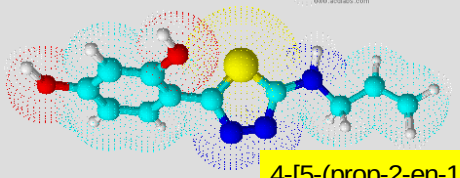
4-[5-(cyclohexylamino)-1,3,4-thiadiazol-2-yl]benzene-1,3-diol



4-(5-benzyl-1,3,4-thiadiazol-2-yl)benzene-1,3-diol

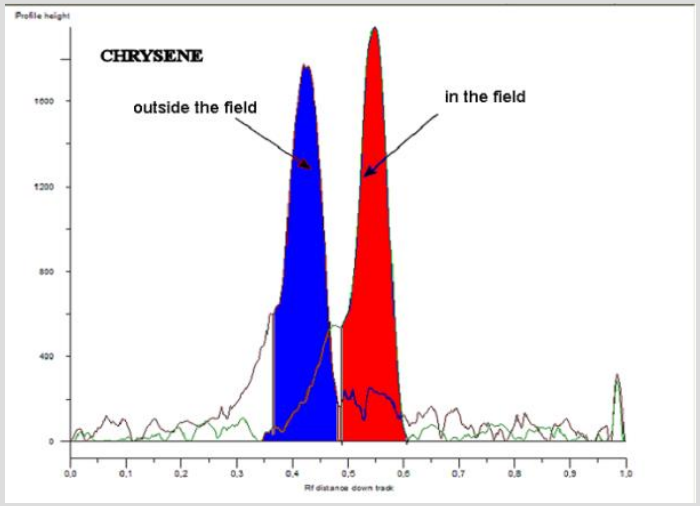


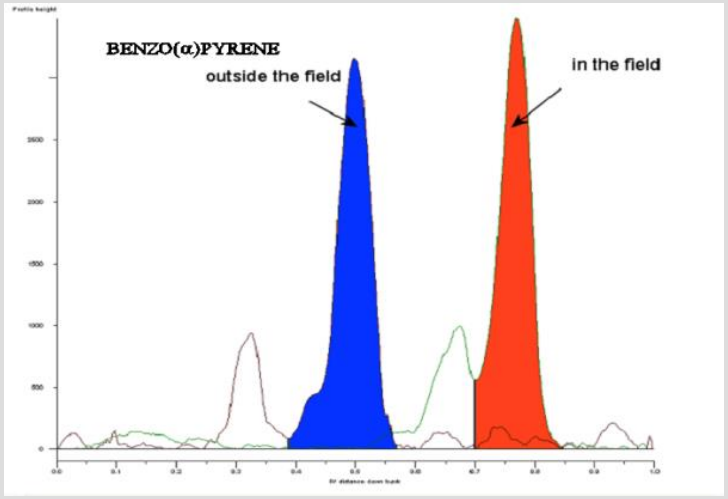
4-(5-benzyl-1,3,4-thiadiazol-2-yl)benzene-1,3-diol



4-[5-(prop-2-en-1-ylamino)-1,3,4-thiadiazol-2-yl]benzene-1,3-diol

# PAH

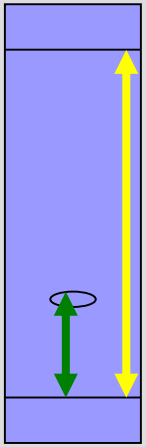


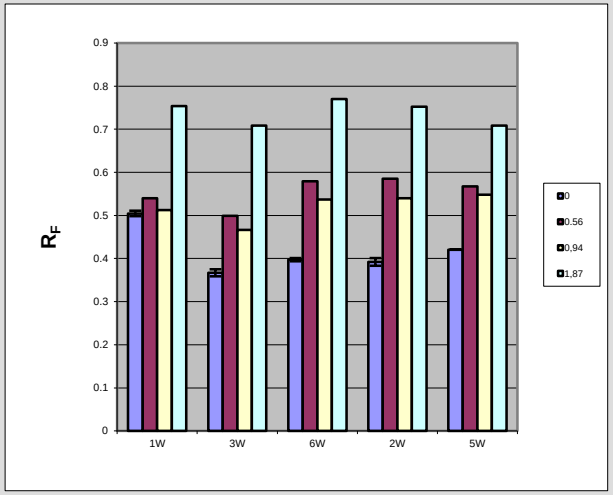



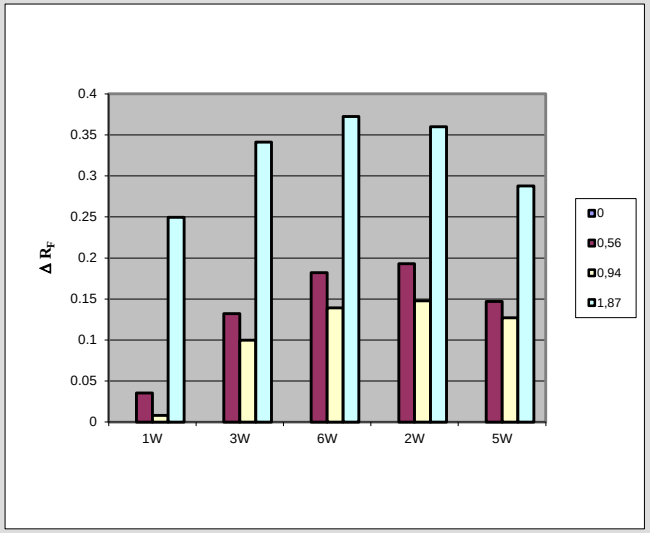

**B= 1.87 T, sationary phase $SiO_2$ 60, mobile phase – n-hexane**

# PAH retention in strong magnetic fields

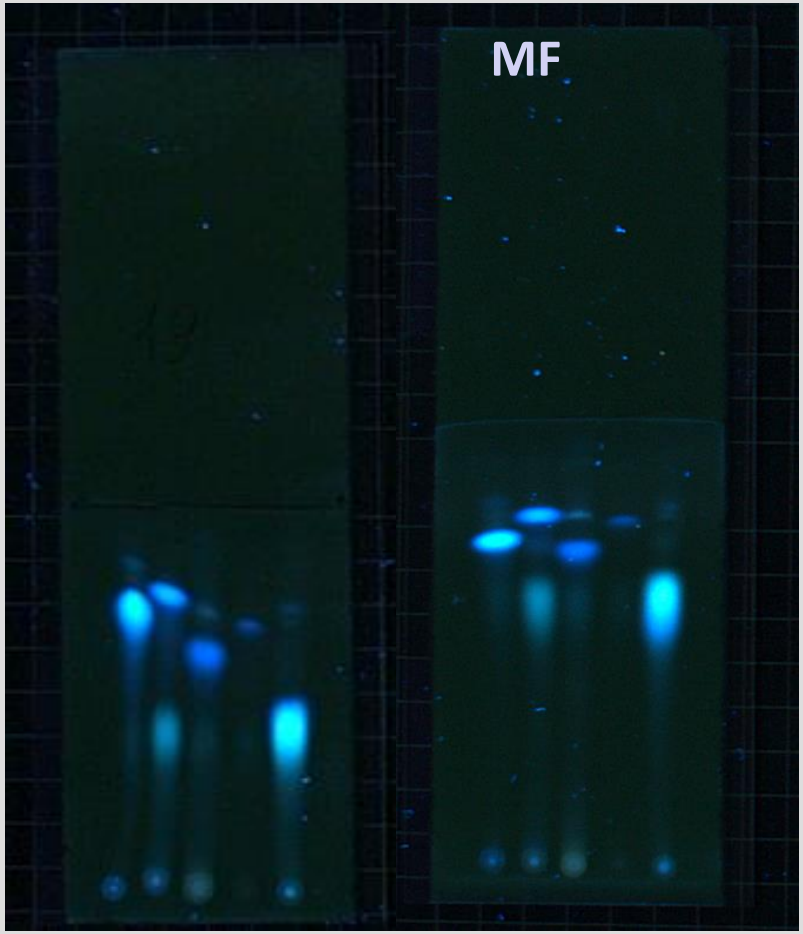
$R_F = a/b$



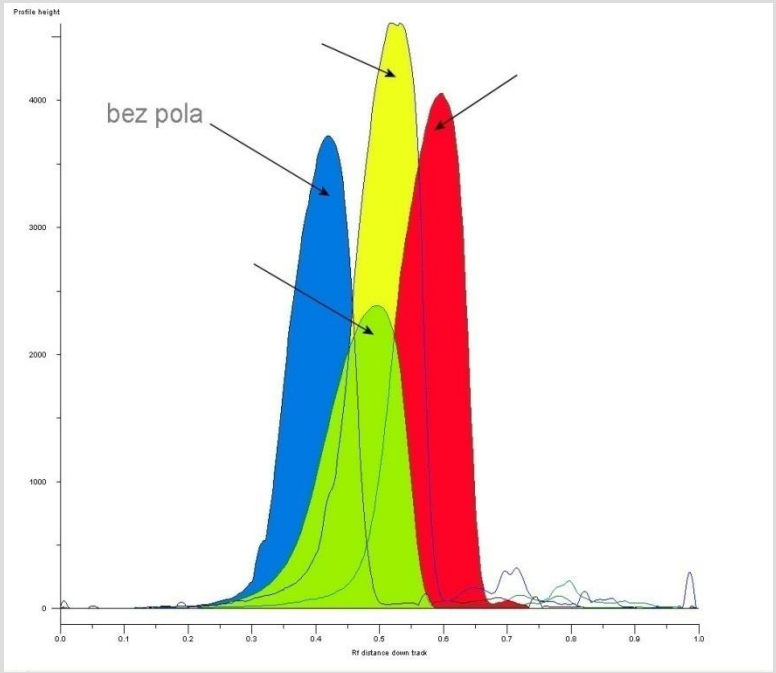


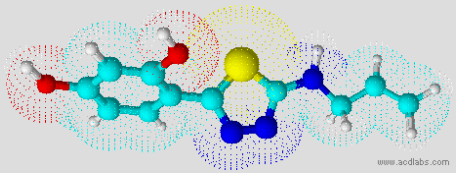



# Rezorcynotiadiazole -NP

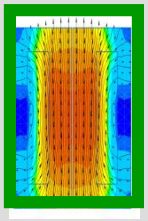


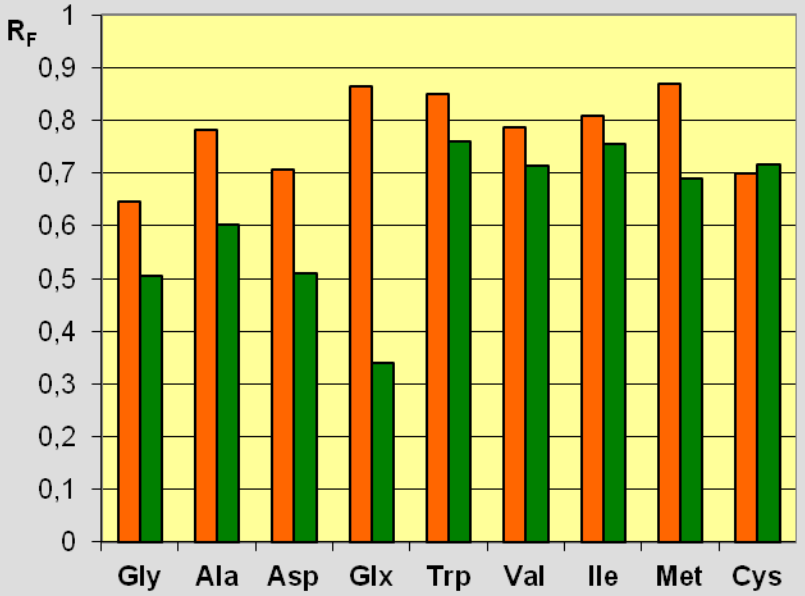

0, 0.56, 1.87, 3.1 T



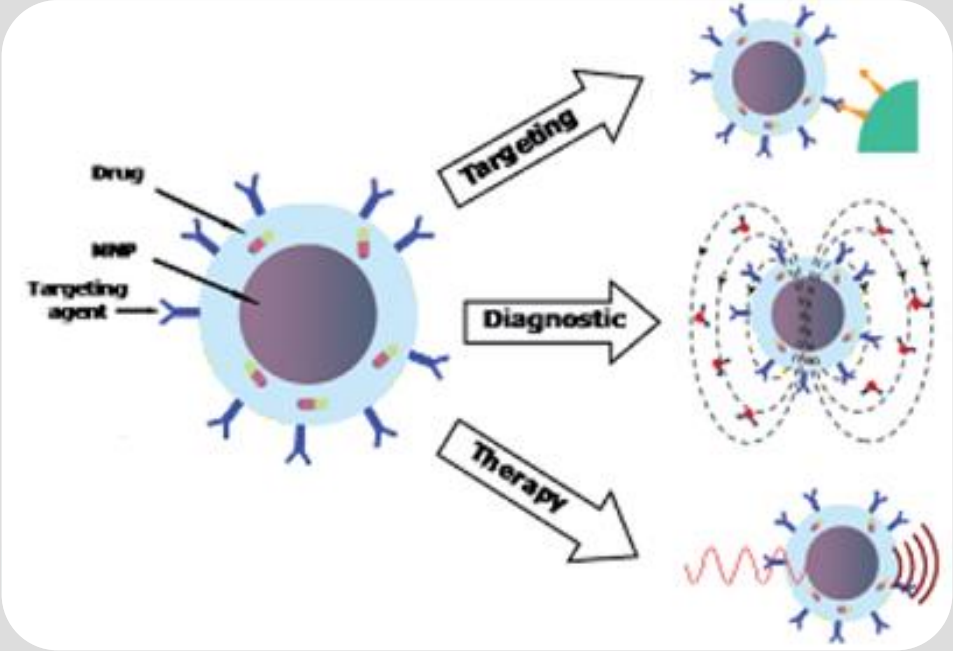



# aminoacids



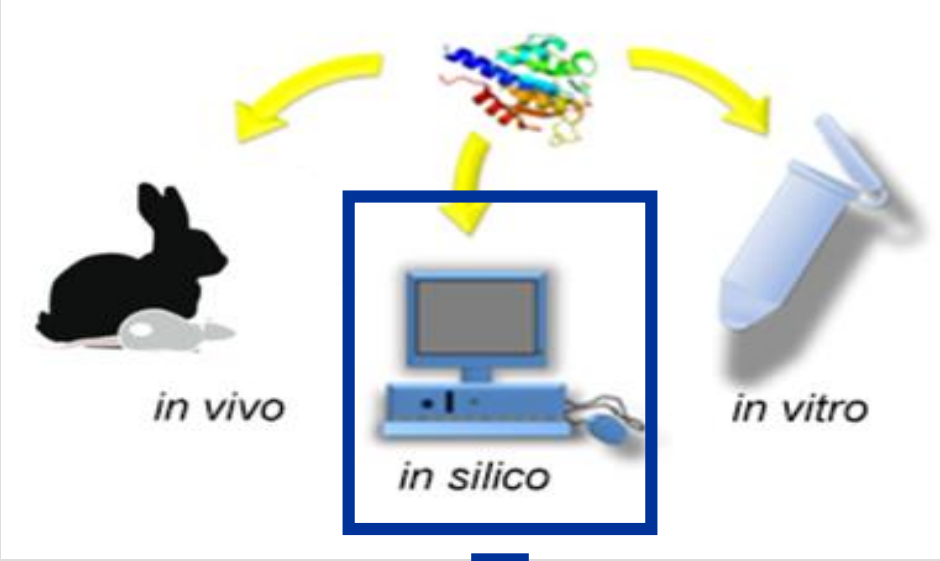



B=1.84 T


Drug
MNP
Targeting agent
Targeting
Diagnostic
Therapy

# important questions

1. • does magnetic field influence interaction of drugs with receptors
2. • does magnetic field influence penetrability of the drugs through biological membranes?
3. •does magnetic field influence some processes in nature?

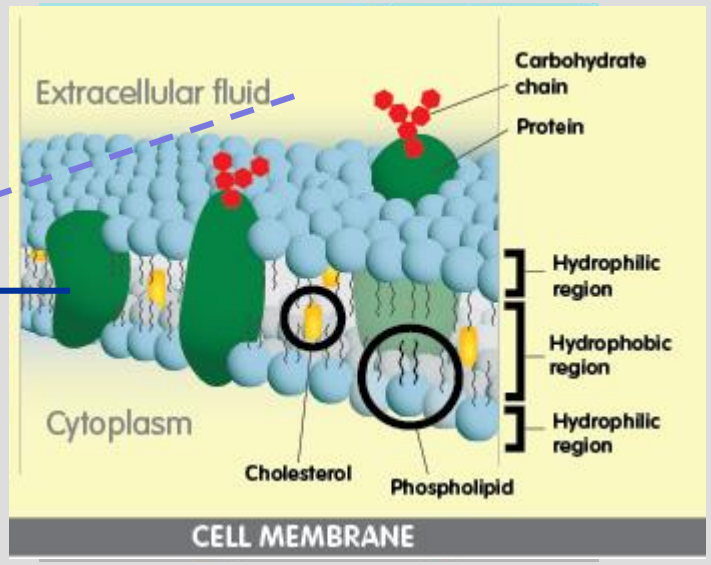



**CHROMATOGRAPHY**

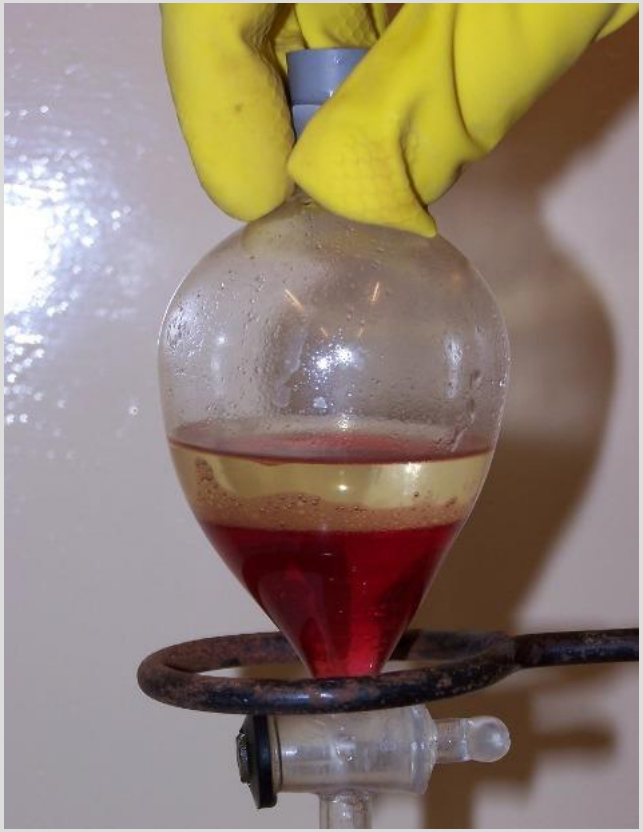
# lipophilicity and magnetic field

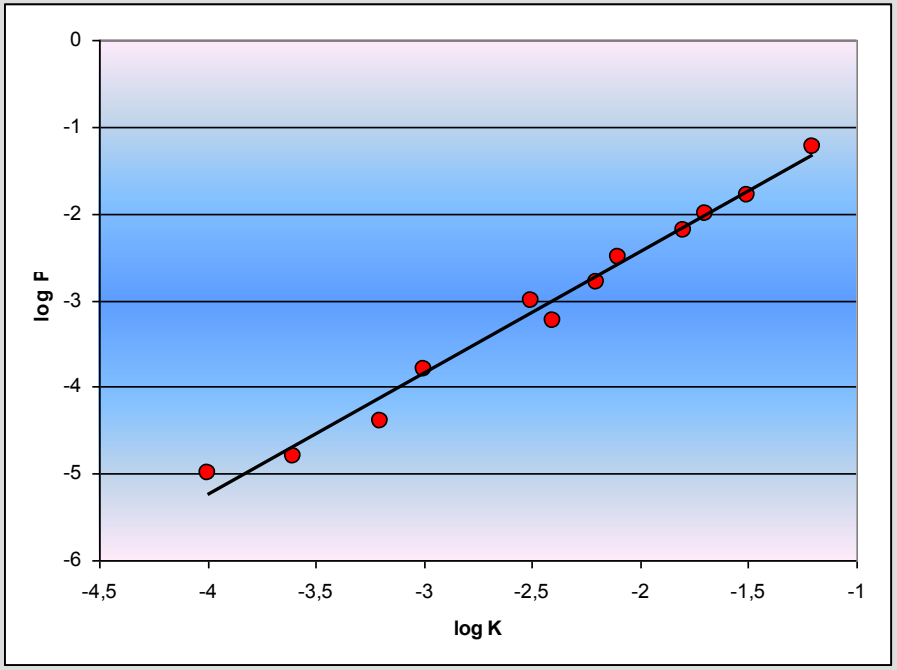
**Partition coefficient n-octanol-water**

$$P = \frac{C_o}{C_w}$$

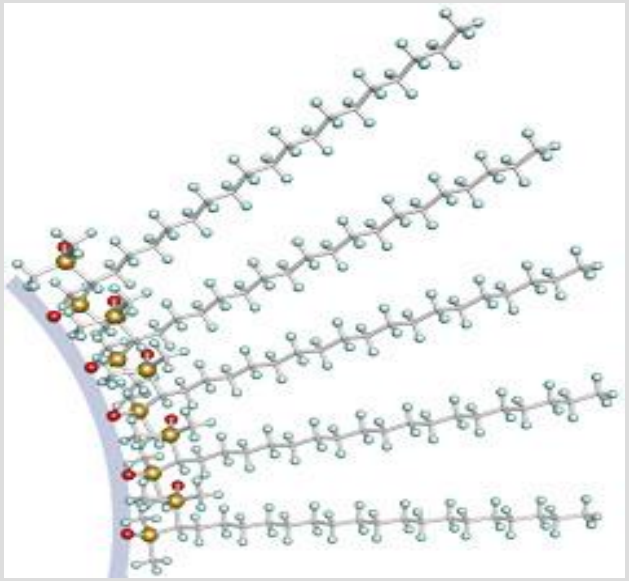


# correlation between log P and log K





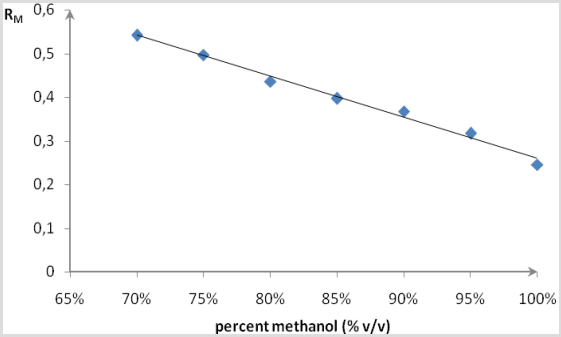
# Chromatographic system imitatating biological membrane



Stationary phase : C-18

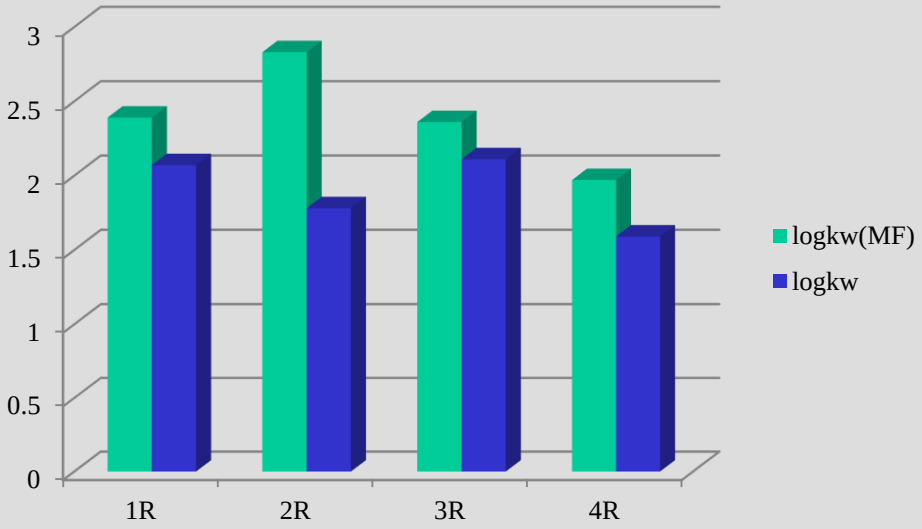
$$\log P = \log \frac{C_o}{C_w} \equiv \log k_w$$

mobile phase: water



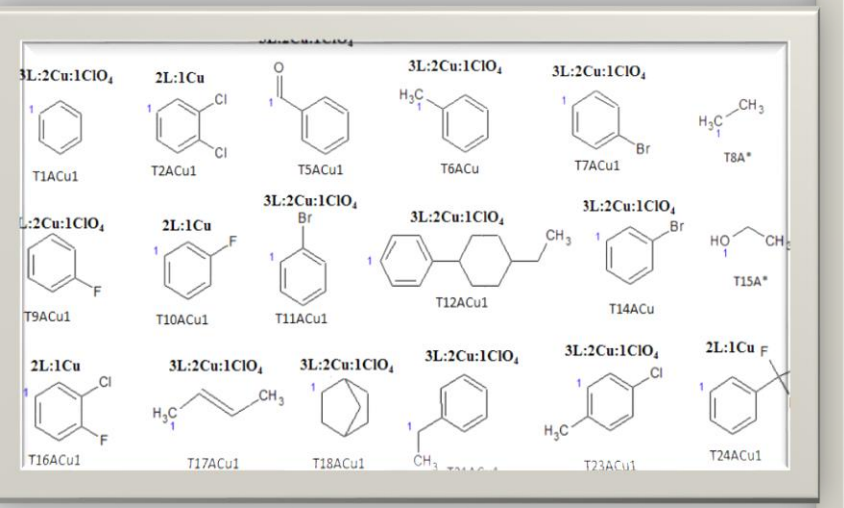

$$R_M = R_{M0} - s\,\varphi$$

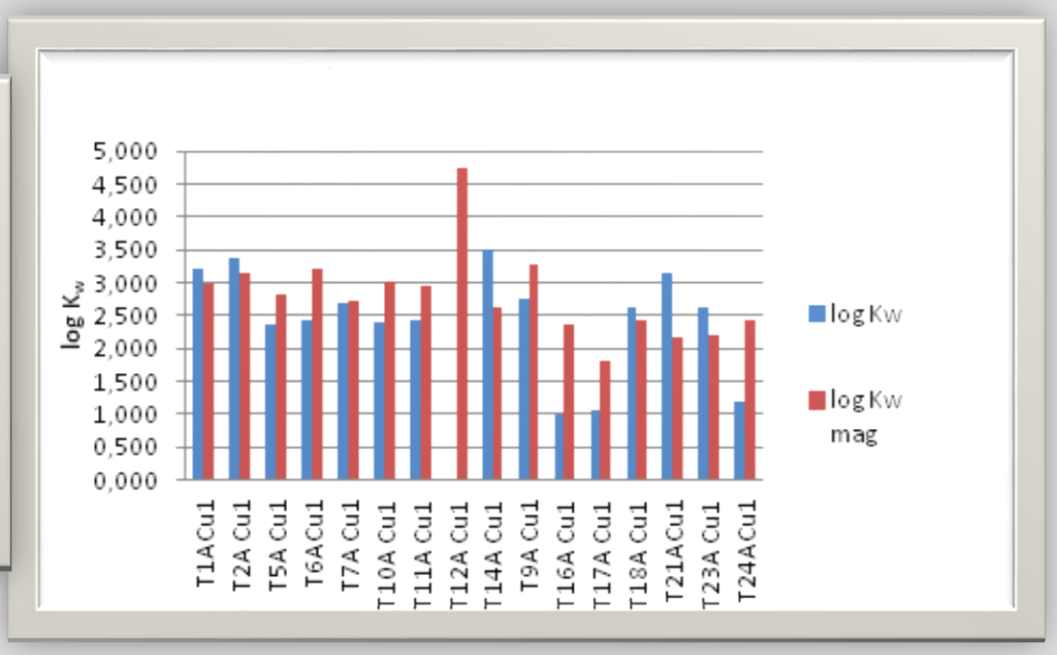
| |
|---|
| 4-[5-(metylamino)-1,3,4-tiadiazol-2yl]benzeno-1,3-diol |
| 4-[5-(cykloheksylo)-1,3,4-tiadiazol-2yl]benzeno-1,3-diol |
| . 4-[5-(prop-2en-1-yloamino)-1,3,4-tiadiazol-2yl]benzeno-1,3-diol |
| 4-(5-benzyl-1,3,4-tiadiazol-2yl)benzeno-1,3-diol |
| 4-[5-(fenyloamino)-1,3,4-tiadiazol-2yl]benzeno-1,3-diol |



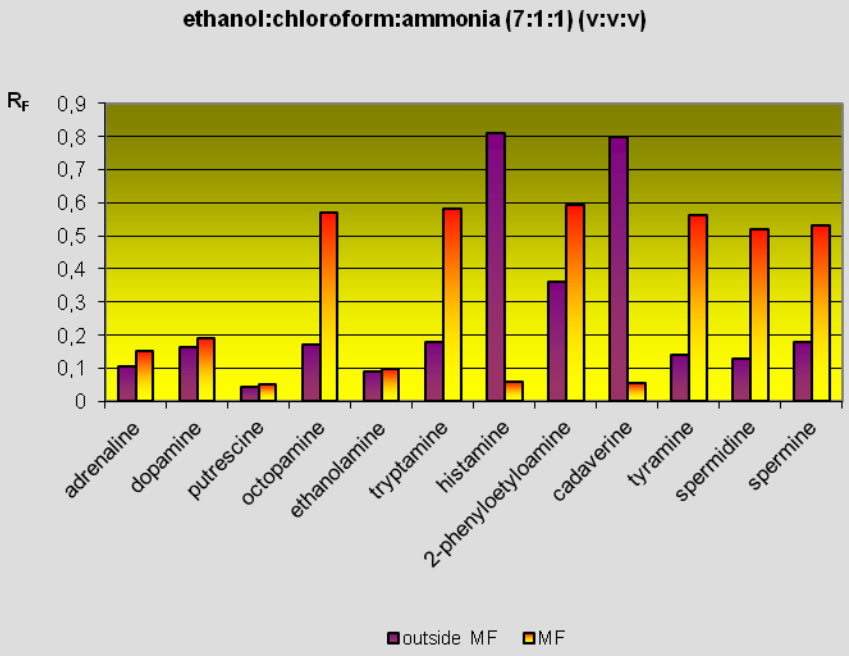

B=1.98T

# complexes


3L:2Cu:1ClO4
T1ACu1
2L:1Cu
T2ACu1
T5ACu1
3L:2Cu:1ClO4
T6ACu
3L:2Cu:1ClO4
T7ACu1
T8A*
T9ACu1
2L:1Cu
T10ACu1
3L:2Cu:1ClO4
T11ACu1
3L:2Cu:1ClO4
T12ACu1
3L:2Cu:1ClO4
T14ACu
T15A*
2L:1Cu
T16ACu1
3L:2Cu:1ClO4
T17ACu1
3L:2Cu:1ClO4
T18ACu1
3L:2Cu:1ClO4
3L:2Cu:1ClO4
T23ACu1
2L:1Cu
T24ACu1


log Kw
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
0,500
0,000
T1ACu1
T2A Cu1
T5A Cu1
T6ACu1
T7A Cu1
T10A Cu1
T11A Cu1
T12A Cu1
T14A Cu1
T9A Cu1
T16A Cu1
T17A Cu1
T18A Cu1
T21ACu1
T23A Cu1
T24ACu1
log Kw
log Kw mag

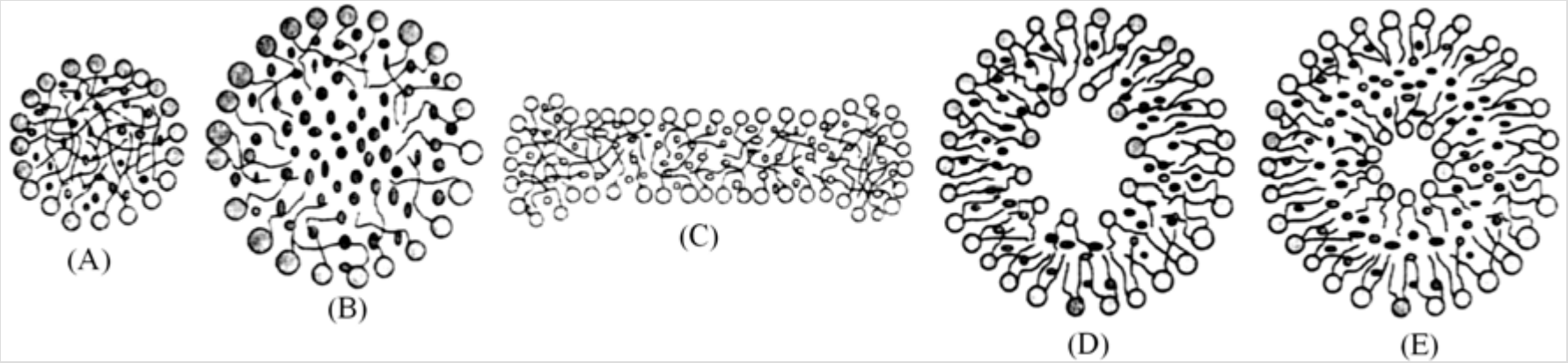
# biogenic amines in magnetic field



# MLC Micellar Liquid Chromatography

Stationary phase– C-18

Mobile phase– buffer (pH=7.4)-organic modifier, surfactant – concentration above CMC

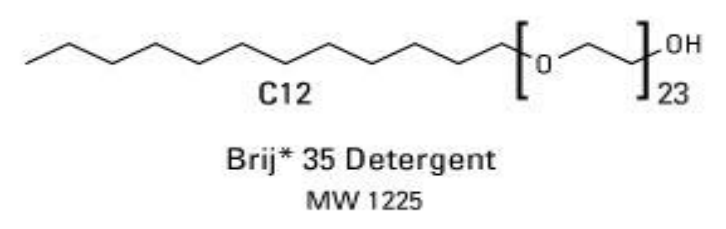


# BMC - **B**iopartitioning **M**icellar **C**hromatography

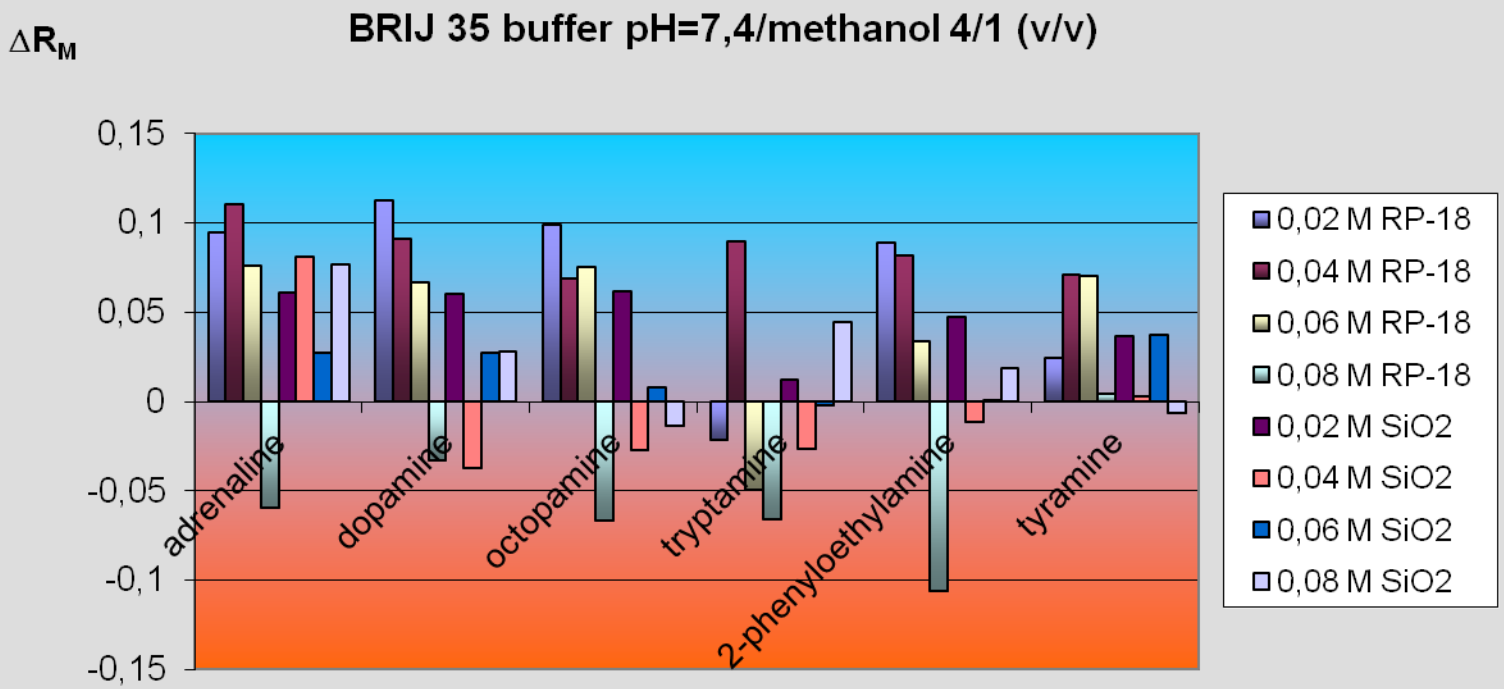
**Stationary phase– C-18**

**organic modifier– iso-buthanol**

**surfactant**



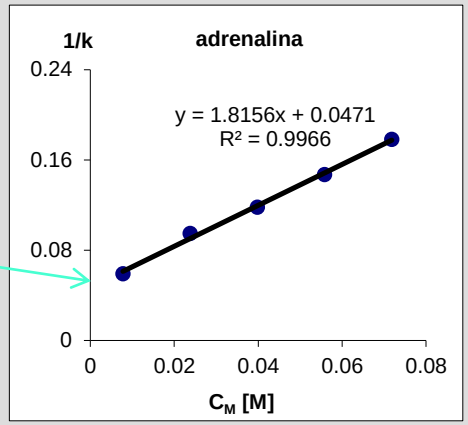
# MLC of biogenic amines in magnetic field



# ***MLC*** - determiantion of physicochemical parameters

## Foley's equation

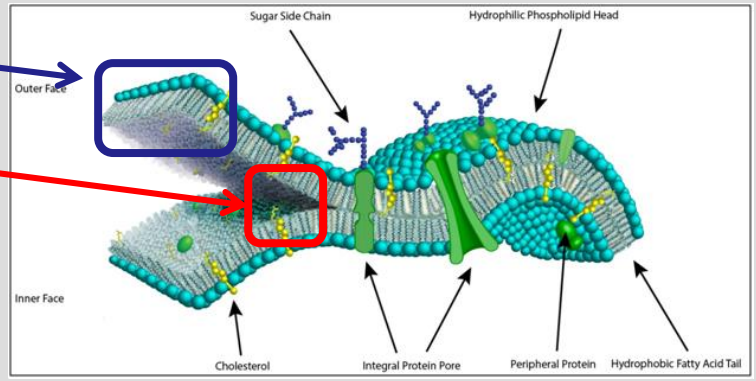
$$\frac{1}{k} = \frac{K_{ma}}{P_{sw}\phi} C_M + \frac{1}{P_{sw}\phi}$$

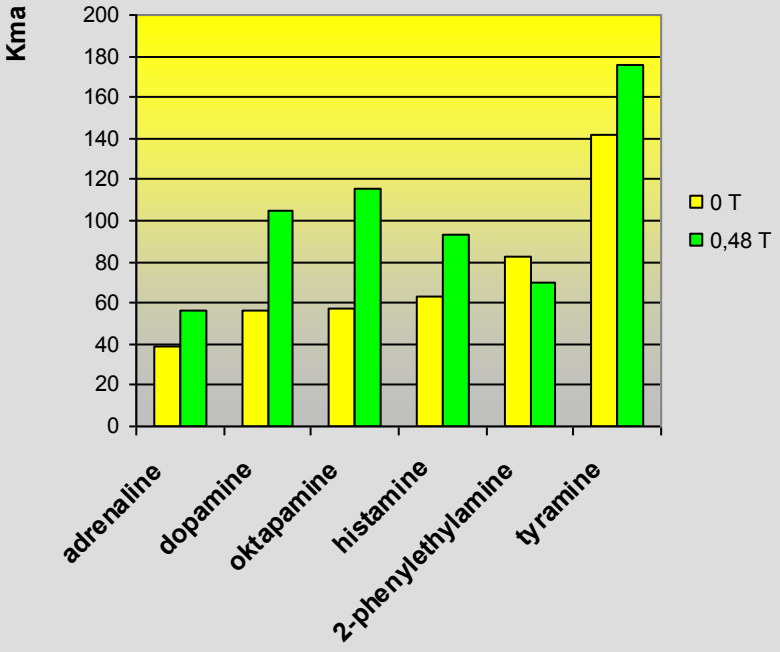


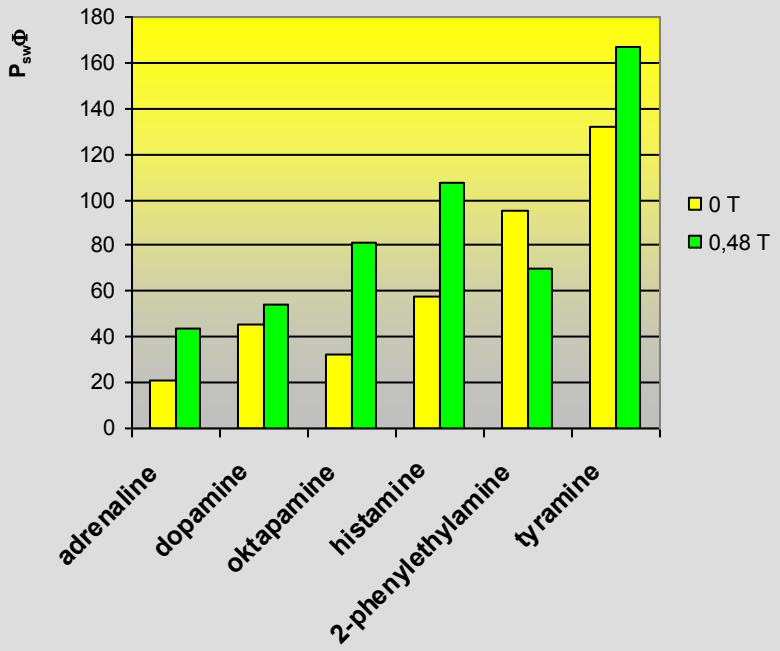

$K_{ma}$ – asociation constant analite – micelle,

$P_{sw}$ – partition coefficient of analyte between stationary phase and water,

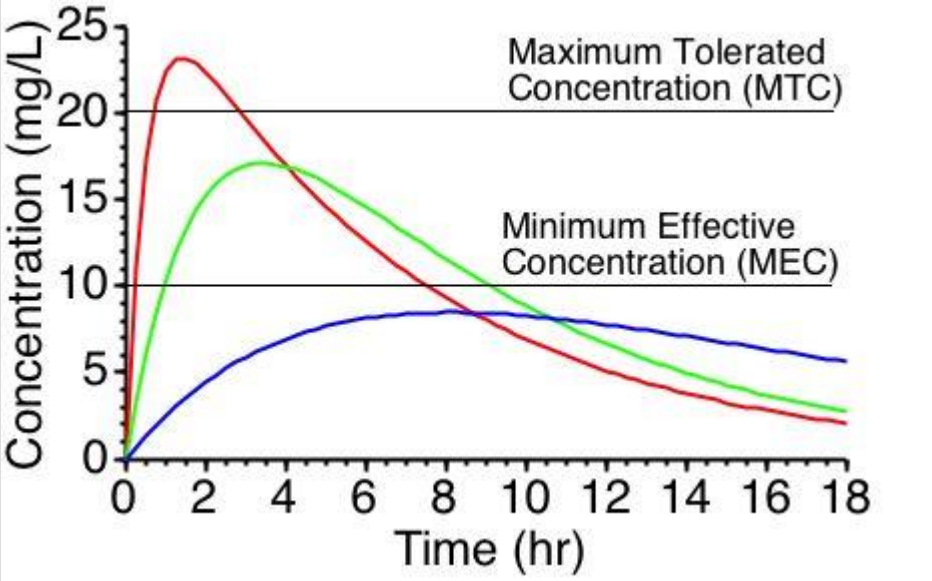
Φ – volume ratio of stationary phase ($V_s$) /mobile phase($V_m$).




Kma
200
180
160
140
120
100
80
60
40
20
0
adrenaline
dopamine
oktapamine
histamine
2-phenylethylamine
tyramine
0 T
0,48 T


$P_{sw}\Phi$
180
160
140
120
100
80
60
40
20
0
adrenaline
dopamine
oktapamine
histamine
2-phenylethylamine
tyramine
0 T
0,48 T

# why the investigations?




change of lipophilicity of substance

change migration velocity of substane

change concentration profile of substance

$V_A > V_B > V_C$


L
• liberation
A
• absorption
D
• distribution
M
• metabolism?
E
• excertion?

**02-0-1065-2007/2014 „*Development of INNR Basic Facility for Generation of Intense Heavy Ion and Polarized Nuclear Beams Aimed and Searching for the Mixed Phase of Nuclear Matter and Investigation of Polarization Phenomena at the Collision Energies to up to 11 GeV*”**


1. Malinowska I., Studziński M., Malinowski H. „*The Effect of a Magnetic Field on the Retention of Polyaromatic Hydrocarbons in Planar Chromatography*”, „*JPC - Journal of Planar Chromatography Modern TLC”* 2008 (**21**) 5 p.379-385

2.Malinowska I., Studziński M., Malinowski H.”*Some aspect of TLC in homogenous magnetic Fields*” *“Journal of Separation Science”* 2011 vol 34 iss 15 p. 1788-1795

3. Malinowska I., Studziński M., Malinowski H. „*Magneto-Thin-Layer Chromatografy as a Tool for the Analysis of Plant Extracts*”, „JPC-Journal of Planar Chromatography Modern TLC” 27(2014)5 p. 340-345.

## acknowledgement

scientific and organisation committee NICA days 2015

dr Mark Studziński

dr H. Malinowski


thank you for your kind attention

# Futher investigations

1. influence of magnetic field interaction of biological active substances with blood proteins
2. Magnetic stationary phase
3. Influence of magnetic field on micelle formation
4. Influence of magnetic filed on interaction of drugs with receptors.
5. Influence of magnetic field kinetics of metabolism processes.

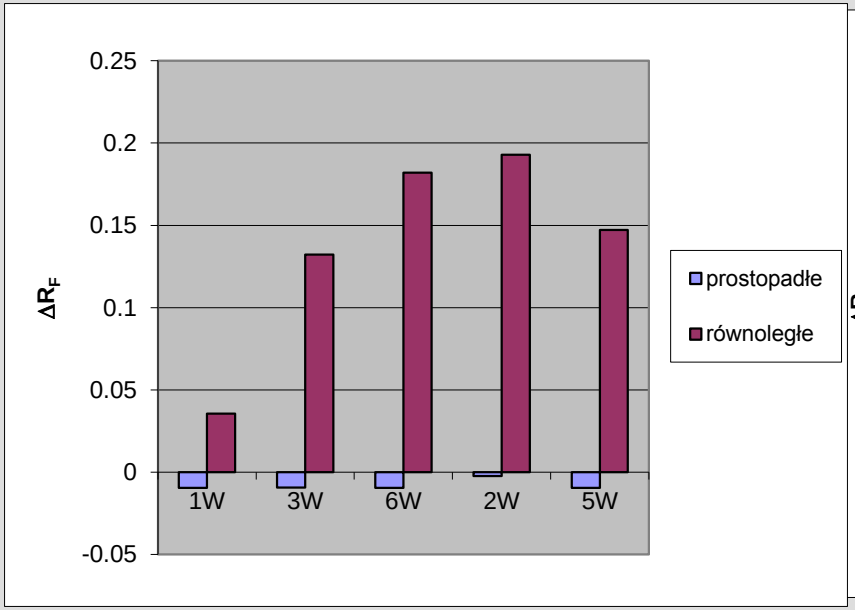
# conclusions

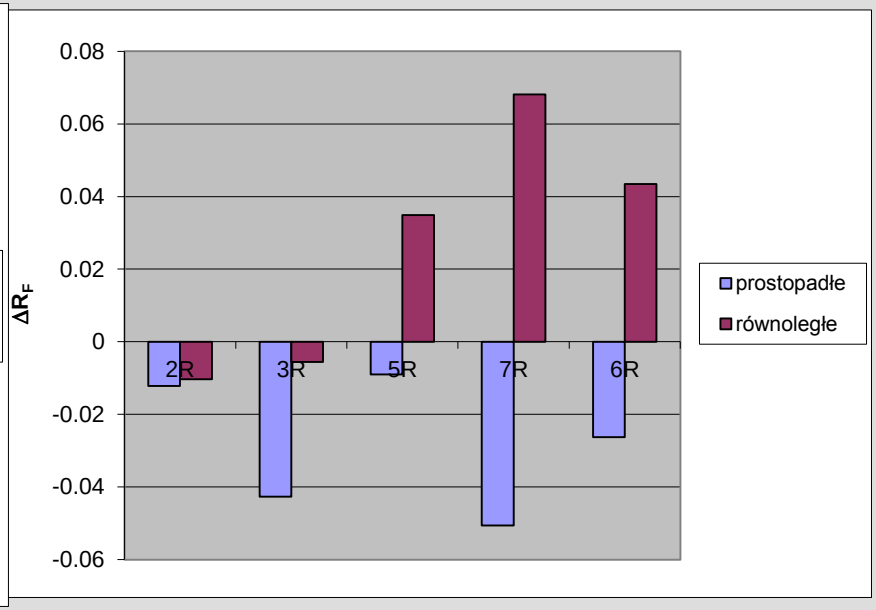
Magnetic field can influence on retention of chromatographic solutes

The influence depends on B of magnetic field, direction of magnetic field lines in relation of mobile phase migration direction.

In micellar systems magnetic field influence on hydrophobicity and interactions of chromatographic solutes with micelles.

# retention differences in perpendicular and paralell magnetic field




WWA

**resorcynthiadiazoles**