CYCLODEXTRIN NEWS
VOLUME 31. No. 03. MARCH 2017 ISSN 0951-256X

Highly Ordered Architectures Built from Cyclodextrin Complexes

Finding explanation for existence of order in nature has been a major scientific inspiration throughout thousands of years dating back to Antiquity. Every one of us may experience that our world is abundant in patterns (observable regularities). These patterns including symmetries, helices, waves, layers, etc… all may be manifested in various physical characteristics and can sometimes be modeled mathematically. Early Greek philosophers (e.g. Plato [1], Aristotle [2] Pythagoras [3] and Empedocles [4]) studied patterns attempting to explain presence of order in our word.

In the Middle Age Fibonacci adapted general mathematical model to describe periodicity in nature [5].

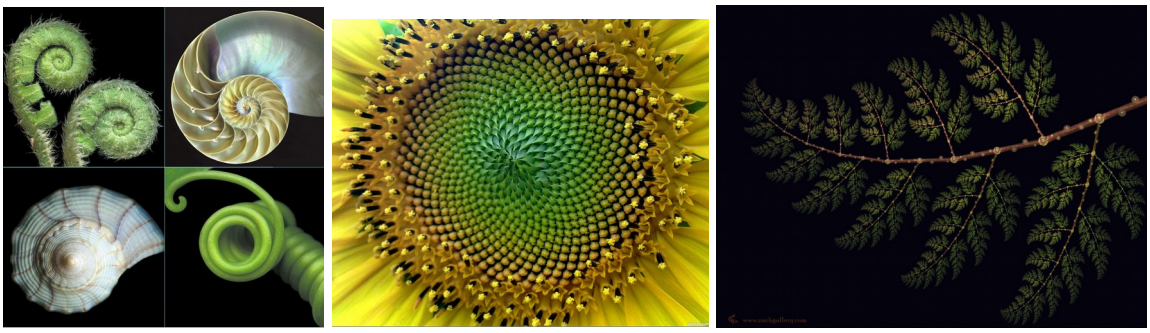


Figure 1. Examples of natural macroscopic ordered structures

In chemistry, systematic structural analysis of ordered substances has begun in the late 19th century with the revolutionary discovery of X-rays by Wilhelm Conrad Röntgen in 1895. Max von Laue investigated the interaction of X-rays with crystals producing a diffraction pattern. In 1913 the thorough research activity of William Henry Bragg and his son, William Lawrence Bragg refined the discipline of X-ray crystallography. Building on the work by von Laue, they formulated the relationship between a crystal's atomic structure and its X-ray diffraction pattern providing a tool which has revolutionized our understanding of the structure of matter ranging from minerals, pharmaceutical materials and catalysts to DNA, proteins and viruses.

A peculiar ordered state of matter, *liquid crystals* were discovered by Friedrich Richard Reinitzer performing experiments with cholesteryl benzoate in 1888. Otto Lehmann studied Reinitzer's peculiar material with polarized microscopy invented by himself. Later, Lehmann coined the term „fließende Krystalle" (liquid crystal) in 1889.

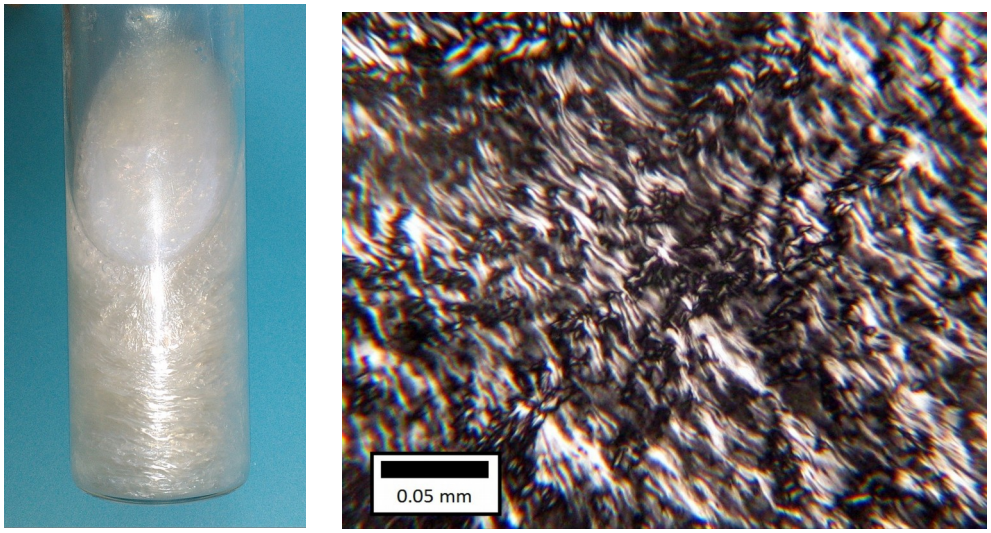
In modern science, Pierre-Gilles de Gennes Nobel Prize laureate in physics (1991) became renown for methods developed for studying order phenomena in simple systems which can be generalized to more complex forms of matter, in particular to liquid crystals and polymers.

Some specially designed cyclodextrin derivatives are thermotropic liquid crystals in themselves, i.e. ordered liquid crystalline phases occur in certain temperature ranges. Derivatives of this property (heptakis(6-S-alkyl-6-thio)-β-CDs - where alkyl is a C2, C4, C10, C16 and C18 unit) forming thermotropic liquid crystals were first reported by Ling et al. [6]. Yang et al. synthesized three cyclodextrin-triphenylene derivatives by introducing the triphenylene unit on cyclodextrin by click chemistry and further acylation of hydroxyl groups of the cyclodextrin unit [7]. One of the three studied CD-based compounds showed column liquid crystal behavior: molecules assemble into elongated, cylindrical structures. Chen et al. constructed a well-defined structure liquid crystal built up of heptakis [6-deoxy-6-(1-H-1,2,3-triazol-4-yl)(methyl)6-(4-methoxybiphenyl-4-yloxy) hexanoyl]-β-cyclodextrin (H6B-β-CD) [8]. Differential scanning calorimetry (DSC), polarizing optical microscopy (POM), and wide-angle X-ray diffraction (WAXD) measurements showed that the supramolecular structure of H6B-β-CD is consisted of a large scale ordered lamellar structure and a small scale ordered structure at low temperature region. By increasing temperature, the small scale structure becomes disordered relatively in the first instance, from smectic E to smectic A phase. Then, the lamellar structure collapses and nematic phase then isotropic phase are observed in sequence.

Albeit relatively rare phenomenon, some cyclodextrin complexes may show liquid crystalline properties in aqueous media. Sony corporation designed a thermotropic liquid crystal system comprising liquid crystal materials in widespread use in TFT (thin-film-transistor) screens wherein cyclodextrin (permethylated beta cyclodextrin) is present as additive. In the transistors, inclusion complex is formed, the viscosity is lowered, consequently the response time is reduced [9].

Unlike the previous example, most of the CD-complexes showing liquid crystalline properties are lyotropic, i.e. the associates comprise hydrophilic and hydrophobic domains which may aggregate alongside and the resulting solvent-induced extended anisotropic arrangement generates the long-range order of the phases. Szejtli and Gerlóczy documented liquid crystalline amiodarone.HCl / γ-CD complex in 1993 (the results were in fact not published by the observers) when they attempted to record solubility isotherms of the drug [10]. Amiodarone.HCl in aqueous solution comprising γ-CD showed different phases in concentration dependent manner at room temperature:

Below 1 % γ-CD:	regular drug solubilization
1 – 4 % γ-CD:	three phases (precipitate, „pearly gel-like" substance + supernatant)
4 – 8 % γ-CD:	only solid phase + „pearly gel-like" phase
8 – 10 % γ-CD:	only „pearly gel-like" phase (see Figure 2 for appearance)

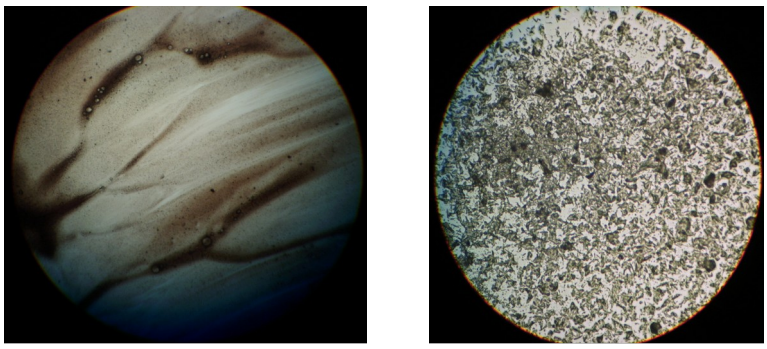


A B

Figure 2. A) Appearance B) Polarized microscopic image of „pearly gel-like" phase (8% amiodarone.HCl / γ-CD complex) at room temperature

The complex in aqueous phase (8% amiodarone.HCl / γ-CD) shows peculiar phase transitions by increasing temperature. The gel phase observable at room temperature collapses at approximately 54 °C. This change can also be observed by DSC: an endothermic enthalpy change may be recorded. Above this temperature, the anisometry in structure is still visually detectable. Structural, hence optical inhomogeneity (as observed from different directions) caused by the orientation of the layers results in so-called Schlieren effect upon stirring (see spectacular texture in Figure 2A). At 60 °C thixotropic liquid crystal phase is present, while at 90 °C the liquid becomes anisometric, a sol phase forms.

Another drug substance, cinacalcet forms crystalline complex (precipitate) with γ-CD. If the solid compex is re-wetted with water, distinct Schlieren texture is obtained, in other words, liquid crystalline-like mesophase is formed [11]. Figure 3 shows the appearance of 1:2 mol/mol cinacalcet complexes under light microscope: liquid crystalline γ-CD complex versus a conventional, anisometric, amorphous cinacalcet/HPBCD complex is depicted.



A B

Figure 3. Appearance of 1:2 mol/mol cinacalcet complexes under normal light microscope A) prepared with γ-CD, B) prepared with HPBCD

Besides the scientific peculiarity of this structural arrangement, this phenomenon in fact may be exploited for practical use. It is notable that although the binding constant of cinacalcet and γ-CD is fairly low (48 M^{-1}) compared to that recorded with HPBCD (194 M^{-1}), however upon the reconstitution of the γ-CD construct, almost two times higher cinacalcet concentration could be attained compared to the HPBCD complex. The explanation of this apparent contradiction is thought to be that the liquid became supersaturated when the liquid crystalline phase was present.

Similarly, tapentadol forms lyotropic liquid crystalline complex with γ-CD, whereas, α-CD and β-CD forms anisotropic complex [12].

A number of surfactant compounds may also form liquid crystalline compositions with different cyclodextrins [9]. Some representative examples are listed below:

- Sodium dodecyl sulfate / α-CD
- Benzoxonium chloride / α-CD
- Benzalkonium chloride / α-CD, γ-CD
- Cetylpyridinium chloride / α-CD, γ-CD
- Cetyltrimethylammonium bromide / α-CD, γ-CD

Using cyclodextrin, more complicated ternary ordered structures may also be constructed e.g. using cationic surfactants, γ-CD and natural anionic polymer hyaluronan as building blocks [13]. The ordered structure of this ternary system can be controlled by modulating electrostatic interactions and host-guest inclusion phenomena. This ternary construct was proposed to be used as tunable drug delivery vehicle. A similar approach was applied for formulating anti-HIV drugs: Song et al. prepared supramolecular assembly containing hyaluronic acid, cationic polymer (poly-L-lysine) and anionic sulfobutylether-β-cyclodextrin [14]. HIV reverse transcriptase inhibitors zidovudine and lamivudine were successfully encapsulated into the polymer assembly in a noncovalent manner. The physicochemical properties and antiviral activity of the polymer assemblies were also studied. The results of this study suggest that the supramolecular assemblies loaded with HIV drugs exert potent antiviral activity and allow sustained drug release.

The above examples illustrate the versatility of ordered structures in the world of cyclodextrins. It is hoped that this editorial highlights that periodicity in the setting-up of these constructs is not only splendid and visually attractive but also may possess true practical relevance.

References

1. Plato (c. 360 BC) Timaeus, 28a
2. Aristotle (c. 355-340 BC), Metaphysics IX 1050a 5-10
3. Aristotle (c. 355-340 BC), Metaphysics 1-5
4. Empedocles (5th century, BC): On Nature
5. Fibonacci, L. (1202 AD): Liber Abaci
6. Ling, C.-C.; Darcy, R.; Risse, W. (1993) Cyclodextrin liquid crystals: synthesis and self-organisation of amphiphilic thio-β-cyclodextrins. Journal of the Chemical Society, Chemical Communications, 5, 438-440
7. Yang, F.; Zhanga, Y.; Guoa, H. (2013) Novel supramolecular liquid crystals: cyclodextrin-triphenylene column liquid crystals based on click chemistry. New Journal of Chemistry, 37, 2275-2279
8. Chen, L.; Hu, T.-H.; Xie, H.-L.; Zhang, H.-L. (2010) A mixed cyclodextrin-biphenyl thermotropic liquid crystal: Synthesis, liquid-crystalline properties, and supramolecular organization. Journal of Polymer Science, 48, 13, 2838-2845
9. Yasuda, A.; Matsui, E. (1996) Liquid crystal composition, its production, and liquid crystal element. Japanese patent JP3804172
10. Puskás, I.; Szente, L. (2016) Highly ordered architectures built from cyclodextrin complexes. 18th International Cyclodextrin Symposium, Gainesville, USA, May 17-21, 2016
11. Puskás, I.; Szente, L; Paetz, J. (2010) Inclusion complex comprising cinacalcet and cyclodextrin. PCT patent application WO2010086129
12. Mathieu, A. (2014) Pharmaceutical formulation comprising tapentadol and cyclodextrin. PCT patent application WO2014023652
13. Szente, L.; Puskás, I.; Csabai, K.; Fenyvesi, É. (2014) Supramolecular proteoglycan aggregate mimics: cyclodextrin-assisted biodegradable polymer assemblies for electrostatic-driven drug delivery. Chemistry an Asian Journal, 9(5), 1365-1372.
14. Song, B.; Puskás, I.; Szente, L.; Hildreth J.E.K. (2016) Hyaluronic acid-based biocompatible supramolecular assembly for sustained release of antiretroviral drug. Journal of Pharmaceutical Sciences 105(9), 2760-2769

István Puskás

CycloLab Cyclodextrin R&D Laboratory, Ltd.

Budapest, HUNGARY

BIBLIOGRAPHY & KEYWORDS

1. CDs: Derivatives, Production, Enzymes, Toxicity

Battistel, M. D.; Azurmendi, H. F.; Freedberg, D. I.

Glycan OH exchange rate determination in aqueous solution: Seeking evidence for transient hydrogen bonds

Kex values for mono- and disaccharides, β-Cyclodextrin

Journal of Physical Chemistry B, American Chemical Society, 2017, 121, 683-695; DOI:10.1021/acs.jpcb.6b10594

Chen, S.; Xiong, Y.; Su, L.; Wang, L.; Wu, J.

Position 228 in Paenibacillus macerans cyclodextrin glycosyltransferase is critical for 2-O-d-glucopyranosyl-l-ascorbic acid synthesis

β-Cyclodextrin, Site-directed mutagenesis, Amino-acid sequence, Catalytic efficiencies

Journal of Biotechnology, 2017, 247, 18 - 24; DOI:10.1016/j.jbiotec.2017.02.011

Cieh, N. L.; Sulaiman, S.; Mokhtar, M. N.; Naim, M. N.

Bleached kenaf microfiber as a support matrix for cyclodextrin glucanotransferase immobilization via covalent binding by different coupling agents

Covalent immobilization, Spacer arms and ligands, Ethylenediamine, o-Phthalaldehyde, Glutaraldehyde

Process Biochemistry, 2017, *In Press;* DOI:10.1016/j.procbio.2017.02.025

Goh, K. M.; Liew, K. J.; Chai, K. P.; Illias, R. M.

Use of megaprimer and overlapping extension PCR (OE-PCR) to mutagenize and enhance cyclodextrin glucosyltransferase (CGTase) function

Protein engineering, Binding and catalytic mechanisms

Methods in Molecular Biology, 2017, 1498, 385-396; DOI:10.1007/978-1-4939-6472-7_27

Kim, N.-R.; Jeong, D.-W.; Ko, D.-S.; Shim, J.-H.

Characterization of novel thermophilic alpha-glucosidase from Bifidobacterium longum

Glycoside hydrolase, Thermostability

International Journal of Biological Macromolecules, 2017, *In Press;* DOI:10.1016/j.ijbiomac.2017.03.009

Lee, Y.-S.; Woo, J.-B.; Ryu, S.-I.; Moon, S.-K.; Han, N. S.; Lee, S.-B.

Glucosylation of flavonol and flavanones by Bacillus cyclodextrin glucosyltransferase to enhance their solubility and stability

Bacillus macerans, Isoquercitrin, Oligoglucosyl naringenin-7-(glucose), Oligoglucosyl hesperetin, Antioxidant activities

Food Chemistry, 2017, 229, 75 - 83; DOI:10.1016/j.foodchem.2017.02.057

Pourreza, N.; Naghdi, T.

d-Limonene as a green bio-solvent for dispersive liquid–liquid microextraction of β-cyclodextrin followed by spectrophotometric determination

β-Carotene, Absorption intensity

Journal of Industrial and Engineering Chemistry, 2017, *In Press;* DOI:10.1016/j.jiec.2017.02.016

Sanna, D.; Alzari, V.; Nuvoli, D.; Nuvoli, L.; Rassu, M.; Sanna, V.; Mariani, A.

β-Cyclodextrin-based supramolecular poly(N-isopropylacrylamide) hydrogels prepared by frontal polymerization

Swelling ratio, Superabsorbent

Carbohydrate Polymers, 2017, 166, 249 - 255; DOI:10.1016/j.carbpol.2017.02.099

Thi, T. D.; Hooghten, R. V.; den Mooter, G. V.

A study of the aggregation of cyclodextrins: Determination of the critical aggregation concentration, size of aggregates and thermodynamics using isodesmic and K2-K models

HP-β-CD, HP-γ-CD, SBE-β-CD

International Journal of Pharmaceutics, 2017, *In Press;* DOI:10.1016/j.ijpharm.2017.02.037

2. CD complexes: Preparation, Properties in solution and in solid phase, Specific guest

Ali, A.; Bidhuri, P.; Uzair, S.

Thermodynamic and spectroscopic studies of alanine and phenylalanine in aqueous β-cyclodextrin solutions

Amino acid, Partial molar isentropic compressibility, Hydration number

Journal of Saudi Chemical Society, 2017, 21, Supplement 1, S136 - S142; DOI:10.1016/j.jscs.2013.11.003

Angelova, S.; Nikolova, V.; Molla, N.; Dudev, T.

Factors governing the host-guest interactions between IIA/IIB group metal cations and α-cyclodextrin: A DFT/CDM study

Metal binding, Metal's radius, Electron configuration, Coordination number

Inorganic Chemistry, American Chemical Society, 2017, 56, 1981-1987; DOI:10.1021/acs.inorgchem.6b02564

Antoniuk, I.; Plazzotta, B.; Wintgens, V.; Volet, G.; Nielsen, T. T.; Pedersen, J. S.; Amiel, C.

Host–guest interaction and structural ordering in polymeric nanoassemblies: Influence of molecular design

Modified dextrans, Cyclodextrin polymers, SAXS, Dextran backbone, Pendant β−cyclodextrin, Adamantyl, Polyethylene glycol spacers, Nucleophile-mediated thiol-click reaction

International Journal of Pharmaceutics, 2017, *In Press;* DOI:10.1016/j.ijpharm.2017.02.061

Blass, J.; Albrecht, M.; Wenz, G.; Zang, Y. N.; Bennewitz, R.

Single-molecule force spectroscopy of fast reversible bonds

Cyclodextrin inclusion complexes, Binding energy

Physical Chemistry Chemical Physics, Royal Society of Chemistry, 2017, 19, 5239-5245; DOI:10.1039/c6cp07532k

Cova, T. F. G. G.; Nunes, S. C. C.; Pais, A. A. C. C.

Free-energy patterns in inclusion complexes: The relevance of non-included moieties in the stability constants

Naphthalene, β-Cyclodextrin

Physical Chemistry Chemical Physics, Royal Society of Chemistry, 2017, 19, 5209-5221; DOI:10.1039/C6CP08081B

Duez, Q.; Knight, G.; Daly, S.; De Winter, J.; Halin, E.; MacAleese, L.; Antoine, R.; Gerbaux, P.; Dugourd, P.

Action-FRET of β-cyclodextrin inclusion complexes

Modulation of the optical properties of a chromophore, Chromophore tagged cyclodextrin receptor, Donor chromophore tagged amyloid beta peptide fragment

New Journal of Chemistry, Royal Society of Chemistry, 2017, 41, 1806-1812; DOI:10.1039/C6NJ03250H

Gokel, G.

Introduction and overview of supramolecular receptor types

Calixarene, Crown ether, Cryptand, Cucurbiturils, Cyclodextrins, Weak force interactions

Reference Module in Chemistry, Molecular Sciences and Chemical Engineering, Elsevier, 2017, *In Press;* DOI:10.1016/B978-0-12-409547-2.12472-2

Han, K.; Go, D.; Tigges, T.; Rahimi, K.; Kuehne, A. J. C.; Walther, A.

Social self-sorting of colloidal families in co-assembling microgel systems

Self-assemblies, Molecular recognition

Angewandte Chemie, International Edition, Wiley-VCH Verlag GmbH & Co. KGaA, 2017, 56, 2176-2182; DOI:10.1002/anie.201612196

Hilschmann, J.; Kali, G.; Wenz, G.

Rotaxanation of polyisoprene to render it soluble in water

Polyisoprene polyrotaxanes, Poly(ethylene glycol) Me ether methacrylate, RAMEB

Macromolecules, American Chemical Society, 2017, 50, 1312-1318; DOI:10.1021/acs.macromol.6b02640

Hirotsu, T.; Higashi, T.; Abu Hashim, I. I.; Misumi, S.; Wada, K.; Motoyama, K.; Arima, H.

Self-assembly PEGylation retaining activity (SPRA) technology via a host-guest interaction surpassing conventional PEGylation methods of proteins

PEGylated β-cyclodextrin, Adamantane-appended-proteins, SPRA-lysozyme, SPRA-insulin

Molecular Pharmaceutics, American Chemical Society, 2017, 14, 368-376; DOI:10.1021/acs.molpharmaceut.6b00678

Ji, X.-f.; Xia, D.-y.; Yan, X.-z.; Wang, H.; Huang, F.-h.

Supramolecular polymer materials based on crown ether and pillararene host-guest recognition motifs

Review, Hydrogen bonding, Stacking interactions, Hydrophobic interactions, External stimuli

Gaofenzi Xuebao, Kexue Chubanshe, 2017, 9-18; DOI:10.11777/j.issn1000-3304.2017.16167

Martín, V. I.; Angulo, M.; López-Cornejo, P.; López-López, M.; Marchena, M. J.; Moyá, M. L.

Stoppering/unstoppering of a rotaxane formed between an N-hetorycle ligand containing surfactant: β-Cyclodextrin pseudorotaxane and pentacyanoferrate(II) ions

NMR spectroscopy, Pyridine ligand substitution

Journal of Colloid and Interface Science, 2017, *In Press;* DOI:10.1016/j.jcis.2017.03.019

Minato, K.; Mayumi, K.; Rina, M.; Kato, K.; Yokoyama, H.; Ito, K.

Mechanical properties of supramolecular elastomers prepared from polymer-grafted polyrotaxane

α-Cyclodextrins, Poly-ε-caprolactone, Polyethylene glycol, Hydroxypropyl cellulose, Slidable cross-links

Polymer, 2017, *In Press;* DOI:10.1016/j.polymer.2017.02.090

Reis, S.; de Fátima, Â.; Guimarães, L.; Jr., C. S. N.

Molecular inclusion process of urease inhibitors into cyclodextrins: A theoretical study

Host/guest complexes, Biginelli adducts, Hydrogen bonds

Chemical Physics Letters, 2017, *In Press;* DOI:10.1016/j.cplett.2017.03.010

3. CDs in Drug Formulation

Abdolmaleki, A.; Ghasemi, F.; Ghasemi, J. B.

Computer-aided drug design to explore cyclodextrin therapeutics and biomedical applications

Review, Affinity for protein targets

Chemical Biology & Drug Design, Wiley-Blackwell, 2017, 89, 257-268; DOI:10.1111/cbdd.12825

Andrade, T. A.; Freitas, T. S.; Araújo, F. O.; Menezes, P. P.; Dória, G. A. A.; Rabelo, A. S.; Quintans-Júnior, L. J.; Santos, M. R.; Bezerra, D. P.; Serafini, M. R.; Menezes, I. R. A.; Nunes, P. S.; Araújo, A. A.; Costa, M. S.; Campina, F. F.; Santos, A. T.; Silva, A. R.; Coutinho, H. D.

Physico-chemical characterization and antibacterial activity of inclusion complexes of Hyptis martiusii Benth essential oil in β-cyclodextrin

Modulatory-antibiotic activity, Paste complexation, Slurry complexation, Biological activity

Biomedicine & Pharmacotherapy, 2017, 89, 201 - 207; DOI:10.1016/j.biopha.2017.01.158

Ashwaq, A.-A. S.; Rasedee, A.; Abdul, A. B.; Taufiq-Yap, Y. H.; Al-Qubaisi, M. S.; Eid, E. E. M.

Characterization, drug release profile and cytotoxicity of dentatin-hydroxypropyl-β-cyclodextrin complex

Gastric adenocarcinoma cell growth, Initial burst release, Prostate cancer

Journal of Inclusion Phenomena and Macrocyclic Chemistry, Springer, 2017, 87, 167-178; DOI:10.1007/s10847-016-0688-y

Cirri, M.; Mennini, N.; Maestrelli, F.; Mura, P.; Ghelardini, C.; di Cesare Mannelli, L.

Development and in vivo evaluation of an innovative "Hydrochlorothiazide-in Cyclodextrins-in Solid Lipid Nanoparticles" formulation with sustained release and enhanced oral bioavailability for potential hypertension treatment in pediatrics

Hypertension treatment, Surfactants, HP-β-CD, SBE-β-CD, High-shear homogenization

International Journal of Pharmaceutics, 2017, 521, 73 - 83; DOI:10.1016/j.ijpharm.2017.02.022

Cumberland, A. L.; Palliser, H. K.; Crombie, G. K.; Walker, D. W.; Hirst, J. J.

Increased anxiety-like phenotype in female guinea pigs following reduced neurosteroid exposure in utero

Allopregnanolone, Fetal programming, Juvenility, (2-Hydroxypropyl)-β-cyclodextrin, Finasteride

International Journal of Developmental Neuroscience, 2017, 58, 50 - 58; DOI:10.1016/j.ijdevneu.2017.02.001

Cyphert, E. L.; Fu, A. S.; von Recum, H. A.

Featured article: Chemotherapeutic delivery using pH-responsive, affinity-based release

Doxorubicin, Adamantane, Cyclodextrin, Tumor-specific drug release, pH-Sensitive hydrazone bond

Experimental Biology and Medicine, 2017, 242, 692-699; DOI:10.1177/1535370217693115

Dai, L.; Liu, R.; Hu, L.-Q.; Wang, J.-H.; Si, C.-L.

Self-assembled PEG-carboxymethylcellulose nanoparticles/α-cyclodextrin hydrogels for injectable and thermosensitive drug delivery

CM-cellulose-betulinic acid/hydroxycamptothecine nanoparticles

RSC Advances, Royal Society of Chemistry, 2017, 7, 2905-2912; DOI:10.1039/C6RA25793C

Fan, G.; Xu, Z.; Liu, X.

Preparation of pomegranate ellagic acid inclusion complex gel and its transdermal permeation in vitro

HP-β-CD, Viscosity, Stability

Procedia Engineering, 2017, 174, 724 - 731; DOI:10.1016/j.proeng.2017.01.212

Feng, K.; Wen, P.; Yang, H.; Li, N.; Lou, W. Y.; Zong, M. H.; Wu, H.

Enhancement of the antimicrobial activity of cinnamon essential oil-loaded electrospun nanofilm by the incorporation of lysozyme

Listeria, Salmonella, Polyvinyl alcohol/β-cyclodextrin/cinnamon essential oil/lysozyme, Antifungal activity

RSC Advances, Royal Society of Chemistry, 2017, 7, 1572-1580; DOI:10.1039/C6RA25977D

Ferreira, L. E. N.; Muniz, B. V.; Burga-Sanchez, J.; Volpato, M. C.; de Paula, E.; Rosa, E. A. R.; Groppo, F. C.

The effect of two drug delivery systems in ropivacaine cytotoxicity and cytokine release by human keratinocytes and fibroblasts

Local anesthetics, HP-β-CD, Apoptosis, Cytokine (IL-1α, TNF-α, IL-6 and IL-10) release

Journal of Pharmacy and Pharmacology, John Wiley & Sons Ltd., 2017, 69, 161-171; DOI:10.1111/jphp.12680

Ferro, M.; Castiglione, F.; Pastori, N.; Punta, C.; Melone, L.; Panzeri, W.; Rossi, B.; Trotta, F.; Mele, A.

Dynamics and interactions of ibuprofen in cyclodextrin nanosponges by solid-state NMR spectroscopy

Polycondensation of β-cyclodextrin with ethylenediaminetetraacetic acid dianhydride, Supramolecular aggregate

Beilstein Journal of Organic Chemistry, 2017, 13, 182-194; DOI:10.3762/bjoc.13.21

Fiorica, C.; Palumbo, F. S.; Pitarresi, G.; Bongiovì, F.; Giammona, G.

Hyaluronic acid and beta cyclodextrins films for the release of corneal epithelial cells and dexamethasone

Hydrogels, Cell release systems, Crosslinking an amino derivative of hyaluronic acid with the divinyl sulfone derivative of β-cyclodextrins

Carbohydrate Polymers, 2017, 166, 281 - 290; DOI:10.1016/j.carbpol.2017.02.071

Gan, T. J.; Singla, N.; Daniels, S. E.; Hamilton, D. A.; Lacouture, P. G.; Reyes, C. R.; Carr, D. B.

Postoperative opioid sparing with injectable hydroxypropyl-β-cyclodextrin-diclofenac: Pooled analysis of data from two Phase III clinical trials

Nonopioid analgesics, Nonsteroidal anti-inflammatory drugs, Pain management, Patients requiring opioids

Journal of Pain Research, 2017, 10, 15-29; DOI:10.2147/JPR.S106578

Garcia-Moreno, M. I.; de la Mata, M.; Sanchez-Fernandez, E. M.; Benito, J. M.; Diaz-Quintana, A.; Fustero, S.; Nanba, E.; Higaki, K.; Sanchez-Alcazar, J. A.; Garcia Fernandez, J. M.; Ortiz Mellet, C.

Fluorinated chaperone-β-cyclodextrin formulations for β-glucocerebrosidase activity enhancement in neuronopathic gaucher disease

Glycomimetics, 1,6-Anhydro-L-idonojirimycin, Immunolabeling

Journal of Medicinal Chemistry, American Chemical Society, 2017, 60, 1829-1842; DOI:10.1021/acs.jmedchem.6b01550

Hamsici, S.; Cinar, G.; Celebioglu, A.; Uyar, T.; Tekinay, A. B.; Guler, M. O.

Bioactive peptide functionalized aligned cyclodextrin nanofibers for neurite outgrowth

Neural regeneration, Neural differentiation, Adamantane-conjugated laminin, Electrospun cyclodextrin nanofibers

Journal of Materials Chemistry B: Materials for Biology and Medicine, Royal Society of Chemistry, 2017, 5, 517-524; DOI:10.1039/C6TB02441F

Hecht, N.; Terveer, N.; Schollmayer, C.; Holzgrabe, U.; Meinel, L.

Opening NADPH oxidase inhibitors for in vivo translation

Solubility, Spray drying, Cyclodextrins, Triazolopyrimidine derivatives, Cardiovascular diseases, Supersaturation ratio

European Journal of Pharmaceutics and Biopharmaceutics, 2017, *In Press;* DOI:10.1016/j.ejpb.2017.03.001

Heydari, S.; Mohammadzade kakhki, R.

Thermodynamic study of complex formation of β-cyclodextrin with ibuprofen by conductometric method and determination of ibuprofen in pharmaceutical drugs

van't Hoff plot, Determination of ibuprofen in the presence of β-CD

Arabian Journal of Chemistry, 2017, 10, Supplement 1, S1223 - S1226; DOI:10.1016/j.arabjc.2013.02.021

Hu, Q.; Guo, F.; Zhao, F.; Fu, Z.; Tang, G.

Cardiovascular toxicity assessment of poly(ethylene imine)-based cationic polymers on zebrafish model

Endothelial cells, Risk assessment in vivo, β-Cyclodextrin, Cell apoptosis, Cardiovasculature toxicity

Journal of Biomaterials Science, Polymer Edition, 2017, 1-13; DOI:10.1080/09205063.2017.1301773

Hu, X.; Sun, M.; Li, Y.; Tang, G.

Evaluation of molecular chaperone drug function: Regorafenib and β-cyclodextrins

Solubility, Dissolution, Phase-solubility study, In vivo distribution and antitumor studies, Bioavailability

Colloids and Surfaces B: Biointerfaces, 2017, 153, 61 - 68; DOI:10.1016/j.colsurfb.2017.02.006

Ignaczak, A.; Palecz, B.; Belica-Pacha, S.

Quantum chemical study and isothermal titration calorimetry of β-cyclodextrin complexes with mianserin in aqueous solution

Interaction parameters

Organic & Biomolecular Chemistry, Royal Society of Chemistry, 2017, 15, 1209-1216; DOI:10.1039/C6OB02109C

Jalalvandi, E.; Hanton, L. R.; Moratti, S. C.

Schiff-base based hydrogels as degradable platforms for hydrophobic drug delivery

In-situ forming hydrogel, Dextran aldehyde polymer, Cyclodextrin-functionalized polyaspartamide with PEG pendants, Phase solubility

European Polymer Journal, 2017, 90, 13 - 24; DOI:10.1016/j.eurpolymj.2017.03.003

Jang, D.; Lee, Y. M.; Lee, J.; Doh, J.; Kim, W. J.

Remission of lymphoblastic leukaemia in an intravascular fluidic environment by pliable drug carrier with a sliding target ligand

Polyrotaxane-based nanoconstruct, Cyclodextrin, Poly(ethylene glycol)

Scientific Reports, Nature Publishing Group, 2017, 7, 40739; DOI:10.1038/srep40739

Kumar, R.; Kaur, K.; Uppal, S.; Mehta, S.

Ultrasound processed nanoemulsion: A comparative approach between resveratrol and resveratrol cyclodextrin inclusion complex to study its binding interactions, antioxidant activity and UV light stability

Bovine serum albumin, Phospholipid stabilized nanoemulsion, Radical diminishing potential

Ultrasonics Sonochemistry, 2017, 37, 478 - 489; DOI:10.1016/j.ultsonch.2017.02.004

Kurniawansyah, F.; Quachie, L.; Mammucari, R.; Foster, N. R.

Improving the dissolution properties of curcumin using dense gas antisolvent technology

Micronization, Methyl-β-cyclodextrin, Polyvinylpyrrolidone, Atomized rapid injection solvent extraction, Carbon dioxide

International Journal of Pharmaceutics, 2017, 521, 239 - 248; DOI:10.1016/j.ijpharm.2017.02.018

Piletti, R.; Bugiereck, A.; Pereira, A.; Gussati, E.; Magro, J. D.; Mello, J.; Dalcanton, F.; Ternus, R.; Soares, C.; Riella, H.; Fiori, M.

Microencapsulation of eugenol molecules by β-cyclodextrin as a thermal protection method of antibacterial action

Natural antibacterial materials, Escherichia coli, Staphylococcus aureus, Thermal protection

Materials Science and Engineering: C, 2017, 75, 259 - 271; DOI:10.1016/j.msec.2017.02.075

Reiser, S.; Sun, M.; Johannsen, M.; Türk, M.

Influence of chemical nature of carrier materials on the dissolution behavior of racemic ibuprofen

Silica carrier, β-Cyclodextrin, Bioavailability

The Journal of Supercritical Fluids, 2017, *In Press;* DOI:10.1016/j.supflu.2017.02.015

Rodrigues, L. B.; Martins, A. O. B. P. B.; Ribeiro-Filho, J.; Cesário, F. R. A. S.; e Castro, F. F.; de Albuquerque, T. R.; Fernandes, M. N. M.; da Silva, B. A. F.; Júnior, L. J. Q.; de Sousa Araújo, A. A.; dos Passos Menezes, P.; Nunes, P. S.; Matos, I. G.; Coutinho, H. D. M.; Wanderley, A. G.; de Menezes, I. R. A.

Anti-inflammatory activity of the essential oil obtained from Ocimum basilicum complexed with β-cyclodextrin (β-CD) in mice

Mice models of paw edema induced by carrageenan, dextran, histamine and arachidonic acid, Vascular permeability

Food and Chemical Toxicology, 2017, *In Press;* DOI:10.1016/j.fct.2017.02.027

Vermet, G.; Degoutin, S.; Chai, F.; Maton, M.; Flores, C.; Neut, C.; Danjou, P.; Martel, B.; Blanchemain, N.

Cyclodextrin modified PLLA parietal reinforcement implant with prolonged antibacterial activity

Visceral mesh, Polylactic acid, Drug delivery system, Degradation study, Ciprofloxacin, Cytocompatibility, Polyethyleneterephthalate, Polypropylene, Semi-resorbable parietal implants

Acta Biomaterialia, 2017, *In Press;* DOI:10.1016/j.actbio.2017.02.017

Yee, E. M.; Hook, J. M.; Bhadbhade, M. M.; Vittorio, O.; Kuchel, R. P.; Brandl, M. B.; Tilley, R. D.; Black, D. S.; Kumar, N.

Preparation, characterization and in vitro biological evaluation of (1:2) phenoxodiol-β-cyclodextrin complex

1H NMR and X-ray crystallography, Isoflavone analogue, Anticancer properties, Co-evaporation method, Enhanced anti-proliferative activity

Carbohydrate Polymers, 2017, 165, 444 - 454; DOI:10.1016/j.carbpol.2017.02.081

Yi, P.; Wang, Y.; Zhang, S.; Zhan, Y.; Zhang, Y.; Sun, Z.; Li, Y.; He, P.

Stimulative nanogels with enhanced thermosensitivity for therapeutic delivery via β-cyclodextrin-induced formation of inclusion complexes

Poly(N-isopropylacrylamide), Anticancer cytotoxicity, Doxorubicin

Carbohydrate Polymers, 2017, 166, 219 - 227; DOI:10.1016/j.carbpol.2017.02.107

4. CDs in Cell Biology

Bhasikuttan, A. C.; Mohanty, J.

Detection, inhibition and disintegration of amyloid fibrils: The role of optical probes and macrocyclic receptors

Review, Neurodegenerative disease, Cyclodextrins, Fibrillation of different proteins/peptides

Chemical Communications, Royal Society of Chemistry, 2017, 53, 2789-2809; DOI:10.1039/c6cc08727b

Collin, A.; Noacco, A.; Talvas, J.; Caldefie-Chezet, F.; Vasson, M.-P.; Farges, M.-C.

Enhancement of lytic activity by leptin is independent from lipid rafts in murine primary splenocytes

Inflammation, Mammary cancer cell, Membrane remodeling, Methyl-β-cyclodextrin, Lipid rafts disrupting agent

Journal of Cellular Physiology, Wiley-Blackwell, 2017, 232, 101-109; DOI:10.1002/jcp.25394

Garcia-Nino, W. R.; Correa, F.; Rodriguez-Barrena, J. I.; Leon-Contreras, J. C.; Buelna-Chontal, M.; Soria-Castro, E.; Hernandez-Pando, R.; Pedraza-Chaverri, J.; Zazueta, C.

Cardioprotective kinase signaling to subsarcolemmal and interfibrillar mitochondria is mediated by caveolar structures

Ischemia/reperfusion, Caveolae disruption with methyl-β-cyclodextrin

Basic Research in Cardiology, Springer, 2017, 112, 15; DOI:10.1007/s00395-017-0607-4

Gautam, S.; Karmakar, S.; Batra, R.; Sharma, P.; Pradhan, P.; Singh, J.; Kundu, B.; Chowdhury, P. K.

Polyphenols in combination with β-cyclodextrin can inhibit and disaggregate α-synuclein amyloids under cell mimicking conditions: A promising therapeutic alternative

Parkinson's disease, Resveratrol, Baicalein, Curcumin, (−)-Epigallocatechin gallate

Biochimica et Biophysica Acta (BBA) - Proteins and Proteomics, 2017, *In Press;* DOI:10.1016/j.bbapap.2017.02.014

Guo, J.; Russell, E. G.; Darcy, R.; Cotter, T. G.; McKenna, S. L.; Cahill, M. R.; O'Driscoll, C. M.

Antibody-targeted cyclodextrin-based nanoparticles for siRNA delivery in the treatment of acute myeloid leukemia: Physicochemical characteristics, in vitro mechanistic studies, and ex vivo patient derived therapeutic efficacy

Antitumor, Antigen-mediated cellular uptake, Bromodomain-containing protein 4, Apoptosis, Cytarabine

Molecular Pharmaceutics, American Chemical Society, 2017, 14, 940-952; DOI:10.1021/acs.molpharmaceut.6b01150

He, C.; Hu, X.; Jung, R. S.; Weston, T. A.; Sandoval, N. P.; Tontonoz, P.; Kilburn, M. R.; Fong, L. G.; Young, S. G.; Jiang, H.

High-resolution imaging and quantification of plasma membrane cholesterol by NanoSIMS

Secondary ion mass spectrometry, Cytolysin perfringolysin O, Cholesterol distribution in the plasma membrane, Methyl-β-cyclodextrin

Proceedings of the National Academy of Sciences of the United States of America, National Academy of Sciences, 2017, 114, 2000-2005; DOI:10.1073/pnas.1621432114

Hoepflinger, M. C.; Hoeftberger, M.; Sommer, A.; Hametner, C.; Foissner, I.

Clathrin in Chara australis: Molecular analysis and involvement in charasome degradation and constitutive endocytosis

Ikarugamycin, Darkness-induced degradation of charasomes, Methyl-β-cyclodextrin, Filipin, Lipid rafts

Frontiers in Plant Science, 2017, 8, 20; DOI:10.3389/fpls.2017.00020

Hsu, H.-T.; Hsu, H.-T.; Lo, Y.-C.; Tseng, Y.-T.; Huang, Y.-M.; Wu, S.-N.; Tseng, Y.-T.

Important modifications by sugammadex, a modified γ-cyclodextrin, of ion currents in differentiated NSC-34 neuronal cells

Activation kinetics, Delayed-rectifier k+ current, Dexamethasone

BMC neuroscience, 2017, 18, 6; DOI:10.1186/s12868-016-0320-5

Liossi, A. S.; Ntountaniotis, D.; Kellici, T. F.; Chatziathanasiadou, M. V.; Megariotis, G.; Mania, M.; Becker-Baldus, J.; Kriechbaum, M.; Krajnc, A.; Christodoulou, E.; Glaubitz, C.; Rappolt, M.; Amenitsch, H.; Mali, G.; Theodorou, D. N.; Valsami, G.; Pitsikalis, M.; Iatrou, H.; Tzakos, A. G.; Mavromoustakos, T.

Exploring the interactions of irbesartan and irbesartan–2-hydroxypropyl-β-cyclodextrin complex with model membranes

Dipalmitoyl phosphatidylcholine (DPPC) bilayers, Phase transition

Biochimica et Biophysica Acta - Biomembranes, 2017, *In Press;* DOI:10.1016/j.bbamem.2017.03.003

Lv, P.; Zhou, C.; Zhao, Y.; Liao, X.; Yang, B.

Modified-epsilon-polylysine-grafted-PEI-β-cyclodextrin supramolecular carrier for gene delivery

Polyethyleneimine, Supramolecular self-assembly, Adamantane-functionalized poly-(ethylene glycol) derivative, Polyplexes, Transfection efficiency

Carbohydrate Polymers, 2017, *In Press;* DOI:10.1016/j.carbpol.2017.02.036

Ma, D.; Zhou, N.; Zhang, T.; Hu, K.; Ma, X.; Gu, N.

Photoresponsive smart hydrogel microsphere via host-guest interaction for 3D cell culture

Polyethylene glycol, β-CD modified poly(methyl vinyl ether-alt-maleic acid), Azobenzene-arginine-glycine-aspartate, Cell adhesion and detachment, Photo-switchable surface

Colloids and Surfaces A: Physicochemical and Engineering Aspects, 2017, 522, 97 - 104; DOI:10.1016/j.colsurfa.2017.02.073

Maiwald, A.; Bauer, O.; Gimpl, G.

Synthesis and characterization of a novel rhodamine labeled cholesterol reporter

Fluorescent cholesterol probe, Membrane domains, Sulforhodamine group, 6-Dansyl-cholestanol, 6-Azi-cholestanol, Methyl-β-cyclodextrin, High density lipoprotein, Endosomal/lysosomal pathway of cholesterol

Biochimica et Biophysica Acta (BBA) - Biomembranes, 2017, *In Press;* DOI:10.1016/j.bbamem.2017.02.018

Ohyama, A.; Higashi, T.; Motoyama, K.; Arima, H.

Ternary complexes of folate-PEG-appended dendrimer (G4)/α-cyclodextrin conjugate, siRNA and low-molecular-weight polysaccharide sacran as a novel tumor-selective siRNA delivery system

Polyamidoamine dendrimer, Cellular uptake, Mice, Intravenous administration

International Journal of Biological Macromolecules, 2017, 99, 21 - 28; DOI:10.1016/j.ijbiomac.2017.02.045

5. CDs in Food, Cosmetics and Agrochemicals

Chu, M.; Pedreño, M.; Alburquerque, N.; Faize, L.; Burgos, L.; Almagro, L.

A new strategy to enhance the biosynthesis of trans-resveratrol by overexpressing stilbene synthase gene in elicited Vitis vinifera cell cultures

Agrobacterium system, Stable transformation, Elicitation with cyclodextrins and methyl jasmonate, Synergistic effect

Plant Physiology and Biochemistry, 2017, 113, 141 - 148; DOI:10.1016/j.plaphy.2017.02.006

Cui, L.; Liu, Y.; Liu, T.; Yuan, Y.; Yue, T.; Cai, R.; Wang, Z.

Extraction of epigallocatechin gallate and epicatechin gallate from tea leaves using β-cyclodextrin

Phenolic compounds, Green extracting agents

Journal of Food Science, Wiley-Blackwell, 2017, 82, 394-400; DOI:10.1111/1750-3841.13622

Guan, X.-l.; Fu, J.-h.; Tang, J.

Study on the release process for lavender essential oil microcapsule by FTIR

α-Cyclodextrin, Hydrogen bonds, β-CD

Guangpuxue Yu Guangpu Fenxi, Beijing Daxue Chubanshe, 2017, 37, 65-69; DOI:10.3964/j.issn.1000-0593(2017)01-0065-05

Guo, Y.; Liu, J.; Zhang, K.; Zhang, H.; Li, Y.; Lei, Z.

Synthesis of stimuli-responsive support material for pectinase immobilization and investigation of its controllable tailoring of enzymatic activity

Controllable biocatalyst, N-Isopropylacrylamide, tert-Butyl methacrylate, ε-Caprolactone, β-CD, Azobenzene, Microspheres, Food industry

Biochemical Engineering Journal, 2017, 121, 188 - 195; DOI:10.1016/j.bej.2017.02.010

Hernandez-Sanchez, P.; Lopez-Miranda, S.; Guardiola, L.; Serrano-Martinez, A.; Gabaldon, J. A.; Nunez-Delicado, E.

Optimization of a method for preparing solid complexes of essential clove oil with β-cyclodextrins

Microwave irradiation, Phase solubility studies, Vacuum oven drying, Freeze-drying, Spray-drying

Journal of the Science of Food and Agriculture, John Wiley & Sons Ltd., 2017, 97, 420-426; DOI:10.1002/jsfa.7781

Parkar, S. G.; Jobsis, C. M.; Herath, T. D.; Stoklosinski, H. M.; van Klink, J. W.; Sansom, C. E.; Sims, I. M.; Hedderley, D. I.

Metabolic and microbial responses to the complexation of manuka honey with α-cyclodextrin after simulated gastrointestinal digestion and fermentation

Methylglyoxal, Dihydroxyacetone, Inhibited Salmonella, Fermentation with human faecal microbiota, Enhanced Lactobacillus reuteri

Journal of Functional Foods, 2017, 31, 266 - 273; DOI:10.1016/j.jff.2017.01.049

Suvarna, V.; Gujar, P.; Murahari, M.

Complexation of phytochemicals with cyclodextrin derivatives – An insight

Natural compounds, Inclusion complex, Functional foods, Bioavaliability, Flavonoids, Phenolic derivatives, Coumestans, Triterpenes, Curcumin, Artemisins, Dihydromyricetin

Biomedicine & Pharmacotherapy, 2017, 88, 1122 - 1144; DOI:10.1016/j.biopha.2017.01.157

6. CDs for other Industrial Applications

Chi, W.; Zheng, L.; He, C.; Han, B.; Zheng, M.; Gao, W.; Sun, C.; Zheng, L.; Sun, C.; Zhou, G.; Gao, X.

Quorum sensing of microalgae associated marine Ponticoccus sp. PD-2 and its algicidal function regulation

β-cyclodextrin, Biofilm formation, Bioluminescence, Antibiotic production, 3-oxo-C8-HSL, 3-oxo-C10-HSL

AMB Express, 2017, 7, 59; DOI:10.1186/s13568-017-0357-6

García-Uriostegui, L.; Melendez-Ortiz, H.; Toriz, G.; Delgado, E.

Post-grafting and characterization of mesoporous silica MCM-41 with a thermoresponsive polymer TEVS/NIPAAm/β-cyclodextrin

Triethoxyvinylsilane, N-Isopropylacrylamide, Adsorbing ibuprofen

Materials Letters, 2017, *In Press;* DOI:10.1016/j.matlet.2017.03.026

Ghorad, A.; Mahalle, S.; Khillare, L. D.; Sangshetti, J. N.; Bhosle, M. R.

β-Cyclodextrin as a biomimetic catalyst for the efficient synthesis of 4-oxo-pyrido[1,2-a]pyrimidine-3-carbonitrile in aqueous medium

Antibacterial activity, 4-oxo-4H-pyrido[1,2-a]pyrimidine-3-carbonitrile derivatives

Catalysis Letters, Springer, 2017, 147, 640-648; DOI:10.1007/s10562-017-1983-y

Gu, H.; Chen, X.; Yu, Q.; Liu, X.; Zhan, W.; Chen, H.; Brash, J. L.

A multifunctional surface for blood contact with fibrinolytic activity, ability to promote endothelial cell adhesion and inhibit smooth muscle cell adhesion

Polyurethane surface, Heparin-like moiety, sulfonated β-cyclodextrin, Anticoagulant activity

Journal of Materials Chemistry B: Materials for Biology and Medicine, Royal Society of Chemistry, 2017, 5, 604-611; DOI:10.1039/C6TB02808J

Guo, L.-D.; Song, Y.-Y.; Yu, H.-R.; Pan, L.-T.; Cheng, C.-J.

Novel smart chiral magnetic microspheres for enantioselective adsorption of tryptophan enantiomers

Multifunctional microspheres, Thermosensitive, Host-guest interaction, Fe_3O_4 nanoparticle core, Acidic-resistant SiO_2 middle shell, Thermosensitive microgel functional shell, β-CD, Regeneration

Applied Surface Science, 2017, 407, 82 - 92; DOI:10.1016/j.apsusc.2017.02.121

Ikotun, B. D.; Mishra, S. B.; Fanourakis, G. C.

Modification of the hydration products of hydrated cement paste by fly ash, β-cyclodextrin and fly ash-β-cyclodextrin composite

Pozzolanic reactions, Concrete

Journal of Inclusion Phenomena and Macrocyclic Chemistry, Springer, 2017, 87, 219-237; DOI:10.1007/s10847-017-0692-x

Lai, S.; Tang, S.; Xie, J.; Cai, C.; Chen, X.; Chen, C.

Highly efficient chiral separation of amlodipine enantiomers via triple recognition hollow fiber membrane extraction

Enantioseparation, Molecularly imprinted hollow fiber membrane, Cross-flow biphasic recognition extraction, D-tartaric acid, Sulfobutyl ether-β-cyclodextrin

Journal of Chromatography A, 2017, 1490, 63 - 73; DOI:10.1016/j.chroma.2017.02.018

Singh, N.; Yadav, M.; Khanna, S.; Sahu, O.

Sustainable fragrance cum antimicrobial finishing on cotton: Indigenous essential oil

Microencapsulation, Textile testing, Lavender essential oil, Chitosan citrate, β-Cyclodextrin-grafted chitosan

Sustainable Chemistry and Pharmacy, 2017, 5, 22 - 29; DOI:10.1016/j.scp.2017.01.003

Topuz, F.; Uyar, T.

Cyclodextrin-functionalized mesostructured silica nanoparticles for removal of polycyclic aromatic hydrocarbons

Water treatment, Tetraethyl orthosilicate, HP-β-CD, β-CD, Pyrene, Anthracene, Phenanthrene, Fluorene, Fluoranthene

Journal of Colloid and Interface Science, 2017, *In Press;* DOI:10.1016/j.jcis.2017.03.015

Yang, H.; Hu, Y.

Separation of para-xylene and meta-xylene by extraction process using aqueous cyclodextrins solution

Hydroxypropyl-β-cyclodextrin, Liquid–liquid extraction, Formation constant, Separation factor α

Chemical Engineering and Processing: Process Intensification, 2017, *In Press;* DOI:10.1016/j.cep.2017.02.011

Zhang, X.; Zhang, N.; Du, C.; Guan, P.; Gao, X.; Wang, C.; Du, Y.; Ding, S.; Hu, X.

Preparation of magnetic epitope imprinted polymer microspheres using cyclodextrin-based ionic liquids as functional monomer for highly selective and effective enrichment of cytochrome c

Surface imprinting, Magnetic property, Mono-6A-deoxy-6-(1-vinylimidazolium)-β-cyclodextrin tosylate, Multiple binding sites

Chemical Engineering Journal, 2017, 317, 988 - 998; DOI:10.1016/j.cej.2017.02.138

Zhou, A.; Zhang, J.; Varrone, C.; Wen, K.; Wang, G.; Liu, W.; Wang, A.; Yue, X.

Process assessment associated to microbial community response provides insight on possible mechanism of waste activated sludge digestion under typical chemical pretreatments

Anaerobic digestion, Solubilizer, β-Cyclodextrin

Energy, 2017, *In Press;* DOI:10.1016/j.energy.2017.02.166

7. CDs in Sensing and Analysis

Creamer, J. S.; Mora, M. F.; Willis, P. A.

Enhanced resolution of chiral amino acids with capillary electrophoresis for biosignature detection in extraterrestrial samples

Biotic and abiotic samples, γ-Cyclodextrin, Sodium taurocholate

Analytical Chemistry, American Chemical Society, 2017, 89, 1329-1337; DOI:10.1021/acs.analchem.6b04338

Duran, G. M.; Abellan, C.; Contento, A. M.; Rios, A.

Discrimination of penicillamine enantiomers using β-cyclodextrin modified CdSe/ZnS quantum dots

Fluorescence intensity, Pharmaceutical formulations, Environmental samples

Microchimica Acta, Springer-Verlag GmbH, 2017, 184, 815-824; DOI:10.1007/s00604-017-2074-x

Feng, Y.; Xiao, Q.; Zhang, Y.; Li, F.; Li, Y.; Li, C.; Wang, Q.; Shi, L.; Lin, H.

Neodymium-doped $NaHoF_4$ nanoparticles as near-infrared luminescent/T2-weighted MR dual-modal imaging agents in vivo

Multimodal bioprobes, Alpha-cyclodextrin

Journal of Materials Chemistry B: Materials for Biology and Medicine, Royal Society of Chemistry, 2017, 5, 504-510; DOI:10.1039/C6TB01961G

Fredy, J. W.; Scelle, J.; Ramniceanu, G.; Doan, B.-T.; Bonnet, C. S.; Toth, E.; Menand, M.; Sollogoub, M.; Vives, G.; Hasenknopf, B.

Mechanostereoselective one-pot synthesis of functionalized head-to-head cyclodextrin [3]rotaxanes and their application as magnetic resonance imaging contrast agents

Copper-catalyzed azide-alkyne cycloaddition, Gadolinium

Organic Letters, American Chemical Society, 2017, 19, 1136-1139; DOI:10.1021/acs.orglett.7b00153

Fujita, K.; Fujiwara, S.; Yamada, T.; Tsuchido, Y.; Hashimoto, T.; Hayashita, T.

Design and function of supramolecular recognition systems based on guest-targeting probe-modified cyclodextrin receptors for ATP

Dipicolylamine, Adenine moiety of ATP, Azobenzene unit, Multipoint recognition system

Journal of Organic Chemistry, American Chemical Society, 2017, 82, 976-981; DOI:10.1021/acs.joc.6b02513

Garrido, J. M. P. J.; Melle-Franco, M.; Strutynski, K.; Borges, F.; Brett, C. M. A.; Garrido, E. M. P. J.

β-Cyclodextrin carbon nanotube-enhanced sensor for ciprofloxacin detection

Wastewater treatment plant effluent

Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering, Taylor & Francis, Inc., 2017, 52, 313-319; DOI:10.1080/10934529.2016.1258864

Hu, X.; Guo, X.; Sun, S.; Zhu, B.; Yu, J.; Guo, X.

Enantioseparation of nine indanone and tetralone derivatives by HPLC using carboxymethyl-β-cyclodextrin as the mobile phase additive

Inclusion complex

Chirality, Wiley-Liss, Inc., 2017, 29, 38-47; DOI:10.1002/chir.22665

Khodaveisi, J.; Shabani, A. M. H.; Dadfarnia, S.; Saberi, D.

A novel sensor for determination of naproxen based on change in localized surface plasmon peak of functionalized gold nanoparticles

Thiolated β-cyclodextrin, Colorimetric sensor

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 2017, 179, 11 - 16; DOI:10.1016/j.saa.2017.02.008

Le, H. T. N.; Jeong, H. K.

Cyclodextrin-graphite oxide-carbon nanotube composites for electrochemical supramolecular recognition

α-CD, β-CD, γ-CD, Biomolecules, Dopamine, Ascorbic acid, Thioridazine

Electrochimica Acta, 2017, 232, 7 - 12; DOI:10.1016/j.electacta.2017.02.119

Michalska, K.; Gruba, E.; Bocian, W.; Cielecka-Piontek, J.

Enantioselective recognition of radezolid by cyclodextrin modified capillary electrokinetic chromatography and electronic circular dichroism

Oxazolidinones, Cyclodextrin as a chiral pseudophase, Anionic single isomer cyclodextrins, Heptakis-(2,3-dihydroxy-6-sulfo)-β-cyclodextrin, Heptakis-(2,3-diacetyl-6-sulfo)-β-cyclodextrin, Heptakis-(2,3-dimethyl-6-sulfo)-β-cyclodextrin

Journal of Pharmaceutical and Biomedical Analysis, 2017, 139, 98 - 108; DOI:10.1016/j.jpba.2017.01.041

Silva, M.; Pérez-Quintanilla, D.; Morante-Zarcero, S.; Sierra, I.; Marina, M. L.; Aturki, Z.; Fanali, S.

Ordered mesoporous silica functionalized with β-cyclodextrin derivative for stereoisomer separation of flavanones and flavanone glycosides by nano-liquid chromatography and capillary electrochromatography

Chiral separation, Flavanones, 3,5-Dimethylphenylcarbamoylated β-CD, Amino-functionalized spherical ordered mesoporous silica

Journal of Chromatography A, 2017, 1490, 166 - 176; DOI:10.1016/j.chroma.2017.02.012

Song, K.; Shen, Y.; Mo, J.; Lu, C.

Combination of a rhodamine derived chemosensor and up-conversion excitation nanocrystals for cysteine detection

α-Cyclodextrin, Energy transfer

Journal of Luminescence, 2017, *In Press;* DOI:10.1016/j.jlumin.2017.03.011

Su, D.; Zhang, Y.; Wang, Z.; Wan, Q.; Yang, N.

Decoration of graphene nano platelets with gold nanoparticles for voltammetry of 4-nonylphenol

Synergistic effect, Electrochemical sensor, Co-electrodeposition procedure, Oxidation peak current

Carbon, 2017, 117, 313 - 321; DOI:10.1016/j.carbon.2017.02.103

Sun, Q.; Fang, S.; Fang, Y.; Qian, Z.; Feng, H.

Fluorometric detection of cholesterol based on β-cyclodextrin functionalized carbon quantum dots via competitive host-guest recognition

p-Nitrophenol, Replacement of guest molecule

Talanta, 2017, *In Press;* DOI:10.1016/j.talanta.2017.02.060

Wang, J.; Qiu, F.; Wu, H.; Li, X.; Zhang, T.; Niu, X.; Yang, D.; Pan, J.; Xu, J.

Fabrication of fluorescent carbon dots-linked isophorone diisocyanate and β-cyclodextrin for detection of chromium ions

One-pot simple hydrothermal method, Water and soil samples

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 2017, 179, 163 - 170; DOI:10.1016/j.saa.2017.02.031

Wei, Y.; Su, Z.; feng Kang, X.; Guo, Y.; Mu, X.

Single-molecule transformation and analysis of glutathione oxidized and reduced in nanopore

Per-6-quaternary ammonium-β-cyclodextrin, Molecular adaptor of protein nanopore

Talanta, 2017, 167, 526 - 531; DOI:10.1016/j.talanta.2017.02.059

Woźniakiewicz, M.; Gładysz, M.; Nowak, P. M.; Kędzior, J.; Kościelniak, P.

Separation of 20 coumarin derivatives using the capillary electrophoresis method optimized by a series of Doehlert experimental designs

Optimization, Response surface methodology, Organic cosolvents, Heptakis(2,3,6-tri-O-methyl)-β-cyclodextrin

Talanta, 2017, *In Press;* DOI:10.1016/j.talanta.2017.02.017

Edited and produced by: CYCLOLAB
Homepage: www.cyclolab.hu
H-1525 P.O. 435, Budapest, Hungary
Tel.: (+361)347-6060
Fax.: (+361)347-6068
e-mail: cyclolab@cyclolab.hu