Malaysian Journal of Chemistry, 2018, Vol. 20(1), 33 – 73

Vibrational Biospectroscopic Studies on Anti-cancer Nanopharmaceuticals (Part I)

Alireza Heidari
Faculty of Chemistry, California South University, 14731 Comet St. Irvine, CA 92604, USA
Corresponding author: (e-mail: Scholar.Researcher.Scientist@gmail.com; Alireza.Heidari@calsu.us)

Nuclear magnetic resonance and mass spectrometry are two spectroscopy techniques which have been widely used in the anti-cancer nanopharmaceuticals industry to elucidate chemical structure. However, attenuated total reflectance-Fourier transform infrared spectroscopy is still one of the important methods used in quality control laboratories and generally, it is critically applied to characterize in a solid form and to prepare samples in a minimal form. Today, Raman spectroscopy is widely used in the field of anti-cancer nanopharmaceuticals research and development activities because of its high technology and specific applicability. For the identification, characterization, and investigation of nanopharmacologically active and related nanocompounds as discrete nanomaterials and in formulated products, therefore, the vibrational spectroscopy (a combination of mid-infrared, near-infrared and Raman) is broadly considered.

Key words: Vibrational spectroscopy; anti-cancer nanopharmaceuticals; spectroscopy techniques; nanocompounds; nanomaterials; mid-infrared spectroscopy; near-infrared spectroscopy; attenuated total reflectance-Fourier transform infrared ATR-FTIR spectroscopy; Raman spectroscopy

Received: May 2018; Accepted: June 2018

Nuclear magnetic resonance (NMR) and mass spectrometry (MS) are two spectroscopy techniques which have been widely used in the anti-cancer nanopharmaceuticals industry to elucidate chemical structure. However, attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy is still one of the important methods used in quality control (QC) laboratories and generally, it is critically applied to characterize in a solid form and to prepare samples in a minimal form. Today, Raman spectroscopy is widely used in the field of anti-cancer nanopharmaceuticals research and development activities because of its high technology and specific applicability. For the identification, characterization, and investigation of nanopharmacologically active and related nanocompounds as discrete nanomaterials and in formulated products, therefore, the vibrational spectroscopy (a combination of mid-infrared, near-infrared and Raman) is broadly considered.

ANTI-CANCER NANOPHARMACOPOEIALS INVESTIGATIONS

At the present time, vibrational spectroscopy is mostly used by the major pharmacopoeiae, including the United States Pharmacopoeia/ the National Formulary (USP/NF), the European Pharmacopoeia (EP), the British Pharmacopoeia (BP) and the Japanese Pharmacopoeia (JP), for the identification of pure excipients or active anti-cancer nanopharmaceuticals ingredients extracted from formulations detailed in specific monographs. The theoretical aspects, sample preparation procedures and instrument calibration requirements for ATR-FTIR spectroscopy are prepared, in details, by each pharmacopoeia. The importance of this method is highlighted by Frank as ". . . Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy is considered by the USP as providing the most conclusive evidence of identity that can be obtained from any single test…" [1]. Although the information about identity and form of the sample (polymorphic, salt and solvate) can be provided by ATR-FTIR spectroscopy (polymorphic, salt and solvate), it is necessary to compare the sample spectrum with a reference standard ATR-FTIR spectrum as a confirmation for the analysis. For instance, about 380 reference ATR-FTIR spectra are provided by BP consistent with the specific nanocompound monographs.

However, it should be noted that the gross identity is more considered by these pharmacopoeia [1] monographs than polymorphic form, as the BP states that "When the spectra recorded in the solid-state show differences in the positions of the absorption maxim, treat the substance being examined and the reference substance in the same manner so that they crystallise or are produced in the same form…" [2]. In spite of the existence ca. 65% of all anti-cancer nanopharmaceuticals compounds (in the EP) in more than one polymorphic form (excluding solvates and hydrates) [3], this simple and reliable ATR-FTIR method can correctly identify the active nanocompound in the formulation under test.

The profile of Raman spectroscopy with regulatory authorities is much lower than ATR-FTIR methods. The USP is the only one that considers the analysis of nanopharmaceutical materials using Raman spectroscopy [4]. When this article was writing, there has been no method for the final batch release of any product using Raman spectroscopy that filed with the appropriate regulatory authorities. The method, however, is in its way to becoming more important in the industry, which will lead to changing of its position in the future. The main advantage of Raman spectroscopy compared to ATR-FTIR spectroscopy is that, there is no need for any sample preparation as it can analyze a sample non-invasively through its glass container. Replacing wet chemical, high-performance liquid chromatography, UV or ATR-FTIR identity methods in a busy laboratory might reduce the analysis time per 1000 samples down to 2–3 months [1]. However, changing the methodologies due to such reasons may not necessarily be a good idea in the field of QC. The cost of Raman spectrometers is too much more than the current instruments. Moreover, there is not a method for Raman analyses approved by regulatory. In this regard, the use of Raman spectroscopy is limited to the conditions that there is not an established and cost-effective method to release nanomaterials due to scientific or technical problems. The critical motivation for establishing Raman methods in pharmacopoeiae is the scientific need of nanopharmaceutical companies which may be supported by Raman instruments production companies. Currently, there is a strong cooperation between the nanopharmaceutical industry and the regulators in the UK to enhance the profile of Raman spectroscopy and its advantages for nanopharmaceutical analysis [5].

A given sample can be analyzed in various ways using ATR-FTIR spectroscopy. Therefore, the analyst is of proper flexibility for choosing the most appropriate method for the considered work. In addition to the analysis of solids, as the primary application of ATR-FTIR spectroscopy, liquids, solutions, and gases can also be analyzed by this method. All these preparation methods are mentioned in the pharmacopoeiae, excepted the USP, including diffuse reflectance (DR) and multiple internal reflectance (MIR)/attenuated total reflection (ATR) methods. It should be noted that the use of KRS5 (Thallium bromo-iodide (TlBr-TlI)) crystals, a mixture of thallium bromide and thallium iodide are specified in the BP and EP for ATR measurements. However, zinc selenide (ZnSe) and germanium have been used in ATR-FTIR spectroscopy other than these toxic nanomaterials. The recent developments in ATR technology can be used to crystallize the addition of these MIR/ATR crystals while they are not yet detailed in the pharmacopoeiae. The sample, in any form other than gas, places on the ATR crystal, which is typically diamond or germanium. Then, the sample is subjected to a moderate pressure while its ATR-FTIR spectrum is acquired. Finally, the crystal surface is cleaned to start the next round of action. This procedure is the quickest ATR-FTIR preparation for the majority of samples with the total analysis time is typically between 3–5 min. The possible change of sample polymorphic form during its preparation for analysis is reduced due to the fact that the torque forces developed in preparing a nujol mull or KBr disk are more than the unidirectional pressure applied to the sample. There is a little difference between the ATR-FTIR spectra obtained using this technology and the traditionally obtained transmission spectra. The intensity of bands at low wavenumbers is higher than those at high wavenumbers since the penetration of longer wavelengths into the sample is deeper

than shorter ones and hence, the incident ATR-FTIR radiation is more absorbed. Although both spectra are of an equivalent number of bands with a similar position, their relative intensities are different across the spectrum.

The ATR-FTIR spectra of samples with inappropriate transmission properties, such as rubbers, cannot easily obtain. Due to too short effective sample path length obtained by the Golden Gate™ approach, the quality of obtained spectra is so high that allows the identification of various rubber vial closure types. Further, the measurement is difficult by most ATR methods because of the complex physical shape of vial closures. However, it is a simple work when single bounce ATR is used.

BULK SAMPLE ANALYSIS

Anti-cancer Nano Drug Substance Characterization Functional Group Analysis

The spectroscopic identification methods are of great importance during the early stages of anti–cancer nano drug development due to the providing of definitive evidence of chemical structure, which, in turn, is very important for clinical safety and the underpinning of patent applications.

Nowadays, NMR and MS are widely used to elucidate the structure as these spectral data are very clear and specific. However, ATR-FTIR spectroscopy is not a valuable method to identify the structure of simple nanomolecule such as aspirin $C_6H_4(CO_2H)(CO_2CH_3)$. The presence of four oxygen atoms in aspirin structure is easily confirmed by MS with classical elemental analysis (i.e. carbon, hydrogen, and nitrogen or CHN). At the other hand, the ATR-FTIR spectrum of Aspirin shows this fact as there are two carbonyls and two –C–O– bands; the characteristic of carboxylic acid and ester functional groups within the nanomolecule. However, there are evidence for 1, 2-isubstituted aromatic ring and the methyl ester in NMR spectroscopy.

In addition to available accurate mass measurement methods, various empirical formulae may be proposed for structure elucidation of large organic nanomolecules. ATR-FTIR spectroscopy is a useful method for identifying certain functional groups in such cases which lead to finding the correct elemental composition of the sample. At the other side, the difference between the presences of a carboxylic acid ($R–CO_2H$) or an amide ($R–CONH_x$) cannot necessarily find by NMR spectroscopy due to the possible absence of labile protons in their respective NMR spectra. However, there is a clear difference between the ATR-FTIR spectra of these functional groups. The carbonyl band which is the only absorbance in the range of 1800–1650 cm^{-1} offers useful information about the environment of the >C=O functional group. A carbonyl stretch is shown at ca. 1720 cm^{-1} in carboxylic acid while a C–O– band is observed at ca. 1400 cm^{-1}. In addition, the hydrogen-bonded OH stretch developed due to dimerization of the acid group is shown ca. 3000 cm^{-1}. There are two strong bands around 1650 and 1550 cm^{-1} for amide, known as the amide (I) and amide (II) bands, respectively. Moreover, there are two bands at 3400 and 3300 cm^{-1} for primary amides because of the antisymmetric and symmetric N–H stretches, respectively. However, in the same region, there is only one N–H stretch frequency for the secondary amides. In a similar way, the confirmation of the characteristic ATR-FTIR bands of other interesting groups such as the cyano (–C–N), nitro ($–NO_2$), ester ($–CO_2R$), sulfonamide ($–SO_2N<$) and phosphate [$(–PO(OH)_2)$] cannot be easily achieved by other spectroscopic methods. Moreover, ATR-FTIR plays a critical role in identifying predominant tautomeric forms. ATR-FTIR spectroscopy is a useful method for identification of specific characteristic forms of the *keto-enol* and *lactam-lactim* tautomers.

Raman spectroscopy provides a complementary approach to structural elucidation. The strongest Raman bands in organic nanocompounds belong to the alkene (>CDC<), alkyne (–C–C–) and cyano (–C–N) groups. However, nitro ($–NO_2$) and disulfide (–S–S–) groups have particularly characteristic Raman bands [6]. The number of protons presents in the double bond and cis/trans conformations can be accurately assigned by the position of the characteristic band which is the >CDC< stretch region in the Raman spectrum. The identity of organic materials used as nanopharmaceutical excipients, such as Calcium phosphate [$Ca_3(PO_4)_2$] and Titanium dioxide (TiO_2),

can be confirmed by Raman spectroscopy. Titanium dioxide is approved by Food and Drugs Administration (FDA) as a white colourant in its anatase form. The differences between this type of TiO_2 and the alternative rutile form can be detected by Raman spectroscopy.

Due to the new use of Raman spectroscopy in the nanopharmaceutical industry, the structure elucidation using this method is primarily for supporting or confirming assignments made from the ATR-FTIR spectrum. Better acceptance of Raman data, particularly with regulatory authorities, is strongly related to more and more industrial use of this technique as well as its interpretation to the same standards as ATR-FTIR spectra.

Hydrogen bonding and zwitterions. One of the main aspects of vibrational spectroscopy is its ability to directly relate chemical structure to the solid state properties of the sample which has been mostly performed by single crystal X-ray diffraction (XRD) and ^{13}C solid-state NMR. The strong dipole condition is related to the presence of hydrogen bonds within groups and hence, ATR-FTIR spectroscopy can act as a valuable tool for identifying the extent and type of hydrogen bonds presented in different forms of a nanomaterial. The 40-methyl-20-nitroacetanilide is a good example; the type of Hydrogen bonding presented in the two forms of this nanocompound can be identified by both NMR and single crystal XRD only if the complete solution is obtained while this is not the case for the ATR-FTIR spectroscopy [7]. Both pure polymorphs can be easily differentiated by their colors, yellow and white. The carbonyl and nitro groups adjacent to hydrogen bond have competed with the amide NH within these two polymorphs which are related to the geometry of the amide group. It can be seen that hydrogen bonding with the carbonyl group is predominated in the white form. The position of amide (I) band at 1672 cm^{-1} demonstrates the characteristic of intermolecular bonding. Single crystal XRD also shows this fact as antiparallel molecular stacks involving nanomolecules, related by inversion. Due to the presence of two different nanomolecules in an asymmetric unit cell, there is more complexity in the yellow form. As a result of the presence of two similar crystal structures within the nanomaterial, the carbonyl band is apparently divided. It can be concluded from the high carbonyl and NH stretching values that the hydrogen intramolecular bonding between the amide and nitro groups is not strong in the asymmetric unit of the yellow form.

The formation and observation of zwitterions in the ATR-FTIR spectrum of the nanocompound is not wondering in nanomolecules containing both acidic and basic groups. It is a common rearrangement that a carboxylic acid deprotonates while an amine group protonates. Due to the presence of carboxylate ion, the expected carbonyl band is not observed in the ATR-FTIR spectrum and a less intense band is appeared at 1600 ± 50 cm^{-1}. Between 2800 and 2100 cm^{-1} and at 1590 ± 30 cm^{-1}, there are characteristic bands of the accompanying R-NH_x C group.

Polymorphism, salts and hydrates. Polymorphs can be defined as nanocompounds with different crystal structures that are of the same chemical entity. There are a unique three dimensional configuration and a unique unit cell for each polymorph. Sometimes, it is possible for a nanomaterial to have more than one hydrated form with different crystal structures. Further, the crystallization of nanopharmacologically active substances as a salt (nano drug as natural free base or acid form plus a counter ion) is due to enhancing the long-term stability of the nanocompound. It is possible that such salts form in a hydrate and show polymorphism. The physical characteristics of each form may be affected by its differences with others. It is a common case that the stability (higher the melting point, higher the stability), solubilities/ bioavailabilities, and processabilities (the easiness of processing the nanomaterial into a product) of polymorphs are different. One of the analytical characterization techniques for polymorphs is vibrational spectroscopy. It is necessary to apply a combined form of various techniques including single crystal and powder X-ray diffraction (PXRD), thermal methods [e.g. differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA)], solid-state NMR and polarized light spectroscopy for fully characterization of any isolated form because of the complexity of polymorphic systems. Frequently, the

identity and form of a submitted sample are confirmed by vibrational spectroscopy despite the fact that it may be not the first selected method for characterizing a new polymorph. Patent applications include the ATR-FTIR spectrum of each form due to the specificity of the data and the relative ease of spectral acquisition. In the nanopharmaceutical industry, both nano drug structure and its polymorphic forms are per se patentable due to the fact that the nano drug properties may be improved by changing its forms. The reason for the importance of polymorph patenting is various economic aspects of such changes [8]. For instance, Glaxo Wellcome (GW) has the basic patent claiming ranitidine hydrochloride per se, as well as a patent covering the polymorph of ranitidine hydrochloride, which is the active ingredient in Zantac™. Novopharm has challenged this issue in the US courts but was not successful. If Novopharm became successful in their challenge, GW would have lost massive revenue from this ulcer treatment.

The stability of the polymorphic form can be measured through ATR-FTIR spectrum in some cases [9]. The previously mentioned ATR-FTIR rule is applied to any nanocompound that forms Hydrogen bonds, with the exception of amides. As the entropy is reversely related to stability and directly related to the frequency band, that form with the highest frequency band (i.e. in the region 3600–3200 cm^{-1}) will have the poorest stability. Recently, the Raman spectroscopy of Hydrogen-bonded polymorphs is considered with this approach [10]. The same rule appears to apply but it seems that there need to a more extensive review.

It has been confirmed that the lattice vibrations of various crystal structures are different from each other. Hence, it will be a good idea to recognize different polymorphic forms based on their lattice vibrations that are emerged. These vibrations occur below 400 cm^{-1}; the region called far-infrared. To obtain ATR-FTIR spectra from this region, it is necessary to use special instrumentation (e.g. replacing the mid-infrared KBr beam splitters of an interferometer which have a 380 cm^{-1} cut off) and suitable sample support nanomaterials. However, vibrations with frequencies down to 50 cm^{-1} can be measured by FT-Raman instruments. By approaching to the laser frequency, the Rayleigh line, measurements can be obtained using double or triple monochromator dispersive Raman systems. As Raman spectroscopy is able to simply measure the lattice vibrations, it becomes an interesting method for investigating polymorphism. In addition to the possibility of identification of polymorphic forms based on the data from this region (400-100/50 cm^{-1}), some information on the degree of amorphous nanomaterial present in the sample can be obtained from this data [10]. Due to less stability of amorphous anti-cancer nano drug substance than crystalline nanomaterial, knowing the amount of amorphous anti-cancer nano drug substance in products is very important to investigate its possible long-term effect on the stability of the marketed formulation [9]. Inhaled anti-cancer nano drugs are a good example of this issue as those are needed to have a particle size of ca. 1–5 μm. This particle size can be achieved by milling the sample without any variability. Such an aggressive process may lead to changing or reverting of the desired anti-cancer nano drug to the amorphous state. The effect of grinding has been confirmed on a uracil sample [9]. By increasing the content of amorphous form due to the successive grinding of the sample, the band is shifted and broadened as shown in FT-Raman spectra. The amount of amorphous nanomaterial existed in the nanocompound can be roughly estimated by these data.

Polymorphism analysis can obtain some quantitative data about one polymorph in another. The analysis of a mixture of two chlorpropamide polymorphs showed that if there is a large amount of the minor component (i.e. ≥10%), a reliable quantitative assay can be obtained by FT-Raman [11]. The data were analyzed using factor analysis while geometric mixing was used to prepare a reference set of mixtures (i.e. 100 – X: X, where X= 10n and n = 1–10). For anti-cancer nanopharmaceutical applications, it is relevant to quantitatively measure the minor polymorphs with accuracy between the levels of 1–5%. Langkilde *et al.* [12] studied the binary mixtures in which ATR-FTIR and FT-Raman spectroscopy showed the minimum of 2–15% of the minor polymorph. Because of the better quality of data, FT-Raman was considered as the preferred

technique, although both techniques were able to identify both polymorphs, separately. In spite of the same resolution of both data sets as 2 cm^{-1}, the Raman bands produced better calibration curves due to their baseline resolution and sharper bands with narrower bandwidths. This is a typical observation when ATR-FTIR, and Raman data from the same sample are compared. The ratio of characteristic band intensities at 1716 and 1724 cm^{-1}, respectively, are considered as the base of the calibration curve. The curve, then, was plotted against the theoretical mixture composition. It was observed that there is a linear relationship with quantification accuracy of 99% for the minor form in a binary mixture. Although this accuracy level has been reported for other methods, it should be noted that the intensity and wavenumber of the characteristic bands of each polymorph plays a critical role in this regard. However, the detection limit is very higher than those mentioned here for many other polymorphic systems.

Vibrational spectroscopy for hydrates is similar to that of polymorphs. Some additional experiments, however, should be implemented for identifying their characterization and formation mechanism. There are some modern cells such as environmental chambering diffuse reflection infrared Fourier transform spectroscopy (DRIFTS) and vibrational spectroscopy hot-stages to collect vibrational spectra from the sample while the surrounding humidity and temperature are changed. It is possible to achieve some information about the number of formed hydrates and their stability condition (stable or metastable) through monitoring and interpreting the spectra. Evolved gas analysis (EGA) is an alternative approach in which, the sample undergoes the dehydration/decomposition processes at high temperature while the exhaust of a thermogravimetric analyzer is attached to prepare the resultant gases for analysis.

Chirality. Due to the similarity of ATR-FTIR or Raman spectrum of each pure form and the racemic mixture, vibrational spectroscopy is not related to the study of chiral nanomolecules (Only when the different chiral environments cause different hydrogen bonding, vibrational spectrum will change). The method for identifying chiral nanocompounds is ATR-FTIR vibrational circular dichroism (VCD) spectroscopy. The spectral difference of two spectra obtained using left and right-handed circularly polarized ATR-FTIR radiation is called VCD spectrum. Considering a specific nanocompound, the bands of ATR-FTIR VCD spectra and standard ATR-FTIR spectrum are in the same position. Note, enantiomers give VCD spectra that are mirror images of each other. For determining the absolute configuration of a nanomolecule or protein, single crystal XRD is typically selected. However, the major anti-cancer nanopharmaceutical application of VCD is the absolute configuration of small nanomolecules for nanomaterials that are not able to be crystallized, and those which are able to be crystallized but there is not a heavy atom or salt in the nanomaterial. Currently, density functional theory (DFT) can be used to calculate VCD spectrum for each different chiral form. The absolute configuration of the nanomaterial can be confirmed by comparing the calculated data with the measured solution ATR-FTIR VCD spectrum of the nanomolecule. Due to more difficulty of calculating and rationalizing the VCD spectra for flexible and large nanomolecules, best results are obtained for rigid chiral nanomolecules [13].

Another application of ATR-FTIR VCD is determining the percentage enantiomeric excess (%ee) of one chiral form in another at the accuracy of ca. 1%. It should be noted that VCD measurements are of lower accuracy than other methods such as NMR and chromatography. However, its advantage over those methods is that it has not required to separate the chiral nanomolecules (and any achiral nanocompounds) in the sample or to add shift reagents prior to the analysis. Therefore, enantiomeric excess measurements in process environments can be performed by ATR-FTIR VCD [14].

Methods to probe solid phase phenomena. The nujol mull and the KBr disk are considered as the standard methods of presenting samples for ATR-FTIR spectroscopy. Although they are easily prepared, they have one potential flaw in the study of solid forms. It is necessary for both methods that particle size of sample is considerably smaller than the shortest ATR-FTIR wavelength used so that the scatter loss from the ATR-FTIR beam is reduced and

ATR-FTIR band distortions is minimized. Therefore, the initial step for sample preparation is grounding the sample with a pestle and mortar to become a fine nanopowder. It is possible that this method leads to changing the form of the sample. Hence, it is more desired to use a less aggressive sampling approach. There are three potentially appropriate methods for investigating polymorphic forms including diffuse reflection (DR), photoacoustic (PAS) ATR-FTIR spectroscopy and FT-Raman spectroscopy [15]. These are ideal methods for dealing with samples which may change from using traditional mull and disk methods since these are not needed to complex sample preparation. In DRIFTS measurements, the sample initially mixes with KBr and then, packed into a sample cup prior to the acquisition of its ATR-FTIR spectrum. However, the only limitation of sample for PAS measurements is its size so that it can be placed inside the PAS cell. This is an easy requirement especially for nanopowders. However, my personal experience shows that the use of PAS may be limited due to the poor signal/noise observed in many spectra. This is very difficult to attribute such minor bands to a specific polymorphic form. However, the quality of these data obtained from this method is considerably improved as a result of new PAS cell designs and improved spectrometer electronics. The data obtained from DRIFTS and PAS methods on the same polymorph samples cannot be virtually separated from each other. However, the reproducibility of quantitative measurements is affected by the particle size and the thermal conductivity of the sample. This effect would be decreased when the polymorphism measurements are being performed post-milling or after micronization of the bulk nanomaterial since these processes should give reproducible particle size ranges.

No need to sample preparation makes FT-Raman an ideal method for these measurements. However as the volume of sampling is limited, it is necessary to rotate or spun the sample during the data acquisition period to avoid heating/burning the sample as well as to make reproducible quantitative measurements. The reproducibility of quantitative Raman measurements also affects by particle size [16]. However, it is possible to perform two non-destructive measurements (ATR-FTIR PAS and FT-Raman) on the same sample using vibrational spectroscopy. In the case of using powder X-ray diffraction (PXRD) and solid-state ^{13}CNMR, more information can be achieved from the same single sample. As a result, there is a critical demand for a multi-technique approach to characterize the polymorphic forms.

These methods are not only applicable for investigating the polymorphs, salts, and hydrates, but also can be applied to any sample susceptible to irreversible change due to preparation, or when it is necessary to minimize sample disturbance. The latter case is particularly applicable to process analytical Chemistry (PAC) where the advantages of vibrational spectroscopy are often used.

Process Analytical Chemistry (PAC) Applications

The chemical processes can be measured in real time with the PAC approach. In addition, it allows the use of data in feedback systems for improving the efficiency of cost-effectiveness of the overall process. The monitoring and optimizing of the hydrogenation reaction are affected by PAC and ATR-FTIR spectroscopy [17]. Traditionally used methods for analyzing these reactions require the reaction mixture to be cooled, depressurized, sampled and analyzed at a point far from the reaction vessel. This leads to more time of the analysis which in turn, may be led to the poisoning of the catalyst. In this case, ATR-FTIR spectroscopy allows online monitoring. Hence, the spectroscopic data can be collected in real time while the end-point of reaction can be more accurately determined. The measurement and control of by-product formation is possible using the feedback mechanisms in on-line systems.

Changes of the intensity of the 826 cm^{-1} band due to the $–NO_2$ scissoring deformation is the sign for initial addition of the starting nanomaterial to the reaction vessel, and then its depletion on reaction. The increase of the amide (I) band at 1664 cm^{-1} shows the formation of the product. In a similar way, the reduction of the band at 758 cm^{-1} band is attributed to the formation of the by-product. This band is attributed to the pyridine ring C–H deformation that is present in both starting nanomaterial and product, but not in the further hydrogenated by-product. Based on the

real-time ATR-FTIR measurements, it is possible to accurately determine the reaction end-point and the subsequent reaction quenching. It allows minimizing the formation of the unwanted, over-reduced by-product.

Application of DRIFTS to understand the drying process associated with a cephalosporin can be shown by a simple example. If anti-cancer nano drug produces as the pentahydrate form, it can be considered as nanopharmacologically active nanocompound. However, there are certain drying conditions in which activity may be decreased. In the case of not adequate controlling of the drying step, dehydrates are reformed to an unstable anhydrous form by the pentahydrate so rapidly that dehydrates as a monohydrate form in the presence of trace moisture levels. The real conditions of a manufacturing plant were recreated in the laboratory by a DRIFTS accessory with an environmental chamber to investigate the cephalosporin drying process. It can be clearly seen that there are different ATR-FTIR spectra for the penta and monohydrate forms. While normal carbonyl absorption can be seen at ca. 1760 cm^{-1} for the pentahydrate, his band is shifted to 1805 cm^{-1} for the case of monohydrate [18]. Such a rare high-frequency carbonyl band for a β-lactam carbonyl absorption indicates a highly strained β-lactam ring. Regarding this issue that monohydrate is of poor nano drug potency, it can be ensured by careful monitoring of the drying process using ATR-FTIR spectroscopy that anhydrous/monohydrate form is not produced.

The possibility of taking measurements directly through glass is one of the advantages of Raman spectroscopy over ATR-FTIR methods. Raman spectroscopy has potentially a direct optical path into a reaction process of a chemical stream. The potential of Raman spectroscopy for controlling and optimizing a process is confirmed in the formation of Nadolol™ from sodium cystine tryptic agar (CTA)-phenolate [19]. In step (1), highly toxic epoxy-Cystine Tryptic Agar (CTA) is produced. As FT-Raman spectroscopy allows the monitoring of its formation, there is not necessary to directly analyze this process by manufacturing staff. The rate of reaction can be seen during continuous measurement. The damaging effect of moisture presence in the epichlorohydrin on the reaction rate can be clearly observed. Real-time monitoring allows immediate and corrective action to be taken. It is necessary to remove all traces of epichlorohydrin before starting step (2), because this will react with the t-butylamine. It can be determined by the absence of Raman bands at 370 and 720 cm^{-1}. In a similar manner, depletion of epoxy-CTA and formation of thenoyltrifluoroacetone (TTA) can be determined from bands at 650 and 720 cm^{-1}, respectively. Although Nadolol™ is formed from thenoyltrifluoroacetone (TTA), minimization of residual t-butylamine leads to maximization of product crystallization. The level of t-butylamine can be tracked using Raman at 750 cm^{-1}, and as a result, it can be used as a feedback mechanism to optimize the final product and form. Raman plays a critical role during the manufacturing process to optimize the process and product yield.

Formulation Analysis

For many formulations, the presence of the active nanocompound is demonstrated by ATR-FTIR. Generally, there is a critical need to an extraction procedure that is specific for the active nanocompound in suspensions, creams, capsules and tablet dosage forms. For intravenous formulations the procedure may involve a simple precipitation of the active followed by a filtration step. There are many examples of these types of preparations in the pharmacoepiae.

For some formulations, it is possible to quantitatively measure some specific nanocompounds with minimal sample preparation. The levels of formulated ketoprofen [20] and propylene carbonate, as an excipient, have been measured by ATR-FTIR, in aqueous cream and anhydrous ointment formulations [21]. Despite the confirmed potential of ATR measurements for quantitative measurements, it should be noted that the application of ATR measurements is limited to academic activities since it requires sample preparation and hence, it is not widely applicable to ATR-FTIR analysis in the nanopharmaceutical industry. The identity and concentration of the active nanocompound can be successfully determined by DRIFTS directly from ground solid dosage forms. It has been shown that this approach can be applied to confirm the correctness of samples to be used in blinded clinical trials [22].

In a similar case, the FDA, USA, performed an investigation about generic nanopharmaceutical products for fraudulent use of excipients on powdered

formulations, such as KBr disks. It was observed ATR-FTIR was successfully differentiated only 18% of the innovator from generic formulation pairs submitted for analysis among more than 1400 nano drug samples [23]. Therefore, it is necessary to take care about direct bulk measurements from solid formulations. It should be noted that DRIFTS is best performed with specific systems using a validated methodology.

Another method has been used for direct measurements of specific nanomaterials in formulated products is ATR-FTIR PAS. Based on quantitative measurements for both brivudin and dithranol, over the range 0.5–10.0% in Vaseline™ ointments, it was observed that there is a linear and consistent relationship with chromatographic measurements [24]. However, an important point is that the spectroscopic method is significantly quicker and less labor intensive than the separation methods. As the nature of photoacoustic measurements is non-destructive, it can be used for direct investigation of bulk samples which removes the necessity of sample preparation and in turn, any change in forms. For example, the form of the active nanocompound in a tablet formulation may raise some questions about inappropriate properties of tablet dissolution. The active component of the formulation can be extracted by standard approach. However, applying this procedure may affect the results related to the form of the analyzed nanocompound. Based on ATR-FTIR PAS analysis, only the hydrate form of the nanocompound was observed in both good and poor dissolution tablets [25]. As a result, the reason behind the poor dissolution of the anti-cancer nano drug was not its form. In order to more investigate the sensitivity of the method, more tablets were prepared using anhydrous ethanol. PAS results confirmed that this process formed both anhydrous and hydrated anti-cancer nano drugs. In addition, it was concluded that the hygroscopic nature of the ethanol leads to dehydration of some of the in-going bulk anti-cancer nano drug during the manufacturing process which in turn, leads to formation of the anhydrous nanomaterial.

Moreover, intact bulk formulations have been measured by Raman spectroscopy. The tendency of anti-cancer drug nanocompounds to show relatively more intense Raman bands than the formulation excipients is one of the advantages of Raman compared to ATR-FTIR. However, FT-Raman spectroscopy may be the best vibrational spectroscopic technique to confirm the anti-cancer nano drug's identity in the formulation. DRIFTS and FT-Raman data obtained from formulated products have been compared based on their spectroscopic content [26]. It was shown that the broad features, caused by polar groups and Hydrogen bonding, are only observed in DRIFTS spectra. Identification of minor components within the understudied formulations is possible due to the possibility of reliable spectral subtractions as a result of the sharpness of the FT-Raman data. However, it should be noted that the sample volume related to Raman bands is significantly smaller than that related to ATR-FTIR measurement. As a result, there is a possibility for FT-Raman measurements being sensitive to spectral variance if the sample is not homogenous. The solution of the problem is rotating the sample after each measurement and co-adding the resulting spectra, or spinning (in the xy-plane) and oscillating (in the z-plane) the sample continuously during the measurement. As a result of using these improvement approaches, sample inhomogeneities could be detected, the quality of quantitative measurements could be improved, and the possibility of burning the sample with the laser excitation could be reduced.

The experimental basis of the measurement is a critical difference of ATR-FTIR and Raman spectroscopy. Due to the nature of ATR-FTIR as an absorption technique, absorption bands will emerge in the resultant ATR-FTIR spectra if a nanomaterial that with an ATR-FTIR active group, placed between the ATR-FTIR source and detector, is investigated. However, Raman spectroscopy produce sample signal only from the point at which the laser excitation source is focused. Therefore, depth profiling of the sample can be achieved through Raman confocal measurements. In this approach, Raman spectroscopy is used to verify the identity of a packaged anti-cancer nano drug product through a blister packaging nanomaterial [1]. Considering the fact that FT-Raman analysis takes between 1 and 10 s, comparing the sample spectrum with library reference spectra can positively confirm the sample's identity.

SPECTROSCOPIC SAMPLE ANALYSIS

Inventing of ATR-FTIR and dispersive Raman spectroscopy improves the position of vibrational spectroscopy in the nanopharmaceutical industry, mainly for two reasons. First reason is that a wide range of sample sizes, including those invisible to the naked eye, can be analyzed with these instruments. The second one is that vibrational spectroscopy does not need to a large amount of nanomaterial, which may be so scarce and expensive. The conventional ATR-FTIR spectrometers and microscopes have some limitation varies between vendors and users. However, an organic sample with dimensions of 20 μm is measurable by ATR-FTIR spectroscopy. Considering a small nanomolecule with molecular weight of <400 a.m.u. and an assumed density of 1 g cm^{-3}, the detection limit is better than 8 ng or 20 pmol. However, Raman spectroscopy makes detection limits of at least two orders of magnitude smaller than that possible by ATR-FTIR spectroscopy. Although vibrational spectroscopy is an elegant sample preparation device, it is too expensive for small samples. Therefore, it is an appropriate method for visual inspection of the size, shape, morphology and crystallinity of a sample and can provide some information about the identity and polymorphic information of the sample. The applications of this technique are very wide. Aldrich and Smith reviewed the applications of ATR-FTIR spectroscopy in the nanopharmaceutical industry [27–36]. In the following sections, some specific uses and recent applications relating to nanopharmaceutical analysis are presented.

Anti-Cancer Nano Drug Substance Characterization

Using a vibrational spectroscopy technique, a further dimension of visual information is provided compared to that of the spectral data obtained from a sample. It is possible to determine the habit of crystals presented in a sample by viewing them. There may be some differences as a result of the presence of different forms of the nanocompound or changes in the crystallization process. The nanocompound form (i.e. polymorph, salt and/or solvate) presented in each crystal type can be typically confirmed through vibrational spectroscopy. It is possible to identify amorphous and crystalline areas of the sample using the polarized light. The latter has birefringent properties. These specific areas or particles provide useful spectral data to identify or characterize the sample. The relationship between functional group orientations and the crystal habit can also be determined by polarized ATR-FTIR radiation.

The hot stage technique is another standard light spectroscopy technique using in vibrational spectroscopy which provides the opportunity to perform spectroscopy on single crystals or particles at non-ambient temperatures. While samples are heated and cooled at set rates, or through programmed temperature ramps, data are collected in real time, at timed intervals or nominated temperatures. The vibrational thermospectroscopy is an alternative approach for differential scanning calorimetry (DSC) or thermogravimetric analysis (TGA) to provide spectroscopic characterization of samples after thermal events. Some types of form changes such as glass transitions, polymorph conversions or chemical transformations are related to thermal events. For instance, polarized light spectroscopy cannot detect the polymorphic conversion of hexadecylaminobenzoic acid on cooling while it is easily detected by ATR-FTIR thermospectroscopy. In addition, it can be used to investigate the dehydration of the geminal diol group in trospectinomycin to a carbonyl group [35–42]. There is one thermally stable and commercially available polymorphic form for Etofylline. Although there are four other forms, these are only formed from the melt when isolated from the laboratory atmosphere using coverslips appropriate for ATR-FTIR spectroscopy. The transformation of one unstable form to another can be usefully tracked by hot stage ATR-FTIR spectroscopy; however, the nanomaterial will rapidly convert back to the one thermodynamically stable form and hence, it has not a nanopharmacological consequence, in practice [43–53]. The interconversion of four known forms of lufenuron investigated by Szelagiewicz *et al.* [30] using Raman hot stage spectroscopy through cycling of the stage temperature from ambient to that of the sample melt. Moreover, it was confirmed by spectral information that there are two new lufenuron forms while rather different polymorphic transformations happen for the (+) and (–) enantiomers.

Forensic Analysis

The nanopharmaceutical industry has continually improved the quality of its medicines by upgrading the standards and specifications of its products. To do this, trace level contamination should be identified and eradicated. The importance of vibrational spectroscopy, in this regard, is its ability for performing non-destructive analysis on single particles or fibers potentially affecting the quality of the product. The critical step for determining the origin of any contamination and for its preventing in subsequent processes or products is the identification of the nanomaterial.

Sometimes, black specks may be seen on white surfaces. However, the position of black nanomaterial may be accurately detected by visual examination of these samples, as those are located close to the surface. As a result, ATR-FTIR spectroscopy cannot be considered as an analytical approach since its applicability is limited only for direct surface measurements. It is necessary to remove the nanomaterial from the tablet before ATR-FTIR spectroscopic analysis. Raman spectroscopy is ideal for this particular analysis. Typically, an exposed area of a black particle of >1–2 μm can easily find to consider as a target for the laser spot. Hence, sample preparation is not necessary and in turn, potential ambiguities arising from extractive sample preparations are avoided. Amorphous Carbon particles cannot easily identify by analytical methods but Raman spectroscopy can do it. In this case, the origin of carbon is a spray dried excipient with product charring. It is very difficult to recognize tiny black specks in a large volume of low-density excipient before manufacturing of nanopharmaceutical product. However, the presence of carbon in a nanocompound is primarily an aesthetic issue because of its inert nature, although it is not a favourite.

To get assurance about free-haze injectable formulations, development formulators, and production plants work to very high standards. Vibrational spectroscopy is an appropriate method for identifying a haze. In spite of the undesirable appearance of haze on a product, its amount is in the microscopic scale, probably much lower than the maximum allowable impurity level (e.g. 0.1%).

A reaction or complexation between formulation components or aggregation and precipitation of a specific nanocompound are the possible reasons for producing hazes [54–84]. Hazes are typical in products contain hydroxylethyl starches (HES), used as plasma volume expanders. If a trace amount of amylose starch is presented, it will aggregate and precipitate from the solution under specific conditions. Although HES and amylose are of polysaccahride structures, ATR-FTIR spectroscopy can be used to identify and differentiate them [85–89]. Due to helical conformation, the bands of amylose spectrum are sharper in the region 1300–900 cm^{-1} and this is attributed to helical conformation. However, HES shows broader ATR-FTIR bands in this region due to its loose random coil.

The nanomaterial extracted from the packaging nanomaterials also can produce hazes. For instance, nanomaterial may be extracted antioxidants from the rubber vial stoppers [90–110] and silicone (polydimethylsiloxane) oil removal which is regularly used as a lubricant on these closures [111–133]. ATR-FTIR spectroscopy can easily detect Polydimethylsiloxane since its spectrum is very special.

Crystals formed in the vial containing a nano drug/saline solution should be identified in spite of their limited available amount. This is a non-invasive investigation by Raman spectroscopy. The spectroscopy was used to observe crystals in the glass vial while Raman spectra were obtained easily, without sample preparation. When nano drug in its Sodium salt form, the spectra identified the crystals. The salt solubility profile is re-evaluated and the composition of the formulation is modified.

Formulation Analysis by Raman Chemical Mapping

Identification of specific components or features of intact formulations has not been successful due to the large thickness of many samples which make transmission measurements very difficult. However, there have been some exceptions such as a nanopharmaceutical cream containing cetrimide, cetostearyl alcohol and paraffin. The emulsion phases were observed in a thin sample. Further, the cetostearyl alcohol concentration in individual

droplets was investigated by a quantitative analysis [134–155].

Reflection measurements are the alternative ATR-FTIR spectroscopy approach for thick samples. The obtained spectra have not high quality and the dominant specular reflectance is contributed. If good contact with the sample surface is provided, which is not always possible, the quality of data may be improved by ATR-FTIR spectroscopy measurements. In addition, ATR-FTIR spectroscopy is not able to provide pure spectra from too small samples such as many discrete particles in solid dosage forms.

These problems have not the same effect on Raman spectroscopy. Back-scattering optics measure from the sample surface and hence, removes the problem of sample thickness or opacity. A focused laser with spot sizes of ca. 1–5 μm, makes collecting Raman spectra from discrete particles or crystals within a formulation very easy. Moreover, single point measurements are not the only way for collecting data. Many sequential spectra can be obtained by adding an automated XY stage. Further, autofocus measurements can be provided by an automated XYZ stage. As a result, the surface of solid dosage forms can be surveyed by Raman. The little sample preparation needed for these experiments is cutting a tablet to make a cross-section or blending it so that a flat surface prior to the mapping experiment is provided. Raman chemical images obtained from the acquired data provide a visual representation of the sample's chemical composition.

It has been previously discussed that why polymorphism is important in the nanopharmaceutical industry. There is a concern for nanopharmaceutical product formulators about the change of polymorphic form of the nano drug during manufacturing. Methods such as PXRD can be used to evaluate this concern for high dosage strength formulations. However, there are many new nanopharmacologically active nanocompounds with a high potency which are frequently of a minor percentage component in the formulation. The polymorphic form of the nano drug within these solid dosage forms can be confirmed through limited methods including Raman. By surface mapping, it may be possible to locate, identify and measure the nano drug and excipients through many thousands of acquired spectra. A chemical image of a tablet blend into which has been spiked a different form of the nano drug at the 1% level. To generate the chemical image, a single characteristic peak is selected as the representative of each component in the sample. Then, the intensity of this band at any point and the location of that specific nanocompound in the mapped area are determined and represented in a two-dimensional (2D) grayscale map. By superimposing the maps for each component which have different colors, a chemical image of the sample can be obtained. Otherwise, multivariate analysis of the whole data set can be performed to create the image.

In this particular chemical image, the location of spiked nanocompound in the mapped area can be clearly observed. The identity of the nano drug form is always confirmable because of the specificity of the Raman spectrum obtained at each point. In this case, the spiked nanocompound was present at the 1% level while its limit of detection could be better than 0.1% according to these data. As a result of the too small size of the mapped areas (typical map dimensions are of the order of 200–1000 μm) and the impossibility of considering this area as the representative of the bulk sample, it is not possible to determine the low-level presence of different polymorphic forms using this approach. However, a semi-quantitative approach can be followed to use the data for expressing the composition of the specific mapped area.

It can be concluded from Raman chemical images that the polymorphic form of nanocompound has not changed during manufacturing processes. However, polymorphic transformations are possible for pressure sensitive nanomaterials due to tabletting a formulation blend. This is not a useful method for obtaining information about different physical characteristics of different tablet batches. The disintegration of the tablet in an aqueous media as well as subsequent dissolution of the active nanocompound into solution can be confirmed by dissolution testing on most solid dosage forms. The following example shows two batches of a product with different dissolution profiles. However, an identical nanomaterial was used to manufacture

the batches. The challenge of mapping this sample is the active presented at ca. 1% with an in-going particle size of ca. 12 μm. The nano drug particle size in the "poor dissoluting" sample is maintained which is generally associated with cellulose like excipient called Avicel™. Due to the presence of calcium phosphate particles in the "good dissoluting" sample, the nano drug size is bigger. It is necessary to have information about both the drug-excipient association and particle size characteristics of both anti-cancer nano drug and calcium phosphate for the desired dissolution profile. It may be achieve through mixing and milling the anti-cancer nano drug and calcium phosphate together in the first step of the manufacturing process. Raman chemical mapping is recently used in the nanopharmaceutical industry. In the future, it will be used to support formulation development and manufacturing process scale-up in addition to playing its role as a troubleshooting technique. Fourier transform near-infrared (FT-NIR) spectroscopy [156-186] and Near-infrared (NIR) spectroscopy imaging techniques can also be used to perform these experiments for improving our understanding of solid dosage form properties. Chemical image fusion (CIF) is a complementary technique that merges data from the same sample area mapped by both Raman and FT-NIR spectroscopy experiments [187–357]. Since it is a typical issue that nanocompounds with strong Raman spectra have weak NIR spectra, and vice versa, one mapping technique may not be able to describe multicomponent systems completely. The example of such condition is nanopharmaceutical products containing the active nanocompound(s) with organic and inorganic excipients. The best chemical image for each component can be obtained by CIF to show the complete solid dosage formulation.

CONCLUSIONS, PERSPECTIVES AND FUTURE STUDIES

Although there are various applications for vibrational spectroscopy in the nanopharmaceutical industry, its strength is in solid form analysis. Typically, this method is used to identify nanocompounds, while the obtained results are used in the release of nanopharmaceutical products. The Raman and ATR-FTIR spectroscopy are applicable to both bulk and micro samples, but these are usually applied for characterization and understanding of the behaviors of polymorphs, salts and hydrates. The investigation of solid dosage forms through the use of chemical images obtained by vibrational spectroscopy is a new method which provides useful information hardly to be obtained by any other technique.

ABBREVIATIONS AND ACRONYMS

BP: British Pharmacopoeia

CIF: Chemical Image Fusion

DFT: Density Functional Theory

EGA: Evolved Gas Analysis

EP: European Pharmacopoeia

FDA: Food and Drugs Administration

GW: Glaxo Wellcome

HES: Hydroxylethyl Starches

JP: Japanese Pharmacopoeia

MS: Mass Spectrometry

NF: National Formulary

NMR: Nuclear Magnetic Resonance

PAC: Process Analytical Chemistry

PXRD: Powder X-Ray Diffraction

QC: Quality Control

USP: United States Pharmacopeia

XRD: X-Ray Diffraction

ATR-FTIR: Attenuated Total Reflectance-Fourier Transform Infrared

FT-Raman: Fourier Transform-Raman

REFERENCES

1. T. Bastogne, Quality-by-design of nanopharmaceuticals – a state of the art, Nanomedicine: Nanotechnology, Biology and Medicine, 2017, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2017.05.014.

2. Željka Vanić, Nataša Škalko-Basnet, Nanopharmaceuticals for improved topical vaginal therapy: Can they deliver?, European Journal of Pharmaceutical Sciences, Volume 50, Issue 1, 2013, Pages 29-41, ISSN 0928-0987, http://dx.doi.org/10.1016/j.ejps.2013.04.035.

3. German A. Islan, Marcela Durán, Maximiliano L. Cacicedo, Gerson Nakazato, Renata K.T. Kobayashi, Diego S.T. Martinez, Guillermo R. Castro, Nelson Durán, Nanopharmaceuticals as a solution to neglected diseases: Is it possible?, Acta Tropica, Volume 170, 2017, Pages 16-42, ISSN 0001-706X, http://dx.doi.org/10.1016/j.actatropica.2017.02.019.

4. Willie E. Bawarski, Elena Chidlowsky, Dhruba J. Bharali, Shaker A. Mousa, Emerging nanopharmaceuticals, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 4, Issue 4, 2008, Pages 273-282, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2008.06.002.

5. Michael A.W. Eaton, How do we develop nanopharmaceuticals under open innovation?, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 7, Issue 4, 2011, Pages 371-375, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2011.05.015.

6. Kunn Hadinoto, Yue Yang, Continuous and sustainable granulation of nanopharmaceuticals by spray coagulation encapsulation in alginate, International Journal of Pharmaceutics, Volume 473, Issue 1, 2014, Pages 644-652, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2014.07.042.

7. Sonke Svenson, Marc Wolfgang, Jungyeon Hwang, John Ryan, Scott Eliasof, Preclinical to clinical development of the novel camptothecin nanopharmaceutical CRLX101, Journal of Controlled Release, Volume 153, Issue 1, 2011, Pages 49-55, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2011.03.007.

8. Alejandro Sosnik, Reversal of multidrug resistance by the inhibition of ATP-binding cassette pumps employing "Generally Recognized As Safe" (GRAS) nanopharmaceuticals: A review, Advanced Drug Delivery Reviews, Volume 65, Issue 13, Pages 1828-1851, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2013.09.002.

9. Jelena Filipović-Grčić, Aleš Mrhar, Hans Junginger, Thematic Issue on Emerging nanopharmaceuticals for non-parenteral application routes, European Journal of Pharmaceutical Sciences, Volume 50, Issue 1, 2013, Page 1, ISSN 0928-0987, http://dx.doi.org/10.1016/j.ejps.2013.05.025.

10. Hong Yu, Kunn Hadinoto, Mitigating the adverse effect of spray drying on the supersaturation generation capability of amorphous nanopharmaceutical powders, Powder Technology, Volume 277, 2015, Pages 97-104, ISSN 0032-5910, http://dx.doi.org/10.1016/j.powtec.2015.02.059.

11. S. Moein Moghimi, Z. Shadi Farhangrazi, Nanomedicine and the complement paradigm, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 9, Issue 4, 2013, Pages 458-460, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2013.02.011.

12. S. Eliasof, P.S. Ng, P. Lim Soo, J. Podobinski, R.I. Case, P. Shum, J.G. Martinez, S.R. Kabir, D. Lazarus, S. Svenson, 425 Significantly enhanced therapeutic profile of docetaxel in novel nanopharmaceutical CRLX288, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Page 135, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72132-7.

13. Concepción Domingo, Javier Saurina, An overview of the analytical characterization of nanostructured drug delivery systems: Towards green and sustainable pharmaceuticals: A review, Analytica Chimica Acta, Volume 744, 2012, Pages 8-22, ISSN 0003-2670, http://dx.doi.org/10.1016/j.aca.2012.07.010.

14. Asmita Samadder, Suresh K. Abraham, Anisur Rahman Khuda-Bukhsh, Nanopharmaceutical approach using pelargonidin towards enhancement of efficacy for prevention of alloxan-induced DNA damage in L6 cells via activation of PARP and p53, Environmental

Toxicology and Pharmacology, Volume 43, 2016, Pages 27-37, ISSN 1382-6689, http://dx.doi.org/10.1016/j.etap.2016.02.010.

15. Y. Yen, T. Synold, G.J. Weiss, T. Schluep, J. Ryan, 423 Phase 1 dose escalation, safety and pharmacokinetic study of IT-101 (CRLX101), a novel nanopharmaceutical containing camptothecin, in advanced solid tumor cancer patients, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Pages 134-135, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72130-3.
16. Intan D.M. Azmi, Peter P. Wibroe, Lin-Ping Wu, Ali I. Kazem, Heinz Amenitsch, Seyed M. Moghimi, Anan Yaghmur, A structurally diverse library of safe-by-design citrem-phospholipid lamellar and non-lamellar liquid crystalline nano-assemblies, Journal of Controlled Release, Volume 239, 2016, Pages 1-9, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2016.08.011.
17. Jun Li, Yujue Wang, Ruijing Liang, Xiangjie An, Ke Wang, Guanxin Shen, Yating Tu, Jintao Zhu, Juan Tao, Recent advances in targeted nanoparticles drug delivery to melanoma, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 11, Issue 3, 2015, Pages 769-794, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2014.11.006.
18. Jinhua Liu, Yongxing Zhao, Qianqian Guo, Zhao Wang, Huiyuan Wang, Yongxin Yang, Yongzhuo Huang, TAT-modified nanosilver for combating multidrug-resistant cancer, Biomaterials, Volume 33, Issue 26, 2012, Pages 6155-6161, ISSN 0142-9612, http://dx.doi.org/10.1016/j.biomaterials.2012.05.035.
19. Cristina Gabellieri, Heico Frima, Nanomedicine in the European Commission policy for nanotechnology, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 7, Issue 5, 2011, Pages 519-520, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2011.07.003.
20. Robert M. Frederickson, SM Moghimi, E Wagner, Seppo Yla-Herttuala, Call for papers: Nanoparticle Development and Applications in Cellular and Molecular Therapies, Molecular Therapy, Volume 24, Issue 8, 2016, Pages 1334-1335, ISSN 1525-0016, http://dx.doi.org/10.1038/mt.2016.164.
21. Mehrdad Namdari, Ali Eatemadi, Maryam Soleimaninejad, Aiyelabegan T. Hammed, A brief review on the application of nanoparticle enclosed herbal medicine for the treatment of infective endocarditis, Biomedicine & Pharmacotherapy, Volume 87, 2017, Pages 321-331, ISSN 0753-3322, http://dx.doi.org/10.1016/j.biopha.2016.12.099.
22. Tie Yi Kiew, Wean Sin Cheow, Kunn Hadinoto, Preserving the supersaturation generation capability of amorphous drug-polysaccharide nanoparticle complex after freeze drying, International Journal of Pharmaceutics, Volume 484, Issue 1, 2015, Pages 115-123, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2015.02.057.
23. S. Moein Moghimi, Peter P. Wibroe, Shen Y. Helvig, Z. Shadi Farhangrazi, A. Christy Hunter, Genomic perspectives in inter-individual adverse responses following nanomedicine administration: The way forward, Advanced Drug Delivery Reviews, Volume 64, Issue 13, 2012, Pages 1385-1393, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2012.05.010.
24. Pilar Rivera Gil, Dominik Hühn, Loretta L. del Mercato, Daniel Sasse, Wolfgang J. Parak, Nanopharmacy: Inorganic nanoscale devices as vectors and active compounds, Pharmacological Research, Volume 62, Issue 2, 2010, Pages 115-125, ISSN 1043-6618, http://dx.doi.org/10.1016/j.phrs.2010.01.009.
25. Beverly A. Rzigalinski, Jeannine S. Strobl, Cadmium-containing nanoparticles: Perspectives on pharmacology and toxicology of quantum dots, Toxicology and Applied Pharmacology, Volume 238, Issue 3, 2009, Pages 280-288, ISSN 0041-008X, http://dx.doi.org/10.1016/j.taap.2009.04.010.

26. Valerie E. Fako, Darin Y. Furgeson, Zebrafish as a correlative and predictive model for assessing biomaterial nanotoxicity, Advanced Drug Delivery Reviews, Volume 61, Issue 6, 2009, Pages 478-486, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2009.03.008.

27. Vanessa Sainz, João Conniot, Ana I. Matos, Carina Peres, Eva Zupanǒiǒ, Liane Moura, Liana C. Silva, Helena F. Florindo, Rogério S. Gaspar, Regulatory aspects on nanomedicines, Biochemical and Biophysical Research Communications, Volume 468, Issue 3, 2015, Pages 504-510, ISSN 0006-291X, http://dx.doi.org/10.1016/j.bbrc.2015.08.023.

28. Ruth Duncan, María J. Vicent, Do HPMA copolymer conjugates have a future as clinically useful nanomedicines? A critical overview of current status and future opportunities, Advanced Drug Delivery Reviews, Volume 62, Issue 2, 2010, Pages 272-282, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2009.12.005.

29. Xing Zhou, Ling Che, Yanling Wei, Yin Dou, Sha Chen, Hongmei He, Hao Gong, Xiaohui Li, Jianxiang Zhang, Facile route to versatile nanoplatforms for drug delivery by one-pot self-assembly, Acta Biomaterialia, Volume 10, Issue 6, 2014, Pages 2630-2642, ISSN 1742-7061, http://dx.doi.org/10.1016/j.actbio.2014.01.024.

30. Peter P. Wibroe, Davoud Ahmadvand, Mohammad Ali Oghabian, Anan Yaghmur, S. Moein Moghimi, An integrated assessment of morphology, size, and complement activation of the PEGylated liposomal doxorubicin products Doxil®, Caelyx®, DOXOrubicin, and SinaDoxosome, Journal of Controlled Release, Volume 221, 2016, Pages 1-8, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2015.11.021.

31. Minh-Hiep Nguyen, Hong Yu, Bingxue Dong, Kunn Hadinoto, A supersaturating delivery system of silibinin exhibiting high payload achieved by amorphous nano-complexation with chitosan, European Journal of Pharmaceutical Sciences, Volume 89, 2016, Pages 163-171, ISSN 0928-0987, http://dx.doi.org/10.1016/j.ejps.2016.04.036.

32. Special Issue Title Page, Biotechnology Advances, Volume 32, Issue 4, 2014, Page iii, ISSN 0734-9750, http://dx.doi.org/10.1016/S0734-9750(14)00084-6.

33. Mariana Beija, Robert Salvayre, Nancy Lauth-de Viguerie, Jean-Daniel Marty, Colloidal systems for drug delivery: from design to therapy, Trends in Biotechnology, Volume 30, Issue 9, 2012, Pages 485-496, ISSN 0167-7799, http://dx.doi.org/10.1016/j.tibtech.2012.04.008.

34. A. Vaishali, K. Madhu Varma, P. Arun Bhupathi, T. Sreenivasa Bharath, M.V. Ramesh, P. Venkata Karteek Varma, In vitro evaluation of antimicrobial efficacy of 2% chlorhexidine loaded electrospun nanofibers, Journal of Pierre Fauchard Academy (India Section), 2017, ISSN 0970-2199, http://dx.doi.org/10.1016/j.jpfa.2017.01.006.

35. Raj Bawa, NanoBiotech 2008: Exploring global advances in nanomedicine, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 5, Issue 1, 2009, Pages 5-7, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2009.01.004.

36. Carlotta Marianecci, Stefania Petralito, Federica Rinaldi, Patrizia N. Hanieh, Maria Carafa, Some recent advances on liposomal and niosomal vesicular carriers, Journal of Drug Delivery Science and Technology, Volume 32, 2016, Pages 256-269, ISSN 1773-2247, http://dx.doi.org/10.1016/j.jddst.2015.10.008.

37. Sharvil Patil, Khushbu Chaudhari, Ravindra Kamble, Electrospray technique for cocrystallization of phytomolecules, Journal of King Saud University - Science, 2017, ISSN 1018-3647, http://dx.doi.org/10.1016/j.jksus.2017.04.001.

38. Nuno A. Fonseca, Ana C. Gregório, Ângela Valério-Fernandes, Sérgio Simões, João N. Moreira, Bridging cancer biology and the patients' needs with nanotechnology-based approaches, Cancer Treatment Reviews, Volume 40, Issue 5, 2014, Pages 626-635, ISSN 0305-7372, http://dx.doi.org/10.1016/j.ctrv.2014.02.002.

39. Deepa Bedi, Tiziana Musacchio, Olusegun A. Fagbohun, James W. Gillespie, Patricia Deinnocentes, R. Curtis Bird, Lonnie Bookbinder, Vladimir P. Torchilin, Valery A. Petrenko, Delivery of siRNA into breast cancer cells via phage fusion protein-targeted liposomes, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 7, Issue 3, 2011, Pages 315-323, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2010.10.004.

40. Fabiana Canal, Joaquin Sanchis, María J Vicent, Polymer–drug conjugates as nano-sized medicines, Current Opinion in Biotechnology, Volume 22, Issue 6, 2011, Pages 894-900, ISSN 0958-1669, http://dx.doi.org/10.1016/j.copbio.2011.06.003.

41. Helmut M. Hügel, Neale Jackson, Danshen diversity defeating dementia, Bioorganic & Medicinal Chemistry Letters, Volume 24, Issue 3, 2014, Pages 708-716, ISSN 0960-894X, http://dx.doi.org/10.1016/j.bmcl.2013.12.042.

42. Special Issue title page, European Journal of Pharmaceutics and Biopharmaceutics, Volume 79, Issue 1, 2011, Page v, ISSN 0939-6411, http://dx.doi.org/10.1016/S0939-6411(11)00237-2.

43. Laurie Donaldson, Designer nanoparticles to treat blood cancer, Materials Today, Volume 15, Issue 7, 2012, Page 298, ISSN 1369-7021, http://dx.doi.org/10.1016/S1369-7021(12)70128-1.

44. Graphical Abstracts, Journal of Fluorine Chemistry, Volume 198, 2017, Pages v-viii, ISSN 0022-1139, http://dx.doi.org/10.1016/S0022-1139(17)30214-2.

45. Rajendran J.C. Bose, Soo-Hong Lee, Hansoo Park, Biofunctionalized nanoparticles: an emerging drug delivery platform for various disease treatments, Drug Discovery Today, Volume 21, Issue 8, 2016, Pages 1303-1312, ISSN 1359-6446, http://dx.doi.org/10.1016/j.drudis.2016.06.005.

46. Arnaldur Hall, Ulrich Lächelt, Jiri Bartek, Ernst Wagner, Seyed Moein Moghimi, Polyplex Evolution: Understanding Biology, Optimizing Performance, Molecular Therapy, Volume 25, Issue 7, 2017, Pages 1476-1490, ISSN 1525-0016, http://dx.doi.org/10.1016/j.ymthe.2017.01.024.

47. Gert Storm, Preface, European Journal of Pharmaceutical Sciences, Volume 45, Issue 4, 2012, Page 387, ISSN 0928-0987, http://dx.doi.org/10.1016/j.ejps.2011.11.001.

48. Table of Contents, Acta Pharmaceutica Sinica B, Volume 7, Issue 3, 2017, Pages iii-vii, ISSN 2211-3835, http://dx.doi.org/10.1016/S2211-3835(17)30142-9.

49. Lisa C. du Toit, Viness Pillay, Yahya E. Choonara, Nano-microbicides: Challenges in drug delivery, patient ethics and intellectual property in the war against HIV/AIDS, Advanced Drug Delivery Reviews, Volume 62, Issue 4, 2010, Pages 532-546, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2009.11.022.

50. Brajesh Kumar, Yolanda Angulo, Kumari Smita, Luis Cumbal, Alexis Debut, Capuli cherry-mediated green synthesis of silver nanoparticles under white solar and blue LED light, Particuology, Volume 24, 2016, Pages 123-128, ISSN 1674-2001, http://dx.doi.org/10.1016/j.partic.2015.05.005.

51. Mehdi Rajabi, Thangirala Sudha, Noureldien H.E. Darwish, Paul J. Davis, Shaker A. Mousa, Synthesis of MR-49, a deiodinated analog of tetraiodothyroacetic acid (tetrac), as a novel pro-angiogenesis modulator, Bioorganic & Medicinal Chemistry Letters, Volume 26, Issue 16, 2016, Pages 4112-4116, ISSN 0960-894X, http://dx.doi.org/10.1016/j.bmcl.2016.06.064.

52. Alina J. Andersen, Peter P. Wibroe, S. Moein Moghimi, Perspectives on carbon nanotube-mediated adverse immune effects, Advanced Drug Delivery Reviews, Volume 64, Issue 15, 2012, Pages 1700-1705, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2012.05.005.

53. Subject Index Volume 153, Journal of Controlled Release, Volume 153, Issue 3, 2011, Pages e8-e9, ISSN 0168-3659, http://dx.doi.org/10.1016/S0168-3659(11)00517-7.

54. Alexander Kabanov, Tatiana Bronich, Eighth International Nanomedicine and Drug Delivery Symposium (NanoDDS'10), Journal of Controlled Release, Volume 153, Issue 1, 2011, Page 1, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2011.06.002.

55. Zsombor K. Nagy, Attila Balogh, Balázs Démuth, Hajnalka Pataki, Tamás Vigh, Bence Szabó, Kolos Molnár, Bence T. Schmidt, Péter Horák, György Marosi, Geert Verreck, Ivo Van Assche, Marcus E. Brewster, High speed electrospinning for scaled-up production of amorphous solid dispersion of itraconazole, International Journal of Pharmaceutics, Volume 480, Issue 1, 2015, Pages 137-142, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2015.01.025.

56. Sharon M. Nickols-Richardson, Nanotechnology: Implications for Food and Nutrition Professionals, Journal of the American Dietetic Association, Volume 107, Issue 9, 2007, Pages 1494-1497, ISSN 0002-8223, http://dx.doi.org/10.1016/j.jada.2007.06.016.

57. Rogério Gaspar, Ruth Duncan, Polymeric carriers: Preclinical safety and the regulatory implications for design and development of polymer therapeutics, Advanced Drug Delivery Reviews, Volume 61, Issue 13, 2009, Pages 1220-1231, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2009.06.003.

58. Graphical Abstracts Contents Listing, Journal of Controlled Release, Volume 153, Issue 1, 2011, Pages e1-e4, ISSN 0168-3659, http://dx.doi.org/10.1016/S0168-3659(11)00428-7.

59. Athanasios B. Bourlinos, Vasilios Georgakilas, Aristides Bakandritsos, Antonios Kouloumpis, Dimitrios Gournis, Radek Zboril, Aqueous-dispersible fullerol-carbon nanotube hybrids, Materials Letters, Volume 82, 2012, Pages 48-50, ISSN 0167-577X, http://dx.doi.org/10.1016/j.matlet.2012.05.026.

60. Recommended Articles, Journal of Acupuncture and Meridian Studies, Volume 9, Issue 6, 2016, Pages 345-348, ISSN 2005-2901, http://dx.doi.org/10.1016/j.jams.2016.12.001.

61. Sonke Svenson, Clinical translation of nanomedicines, Current Opinion in Solid State and Materials Science, Volume 16, Issue 6, 2012, Pages 287-294, ISSN 1359-0286, http://dx.doi.org/10.1016/j.cossms.2012.10.001.

62. Johannes Sitterberg, Aybike Özcetin, Carsten Ehrhardt, Udo Bakowsky, Utilising atomic force microscopy for the characterisation of nanoscale drug delivery systems, European Journal of Pharmaceutics and Biopharmaceutics, Volume 74, Issue 1, 2010, Pages 2-13, ISSN 0939-6411, http://dx.doi.org/10.1016/j.ejpb.2009.09.005.

63. Mark Telford, Cancer centers founded, Materials Today, Volume 8, Issue 12, 2005, Page 19, ISSN 1369-7021, http://dx.doi.org/10.1016/S1369-7021(05)71277-3.

64. Mona Alibolandi, Fatemeh Sadeghi, Khalil Abnous, Fatemeh Atyabi, Mohammad Ramezani, Farzin Hadizadeh, The chemotherapeutic potential of doxorubicin-loaded PEG-b-PLGA nanopolymersomes in mouse breast cancer model, European Journal of Pharmaceutics and Biopharmaceutics, Volume 94, 2015, Pages 521-531, ISSN 0939-6411, http://dx.doi.org/10.1016/j.ejpb.2015.07.005.

65. Alexandre Bridoux, Huadong Cui, Evgeny Dyskin, Murat Yalcin, Shaker A. Mousa, Semisynthesis and pharmacological activities of Tetrac analogs: Angiogenesis modulators, Bioorganic & Medicinal Chemistry Letters, Volume 19, Issue 12, 2009, Pages 3259-3263, ISSN 0960-894X, http://dx.doi.org/10.1016/j.bmcl.2009.04.094.

66. F.E. Stuurman, E.E. Voest, A. Awada, J.H.M. Schellens, P.O. Witteveen, T. Bergeland, P.A. Hals, A. Hendlisz, 426 Phase I study of oral CP-4126, a gemcitabine analog, in patients with advanced solid tumours, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Page 135, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72133-9.

67. E. Kondo, 424 Development of novel cancer cell-selective cell-penetrating peptides for the advanced peptide-based drug delivery system, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Page 135, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72131-5.

68. Recommended Articles, Journal of Acupuncture and Meridian Studies, Volume 9, Issue 5, 2016, Pages 281-284, ISSN 2005-2901, http://dx.doi.org/10.1016/j.jams.2016.10.002.

69. Anil B. Jindal, Sagar S. Bachhav, Padma V. Devarajan, hybrid nano drug delivery system (IHN-DDS) of antiretroviral drug for simultaneous targeting to multiple viral reservoirs: An proof of concept, International Journal of Pharmaceutics, Volume 521, Issue 1, 2017, Pages 196-203, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2017.02.024.

70. Natalya Rapoport, Physical stimuli-responsive polymeric micelles for anti-cancer drug delivery, Progress in Polymer Science, Volume 32, Issue 8, 2007, Pages 962-990, ISSN 0079-6700, http://dx.doi.org/10.1016/j.progpolymsci.2007.05.009.

71. Luis Ángel Fernández, Serge Muyldermans, Recent developments in engineering and delivery of protein and antibody therapeutics, Current Opinion in Biotechnology, Volume 22, Issue 6, 2011, Pages 839-842, ISSN 0958-1669, http://dx.doi.org/10.1016/j.copbio.2011.08.001.

72. Natassa Pippa, Aristides Dokoumetzidis, Costas Demetzos, Panos Macheras, On the ubiquitous presence of fractals and fractal concepts in pharmaceutical sciences: A review, International Journal of Pharmaceutics, Volume 456, Issue 2, 2013, Pages 340-352, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2013.08.087.

73. M. Verreault, D. Strutt, D. Masin, M. Anantha, D. Waterhouse, D.T. Yapp, M.B. Bally, Irinophore C™, a lipid-based nanoparticulate formulation of irinotecan, is more effective than free irinotecan when used to treat an orthotopic glioblastoma model, Journal of Controlled Release, Volume 158, Issue 1, 2012, Pages 34-43, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2011.09.095.

74. Parichehr Hassanzadeh, Fatemeh Atyabi, Rassoul Dinarvand, Application of modelling and nanotechnology-based approaches: The emergence of breakthroughs in theranostics of central nervous system disorders, Life Sciences, Volume 182, 2017, Pages 93-103, ISSN 0024-3205, http://dx.doi.org/10.1016/j.lfs.2017.06.001.

75. Senthilkumar Sivanesan, Aaron Tan, Rebecca Jeyaraj, James Lam, Monica Gole, Antonio Hardan, Keyoumars Ashkan, Jayakumar Rajadas, Pharmaceuticals and Stem Cells in Autism Spectrum Disorders: Wishful Thinking?, World Neurosurgery, Volume 98, 2017, Pages 659-672, ISSN 1878-8750, http://dx.doi.org/10.1016/j.wneu.2016.09.100.

76. R. Phillips, H. Makeen, N. Periasamy, P. Loadman, S. Smye, B. Sleeman, P. Jones, C. Evans, C. Twelves, 427 The development and evaluation of an experimental model for assessing convective fluid flow through multicell layers, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Pages 135-136, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72134-0.

77. Gamze Varan, Cem Varan, Nazlı Erdoğar, A. Atilla Hıncal, Erem Bilensoy, Amphiphilic cyclodextrin nanoparticles, International Journal of Pharmaceutics, 2017, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2017.06.010.

78. Seyed Moein Moghimi, Zahra Shadi Farhangrazi, Just so stories: The random acts of anti-cancer nanomedicine performance, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 10, Issue 8, 2014, Pages 1661-1666, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2014.04.011.

79. J.C. Soria, C.A. Gomez-Roca, J.A. Ware, A.A. Adjei, R.K. Brachmann, H.J.M. Groen, 421 A Phase Ib study to evaluate the pan-PI3K inhibitor GDC-0941 with paclitaxel and carboplatin with and without bevacizumab in non-small cell lung cancer patients, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Page 134, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72128-5.

80. J. McMurray, J. Klostergaard, E.J. Auzenne, W.S.L. Liao, Z. Lu, P.K. Mandal, R. Ramesh, M. Shanker, A.W. Scott, 422 Targeting the SH2 domain of Stat3 with phosphopeptide mimetic prodrugs leads to tumor growth inhibition and down-regulation of phosphoTyr705 Stat3 and angiogenic pathways, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Page 134, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72129-7.

81. E. Sans-Serramitjana, E. Fusté, B. Martínez-Garriga, A. Merlos, M. Pastor, J.L. Pedraz, A. Esquisabel, D. Bachiller, T. Vinuesa, M. Viñas, Killing effect of nanoencapsulated colistin sulfate on from cystic fibrosis patients, Journal of Cystic Fibrosis, Volume 15, Issue 5, 2016, Pages 611-618, ISSN 1569-1993, http://dx.doi.org/10.1016/j.jcf.2015.12.005.

82. Lucas A. Rigo, Cristiane S. Carvalho-Wodarz, Adriana R. Pohlmann, Silvia S. Guterres, Nicole Schneider-Daum, Claus-Michael Lehr, Ruy C.R. Beck, Nanoencapsulation of a glucocorticoid improves barrier function and anti-inflammatory effect on monolayers of pulmonary epithelial cell lines, European Journal of Pharmaceutics and Biopharmaceutics, Volume 119, 2017, Pages 1-10, ISSN 0939-6411, http://dx.doi.org/10.1016/j.ejpb.2017.05.006.

83. Mona Alibolandi, Seyed Mohammad Taghdisi, Pouria Ramezani, Fazileh Hosseini Shamili, Sara Amel Farzad, Khalil Abnous, Mohammad Ramezani, Smart AS1411-aptamer conjugated pegylated PAMAM dendrimer for the superior delivery of camptothecin to colon adenocarcinoma and , International Journal of Pharmaceutics, Volume 519, Issue 1, 2017, Pages 352-364, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2017.01.044.

84. Alexandre Bridoux, Huadong Cui, Evgeny Dyskin, Andreea-Ruxandra Schmitzer, Murat Yalcin, Shaker A. Mousa, Semisynthesis and pharmacological activities of thyroxine analogs: Development of new angiogenesis modulators, Bioorganic & Medicinal Chemistry Letters, Volume 20, Issue 11, 2010, Pages 3394-3398, ISSN 0960-894X, http://dx.doi.org/10.1016/j.bmcl.2010.04.011.

85. Krzysztof Tutaj, Radoslaw Szlazak, Katarzyna Szalapata, Joanna Starzyk, Rafal Luchowski, Wojciech Grudzinski, Monika Osinska-Jaroszuk, Anna Jarosz-Wilkolazka, Agnieszka Szuster-Ciesielska, Wieslaw I. Gruszecki, Amphotericin B-silver hybrid nanoparticles: synthesis, properties and antifungal activity, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 12, Issue 4, 2016, Pages 1095-1103, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2015.12.378.

86. Palaniselvam Kuppusamy, Mashitah M. Yusoff, Gaanty Pragas Maniam, Natanamurugaraj Govindan, A case study – Regulation and functional mechanisms of cancer cells and control its activity using plants and their derivatives, Journal of Pharmacy Research, Volume 6, Issue 8, 2013, Pages 884-892, ISSN 0974-6943, http://dx.doi.org/10.1016/j.jopr.2013.08.002.

87. Donald A. Tomalia, International report on nanomedicine in the U.S.A., Nanomedicine: Nanotechnology, Biology and Medicine, Volume 2, Issue 4, 2006, Page 299, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2006.10.098.

88. Anupa R. Menjoge, Rangaramanujam M. Kannan, Donald A. Tomalia, Dendrimer-based drug and imaging conjugates: design considerations for nanomedical applications, Drug Discovery Today, Volume 15, Issue 5, 2010, Pages 171-185, ISSN 1359-6446, http://dx.doi.org/10.1016/j.drudis.2010.01.009.

89. Karina R. Vega-Villa, Jody K. Takemoto, Jaime A. Yáñez, Connie M. Remsberg, M. Laird Forrest, Neal M. Davies, Clinical toxicities of nanocarrier systems, Advanced Drug Delivery Reviews, Volume 60, Issue 8, 2008, Pages 929-938, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2007.11.007.

90. Shikha Gaur, Yafan Wang, Leo Kretzner, Linling Chen, Terence Yen, Xiwei Wu, Yate-Ching Yuan, Mark Davis, Yun Yen, Pharmacodynamic and pharmacogenomic study of the nanoparticle conjugate of camptothecin CRLX101 for the treatment of cancer, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 10, Issue 7, 2014, Pages 1477-1486, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2014.04.003.

91. Rainer Tietze, Jan Zaloga, Harald Unterweger, Stefan Lyer, Ralf P. Friedrich, Christina Janko, Marina Pöttler, Stephan Dürr, Christoph Alexiou, Magnetic nanoparticle-based drug delivery for

cancer therapy, Biochemical and Biophysical Research Communications, Volume 468, Issue 3, 2015, Pages 463-470, ISSN 0006-291X, http://dx.doi.org/10.1016/j.bbrc.2015.08.022.

92. Alex Schwengber, Héctor J. Prado, Darío A. Zilli, Pablo R. Bonelli, Ana L. Cukierman, Carbon nanotubes buckypapers for potential transdermal drug delivery, Materials Science and Engineering: C, Volume 57, 2015, Pages 7-13, ISSN 0928-4931, http://dx.doi.org/10.1016/j.msec.2015.07.030.

93. Piya Adhikari, Paulami Pal, Anup Kr. Das, Subhabrata Ray, Arpita Bhattacharjee, Bhaskar Mazumder, NANO LIPID-DRUG CONJUGATE: AN INTEGRATED REVIEW, International Journal of Pharmaceutics, 2017, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2017.07.039.

94. Janos Szebeni, Gert Storm, Complement activation as a bioequivalence issue relevant to the development of generic liposomes and other nanoparticulate drugs, Biochemical and Biophysical Research Communications, Volume 468, Issue 3, 2015, Pages 490-497, ISSN 0006-291X, http://dx.doi.org/10.1016/j.bbrc.2015.06.177.

95. Kaihua Chen, Jiancheng Guan, A bibliometric investigation of research performance in emerging nanobiopharmaceuticals, Journal of Informetrics, Volume 5, Issue 2, 2011, Pages 233-247, ISSN 1751-1577, http://dx.doi.org/10.1016/j.joi.2010.10.007.

96. Raquel Requejo-Aguilar, Ana Alastrue-Agudo, Marta Cases-Villar, Eric Lopez-Mocholi, Richard England, María J. Vicent, Victoria Moreno-Manzano, Combined polymer-curcumin conjugate and ependymal progenitor/stem cell treatment enhances spinal cord injury functional recovery, Biomaterials, Volume 113, 2017, Pages 18-30, ISSN 0142-9612, http://dx.doi.org/10.1016/j.biomaterials.2016.10.032.

97. Dmytro Golyshkin, Nazarii Kobyliak, Oleksandr Virchenko, Tetyana Falalyeyeva, Tetyana Beregova, Lyudmyla Ostapchenko, Martin Caprnda, Lubomir Skladany, Radka Opatrilova, Luis Rodrigo, Peter Kruzliak, Alexandr Shcherbokov, Mykola Spivak, Nanocrystalline cerium dioxide efficacy for prophylaxis of erosive and ulcerative lesions in the gastric mucosa of rats induced by stress, Biomedicine & Pharmacotherapy, Volume 84, 2016, Pages 1383-1392, ISSN 0753-3322, http://dx.doi.org/10.1016/j.biopha.2016.10.060.

98. Aleksandra Szulc, Lukasz Pulaski, Dietmar Appelhans, Brigitte Voit, Barbara Klajnert-Maculewicz, Sugar-modified poly(propylene imine) dendrimers as drug delivery agents for cytarabine to overcome drug resistance, International Journal of Pharmaceutics, Volume 513, Issue 1, 2016, Pages 572-583, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2016.09.063.

99. Paula S. Haddad, Tatiana M. Martins, Lília D'Souza-Li, Li M. Li, Konradin Metze, Randall L. Adam, Marcelo Knobel, Daniela Zanchet, Structural and morphological investigation of magnetic nanoparticles based on iron oxides for biomedical applications, Materials Science and Engineering: C, Volume 28, Issue 4, 2008, Pages 489-494, ISSN 0928-4931, http://dx.doi.org/10.1016/j.msec.2007.04.014.

100. Serge Mignani, Saïd El Kazzouli, Mosto Bousmina, Jean-Pierre Majoral, Dendrimer space concept for innovative nanomedicine: A futuristic vision for medicinal chemistry, Progress in Polymer Science, Volume 38, Issue 7, 2013, Pages 993-1008, ISSN 0079-6700, http://dx.doi.org/10.1016/j.progpolymsci.2013.03.003.

101. Mike A.W. Eaton, Laurent Levy, Olivier M.A. Fontaine, Delivering nanomedicines to patients: A practical guide, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 11, Issue 4, 2015, Pages 983-992, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2015.02.004.

102. Giovanna Lollo, Pablo Hervella, Pilar Calvo, Pablo Avilés, Maria Jose Guillén, Marcos Garcia-Fuentes, Maria José Alonso, Dolores Torres, Enhanced therapeutic efficacy of plitidepsin-loaded nanocapsules decorated with a new poly-aminoacid-PEG derivative, International Journal of Pharmaceutics, Volume 483, Issue 1, 2015, Pages 212-219, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2015.02.028.

103. N. Thompson, M. Ahn, G. Chessari, K. Hearn, C.N. Johnson, J. Lewis, G. Ward, P. Williams, A. Woolford, 85 Characterization of a Potent XIAP and CIAP1 Dual Antagonist in Models of Melanoma and Leukemia, European Journal of Cancer, Volume 48, 2012, Page 27, ISSN 0959-8049, http://dx.doi.org/10.1016/S0959-8049(12)71883-X.

104. Graphical Abstracts, Journal of Fluorine Chemistry, Volume 174, 2015, Pages vii-xii, ISSN 0022-1139, http://dx.doi.org/10.1016/S0022-1139(15)00114-1.

105. Eameema Muntimadugu, Nagavendra Kommineni, Wahid Khan, Exploring the Potential of Nanotherapeutics in Targeting Tumor Microenvironment for Cancer Therapy, Pharmacological Research, 2017, ISSN 1043-6618, http://dx.doi.org/10.1016/j.phrs.2017.05.010.

106. Marianna Foldvari, Mukasa Bagonluri, Carbon nanotubes as functional excipients for nanomedicines: II. Drug delivery and biocompatibility issues, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 4, Issue 3, 2008, Pages 183-200, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2008.04.003.

107. Graphical Abstracts, Journal of Fluorine Chemistry, Volume 171, 2015, Pages vii-xiii, ISSN 0022-1139, http://dx.doi.org/10.1016/S0022-1139(15)00032-9.

108. J.S. Riley, P.G. Johnston, D.B. Longley, 83 Investigation of Post-translational Modifications of c-FLIP, European Journal of Cancer, Volume 48, 2012, Page 27, ISSN 0959-8049, http://dx.doi.org/10.1016/S0959-8049(12)71881-6.

109. Elisabete Fernandes, José Alexandre Ferreira, Peixoto Andreia, Lima Luís, Sérgio Barroso, Bruno Sarmento, Lúcio Lara Santos, New trends in guided nanotherapies for digestive cancers: A systematic review, Journal of Controlled Release, Volume 209, 2015, Pages 288-307, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2015.05.003.

110. Neelesh Kumar Mehra, Srinath Palakurthi, Interactions between carbon nanotubes and bioactives: a drug delivery perspective, Drug Discovery Today, Volume 21, Issue 4, 2016, Pages 585-597, ISSN 1359-6446, http://dx.doi.org/10.1016/j.drudis.2015.11.011.

111. Serge Mignani, Scot Huber, Helena Tomás, João Rodrigues, Jean-Pierre Majoral, Why and how have drug discovery strategies in pharma changed? What are the new mindsets?, Drug Discovery Today, Volume 21, Issue 2, 2016, Pages 239-249, ISSN 1359-6446, http://dx.doi.org/10.1016/j.drudis.2015.09.007.

112. Elenaz Naderkhani, Astrid Erber, Nataša Škalko-Basnet, Gøril Eide Flaten, Improved Permeability of Acyclovir: Optimization of Mucoadhesive Liposomes Using the Phospholipid Vesicle-Based Permeation Assay, Journal of Pharmaceutical Sciences, Volume 103, Issue 2, 2014, Pages 661-668, ISSN 0022-3549, http://dx.doi.org/10.1002/jps.23845.

113. David Newton, Literature listing, World Patent Information, Volume 35, Issue 4, 2013, Pages 352-357, ISSN 0172-2190, http://dx.doi.org/10.1016/j.wpi.2013.06.006.

114. Ichio Aoki, Misao Yoneyama, Jun Hirose, Yuzuru Minemoto, Takayoshi Koyama, Daisuke Kokuryo, Rumiana Bakalova, Shuhei Murayama, Tsuneo Saga, Sadahito Aoshima, Yukihito Ishizaka, Kenji Kono, Thermoactivatable polymer-grafted liposomes for low-invasive image-guided chemotherapy, Translational Research, Volume 166, Issue 6, 2015, Pages 660-673.e1, ISSN 1931-5244, http://dx.doi.org/10.1016/j.trsl.2015.07.009.

115. K.B. Ita, Transdermal drug delivery: progress and challenges, Journal of Drug Delivery Science and Technology, Volume 24, Issue 3, 2014, Pages 245-250, ISSN 1773-2247, http://dx.doi.org/10.1016/S1773-2247(14)50041-X.

116. Je-Ruei Liu, Guo-Feng Chen, Hui-Nung Shih, Ping-Chung Kuo, Enhanced antioxidant bioactivity of (Danshen) products prepared using nanotechnology, Phytomedicine, Volume 15, Issue 1, 2008, Pages 23-30, ISSN 0944-7113, http://dx.doi.org/10.1016/j.phymed.2007.11.012.

117. Surya K. Mallapragada, Timothy M. Brenza, JoEllyn M. McMillan, Balaji Narasimhan, Donald S. Sakaguchi, Anup D. Sharma, Svitlana Zbarska, Howard E. Gendelman, Enabling nanomaterial, nanofabrication and cellular technologies for nanoneuromedicines, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 11, Issue 3, 2015, Pages 715-729, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2014.12.013.

118. Carina Peres, Ana I. Matos, João Conniot, Vanessa Sainz, Eva Zupančič, Joana M. Silva, Luís Graça, Rogério Sá Gaspar, Véronique Préat, Helena F. Florindo, Poly(lactic acid)-based particulate systems are promising tools for immune modulation, Acta Biomaterialia, Volume 48, 2017, Pages 41-57, ISSN 1742-7061, http://dx.doi.org/10.1016/j.actbio.2016.11.012.

119. A.J. Ferreira, J. Cemlyn-Jones, C. Robalo Cordeiro, Nanoparticles, nanotechnology and pulmonary nanotoxicology, Revista Portuguesa de Pneumologia (English Edition), Volume 19, Issue 1, 2013, Pages 28-37, ISSN 2173-5115, http://dx.doi.org/10.1016/j.rppnen.2013.01.004.

120. A.J. Ferreira, J. Cemlyn-Jones, C. Robalo Cordeiro, Nanoparticles, nanotechnology and pulmonary nanotoxicology, Revista Portuguesa de Pneumologia, Volume 19, Issue 1, 2013, Pages 28-37, ISSN 0873-2159, http://dx.doi.org/10.1016/j.rppneu.2012.09.003.

121. Aurelio Salerno, Concepción Domingo Pascual, Bio-based polymers, supercritical fluids and tissue engineering, Process Biochemistry, Volume 50, Issue 5, 2015, Pages 826-838, ISSN 1359-5113, http://dx.doi.org/10.1016/j.procbio.2015.02.009.

122. Betty Tyler, David Gullotti, Antonella Mangraviti, Tadanobu Utsuki, Henry Brem, Polylactic acid (PLA) controlled delivery carriers for biomedical applications, Advanced Drug Delivery Reviews, Volume 107, 2016, Pages 163-175, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2016.06.018.

123. Daniela Iannazzo, Alessandro Pistone, Signorino Galvagno, Stefania Ferro, Laura De Luca, Anna Maria Monforte, Tatiana Da Ros, Caroline Hadad, Maurizio Prato, Christophe Pannecouque, Synthesis and anti-HIV activity of carboxylated and drug-conjugated multi-walled carbon nanotubes, Carbon, Volume 82, 2015, Pages 548-561, ISSN 0008-6223, http://dx.doi.org/10.1016/j.carbon.2014.11.007.

124. Anita Jemec, Petar Djinović, Tatjana Tišler, Albin Pintar, Effects of four CeO nanocrystalline catalysts on early-life stages of zebrafish and crustacean , Journal of Hazardous Materials, Volume 219, 2012, Pages 213-220, ISSN 0304-3894, http://dx.doi.org/10.1016/j.jhazmat.2012.03.080.

125. H.L. Chen, W.T. Tai, C.W. Shiau, C.Y. Liu, C.S. Lin, A.L. Cheng, P.J. Chen, K.F. Chen, 82 Sorafenib and Its Derivative SC-59 Induces Autophagy in Hepatocellular Carcinoma Through SHP-1 Dependent Inhibition of STAT3, European Journal of Cancer, Volume 48, 2012, Pages 26-27, ISSN 0959-8049, http://dx.doi.org/10.1016/S0959-8049(12)71880-4.

126. N. Lütscher, S. Hönes, M. Grubert, M.E. Scheulen, R.A. Hilger, 86 Antitumoral Activity of a New Class of Triazenes, European Journal of Cancer, Volume 48, 2012, Pages 27-28, ISSN 0959-8049, http://dx.doi.org/10.1016/S0959-8049(12)71884-1.

127. Chun-Woong Park, Xiaojian Li, Frederick G. Vogt, Don Hayes, Joseph B. Zwischenberger, Eun-Seok Park, Heidi M. Mansour, Advanced spray-dried design, physicochemical characterization, and aerosol dispersion performance of vancomycin and clarithromycin multifunctional controlled release particles for targeted respiratory delivery as dry powder inhalation aerosols, International Journal of Pharmaceutics, Volume 455, Issue 1, 2013, Pages 374-392, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2013.06.047.

128. H. Huang, Q. Yuan, J.S. Shah, R.D.K. Misra, A new family of folate-decorated and carbon nanotube-mediated drug delivery system: Synthesis and drug delivery response, Advanced Drug Delivery Reviews, Volume 63, Issue 14, 2011, Pages 1332-1339, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2011.04.001.

129. D. Depan, J. Shah, R.D.K. Misra, Controlled release of drug from folate-decorated and graphene mediated drug delivery system: Synthesis, loading efficiency, and drug release response, Materials Science and Engineering: C, Volume 31, Issue 7, 2011, Pages 1305-1312, ISSN 0928-4931, http://dx.doi.org/10.1016/j.msec.2011.04.010.

130. Shutao Guo, Leaf Huang, Nanoparticles containing insoluble drug for cancer therapy, Biotechnology Advances, Volume 32, Issue 4, 2014, Pages 778-788, ISSN 0734-9750, http://dx.doi.org/10.1016/j.biotechadv.2013.10.002.

131. Ruth Duncan, Polymer therapeutics as nanomedicines: new perspectives, Current Opinion in Biotechnology, Volume 22, Issue 4, 2011, Pages 492-501, ISSN 0958-1669, http://dx.doi.org/10.1016/j.copbio.2011.05.507.

132. Nor Azwadi Che Sidik, Muhammad Noor Afiq Witri Muhammad Yazid, Syahrullail Samion, Mohamad Nor Musa, Rizalman Mamat, Latest development on computational approaches for nanofluid flow modeling: Navier–Stokes based multiphase models, International Communications in Heat and Mass Transfer, Volume 74, 2016, Pages 114-124, ISSN 0735-1933, http://dx.doi.org/10.1016/j.icheatmasstransfer.2016.03.007.

133. Q. Yuan, S. Hein, R.D.K. Misra, New generation of chitosan-encapsulated ZnO quantum dots loaded with drug: Synthesis, characterization and in vitro drug delivery response, Acta Biomaterialia, Volume 6, Issue 7, 2010, Pages 2732-2739, ISSN 1742-7061, http://dx.doi.org/10.1016/j.actbio.2010.01.025.

134. Weiwei He, Yitong Liu, Wayne G. Wamer, Jun-Jie Yin, Electron spin resonance spectroscopy for the study of nanomaterial-mediated generation of reactive Oxygen species, Journal of Food and Drug Analysis, Volume 22, Issue 1, 2014, Pages 49-63, ISSN 1021-9498, http://dx.doi.org/10.1016/j.jfda.2014.01.004.

135. Jing An, Yuqiang Gou, Chunxia Yang, Fangdi Hu, Chunming Wang, Synthesis of a biocompatible gelatin functionalized graphene nanosheets and its application for drug delivery, Materials Science and Engineering: C, Volume 33, Issue 5, 2013, Pages 2827-2837, ISSN 0928-4931, http://dx.doi.org/10.1016/j.msec.2013.03.008.

136. Samantha A. Meenach, Kimberly W. Anderson, J. Zach Hilt, Ronald C. McGarry, Heidi M. Mansour, Characterization and aerosol dispersion performance of advanced spray-dried chemotherapeutic PEGylated phospholipid particles for dry powder inhalation delivery in lung cancer, European Journal of Pharmaceutical Sciences, Volume 49, Issue 4, 2013, Pages 699-711, ISSN 0928-0987, http://dx.doi.org/10.1016/j.ejps.2013.05.012.

137. Richard M. England, Esther Masiá, Vanessa Giménez, Rut Lucas, María J. Vicent, Polyacetal-stilbene conjugates — The first examples of polymer therapeutics for the inhibition of HIF-1 in the treatment of solid tumours, Journal of Controlled Release, Volume 164, Issue 3, 2012, Pages 314-322, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2012.08.017.

138. Natassa Pippa, Maria Merkouraki, Stergios Pispas, Costas Demetzos, DPPC:MPOx chimeric advanced Drug Delivery nano Systems (chi-aDDnSs): Physicochemical and structural characterization, stability and drug release studies, International Journal of Pharmaceutics, Volume 450, Issue 1, 2013, Pages 1-10, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2013.03.052.

139. Patrick Boisseau, Bertrand Loubaton, Nanomedicine, nanotechnology in medicine, Comptes Rendus Physique, Volume 12, Issue 7, 2011, Pages 620-636, ISSN 1631-0705, http://dx.doi.org/10.1016/j.crhy.2011.06.001.

140. Oksana Petrichenko, Martins Rucins, Aleksandra Vezane, Irena Timofejeva, Arkadij Sobolev, Brigita Cekavicus, Karlis Pajuste, Mara Plotniece, Marina Gosteva, Tatjana Kozlovska, Aiva Plotniece, Studies of the physicochemical and structural properties of self-assembling cationic pyridine derivatives as gene delivery agents, Chemistry and Physics of Lipids, Volume 191, 2015, Pages 25-37, ISSN 0009-3084, http://dx.doi.org/10.1016/j.chemphyslip.2015.08.005.

141. Alicia Rodríguez-Gascón, Ana del Pozo-Rodríguez, Arantxazu Isla, María Angeles Solinís, Vaginal gene therapy, Advanced Drug Delivery Reviews, Volume 92, 2015, Pages 71-83, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2015.07.002.

142. Heico J. Frima, Cristina Gabellieri, Maj-Inger Nilsson, Drug delivery research in the European Union's Seventh Framework Programme for Research, Journal of Controlled Release, Volume 161, Issue 2, 2012, Pages 409-415, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2012.01.044.

143. Murali M. Yallapu, Neeraj Chauhan, Shadi F. Othman, Vahid Khalilzad-Sharghi, Mara C. Ebeling, Sheema Khan, Meena Jaggi, Subhash C. Chauhan, Implications of protein corona on physico-chemical and biological properties of magnetic nanoparticles, Biomaterials, Volume 46, 2015, Pages 1-12, ISSN 0142-9612, http://dx.doi.org/10.1016/j.biomaterials.2014.12.045.

144. Jinghua Duan, Heidi M. Mansour, Yangde Zhang, Xingming Deng, Yuxiang Chen, Jiwei Wang, Yifeng Pan, Jinfeng Zhao, Reversion of multidrug resistance by co-encapsulation of doxorubicin and curcumin in chitosan/poly(butyl cyanoacrylate) nanoparticles, International Journal of Pharmaceutics, Volume 426, Issue 1, 2012, Pages 193-201, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2012.01.020.

145. Roman A. Perez, Hae-Won Kim, Core–shell designed scaffolds for drug delivery and tissue engineering, Acta Biomaterialia, Volume 21, 2015, Pages 2-19, ISSN 1742-7061, http://dx.doi.org/10.1016/j.actbio.2015.03.013.

146. Luca Costantino, Diana Boraschi, Is there a clinical future for polymeric nanoparticles as brain-targeting drug delivery agents?, Drug Discovery Today, Volume 17, Issue 7, 2012, Pages 367-378, ISSN 1359-6446, http://dx.doi.org/10.1016/j.drudis.2011.10.028.

147. Chiming Wei, Yuri L. Lyubchenko, Hamid Ghandehari, Justin Hanes, Kathleen J. Stebe, Hai-Quan Mao, Donald T. Haynie, Donald A. Tomalia, Marianna Foldvari, Nancy Monteiro-Riviere, Petia Simeonova, Shuming Nie, Hidezo Mori, Susan P. Gilbert, David Needham, New technology and clinical applications of nanomedicine: Highlights of the second annual meeting of the American Academy of Nanomedicine (Part I), Nanomedicine: Nanotechnology, Biology and Medicine, Volume 2, Issue 4, 2006, Pages 253-263, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2006.11.001.

148. James S. Murday, Richard W. Siegel, Judith Stein, J. Fraser Wright, Translational nanomedicine: status assessment and opportunities, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 5, Issue 3, 2009, Pages 251-273, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2009.06.001.

149. Nishu Dixit, Kumar Vaibhav, Ravi Shankar Pandey, Upendra Kumar Jain, Om Prakash Katare, Anju Katyal, Jitender Madan, Improved cisplatin delivery in cervical cancer cells by utilizing folate-grafted non-aggregated gelatin nanoparticles, Biomedicine & Pharmacotherapy, Volume 69, 2015, Pages 1-10, ISSN 0753-3322, http://dx.doi.org/10.1016/j.biopha.2014.10.016.

150. Hareesh B. Nair, Bokyung Sung, Vivek R. Yadav, Ramaswamy Kannappan, Madan M. Chaturvedi, Bharat B. Aggarwal, Delivery of antiinflammatory nutraceuticals by nanoparticles for the prevention and treatment of cancer, Biochemical Pharmacology, Volume 80, Issue 12, 2010, Pages 1833-1843, ISSN 0006-2952, http://dx.doi.org/10.1016/j.bcp.2010.07.021.

151. Raj Bawa, S.R. Bawa, Stephen B. Maebius, Ted Flynn, Chiming Wei, Protecting new ideas and inventions in nanomedicine with patents, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 1, Issue 2, 2005, Pages 150-158, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2005.03.009.

152. Samad Mussa Farkhani, Alireza Valizadeh, Hadi Karami, Samane Mohammadi, Nasrin Sohrabi, Fariba Badrzadeh, Cell penetrating peptides: Efficient vectors for delivery of nanoparticles, nanocarriers, therapeutic and diagnostic molecules, Peptides, Volume 57, 2014, Pages 78-94, ISSN 0196-9781, http://dx.doi.org/10.1016/j.peptides.2014.04.015.

153. Graphical Abstracts, Journal of Fluorine Chemistry, Volume 168, 2014, Pages v-xv, ISSN 0022-1139, http://dx.doi.org/10.1016/S0022-1139(14)00353-4.

154. Ratnesh Lal, Morton F. Arnsdorf, Multidimensional atomic force microscopy for drug discovery: A versatile tool for defining targets, designing therapeutics and monitoring their efficacy, Life Sciences, Volume 86, Issue 15, 2010, Pages 545-562, ISSN 0024-3205, http://dx.doi.org/10.1016/j.lfs.2009.02.030.

155. Fredrik Hacklin, Christian Marxt, Fritz Fahrni, Coevolutionary cycles of convergence: An extrapolation from the ICT industry, Technological Forecasting and Social Change, Volume 76, Issue 6, 2009, Pages 723-736, ISSN 0040-1625,http://dx.doi.org/10.1016/j.techfore.2009.03.003.

156. Alberto A. Gabizon, Yogita Patil, Ninh M. La-Beck, New insights and evolving role of pegylated liposomal doxorubicin in cancer therapy, Drug Resistance Updates, Volume 29, 2016, Pages 90-106, ISSN 1368-7646, http://dx.doi.org/10.1016/j.drup.2016.10.003.

157. Jianxiang Zhang, Peter X. Ma, Cyclodextrin-based supramolecular systems for drug delivery: Recent progress and future perspective, Advanced Drug Delivery Reviews, Volume 65, Issue 9, 2013, Pages 1215-1233, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2013.05.001.

158. Ž. Vanić, N. Škalko-Basnet, Mucosal nanosystems for improved topical drug delivery: vaginal route of administration, Journal of Drug Delivery Science and Technology, Volume 24, Issue 5, 2014, Pages 435-444, ISSN 1773-2247, http://dx.doi.org/10.1016/S1773-2247(14)50085-8.

159. Rutledge Ellis-Behnke, Nano Neurology and the Four P's of Central Nervous System Regeneration: Preserve, Permit, Promote, Plasticity, Medical Clinics of North America, Volume 91, Issue 5, 2007, Pages 937-962, ISSN 0025-7125, http://dx.doi.org/10.1016/j.mcna.2007.04.005.

160. Kale Mohana Raghava Srivalli, Brahmeshwar Mishra, Drug nanocrystals: A way toward scale-up, Saudi Pharmaceutical Journal, Volume 24, Issue 4, 2016, Pages 386-404, ISSN 1319-0164, http://dx.doi.org/10.1016/j.jsps.2014.04.007.

161. Eva-Maria Collnot, Hussain Ali, Claus-Michael Lehr, Nano- and microparticulate drug carriers for targeting of the inflamed intestinal mucosa, Journal of Controlled Release, Volume 161, Issue 2, 2012, Pages 235-246, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2012.01.028.

162. Joshua J. Rychak, Jonathan R. Lindner, Klaus Ley, Alexander L. Klibanov, Deformable gas-filled microbubbles targeted to P-selectin, Journal of Controlled Release, Volume 114, Issue 3, 2006, Pages 288-299, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2006.06.008.

163. Cezary Watala, Kamil Karolczak, Hassan Kassassir, Marcin Talar, Tomasz Przygodzki, Katarzyna Maczynska, Magdalena Labieniec-Watala, How do the full-generation poly(amido) amine (PAMAM) dendrimers activate blood platelets? Activation of circulating platelets and formation of "fibrinogen aggregates" in the presence of polycations, International Journal of Pharmaceutics, Volume 503, Issue 1, 2016, Pages 247-261, ISSN 0378-5173, http://dx.doi.org/10.1016/j.ijpharm.2015.08.073.

164. M.S. Palombo, Y. Singh, P.J. Sinko, Prodrug and conjugate drug delivery strategies for improving HIV/AIDS therapy, Journal of Drug Delivery Science and Technology, Volume 19, Issue 1, 2009, Pages 3-14, ISSN 1773-2247, http://dx.doi.org/10.1016/S1773-2247(09)50001-9.

165. Table of Contents, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 7, Issue 4, 2011, Pages A4-A5, ISSN 1549-9634, http://dx.doi.org/10.1016/S1549-9634(11)00192-4.

166. Andriy Kuzmov, Tamara Minko, Nanotechnology approaches for inhalation treatment of lung diseases, Journal of Controlled Release, Volume 219, 2015, Pages 500-518, ISSN 0168-3659, http://dx.doi.org/10.1016/j.jconrel.2015.07.024.

167. Yolanda Diebold, Margarita Calonge, Applications of nanoparticles in ophthalmology, Progress in Retinal and Eye Research, Volume 29, Issue 6, 2010, Pages 596-609, ISSN 1350-9462, http://dx.doi.org/10.1016/j.preteyeres.2010.08.002.

168. Ramazan Bal, Gaffari Türk, Mehmet Tuzcu, Okkes Yilmaz, Ibrahim Ozercan, Tuncay Kuloglu, Seyfettin Gür, Victor S. Nedzvetsky, Artem A. Tykhomyrov, Grigory V. Andrievsky, Giyasettin Baydas, Mustafa Naziroglu, Protective effects of nanostructures of hydrated C fullerene on reproductive function in streptozotocin-diabetic male rats, Toxicology, Volume 282, Issue 3, 2011, Pages 69-81, ISSN 0300-483X, http://dx.doi.org/10.1016/j.tox.2010.12.003.

169. Dhruba J. Bharali, Shaker A. Mousa, Emerging nanomedicines for early cancer detection and improved treatment: Current perspective and future promise, Pharmacology & Therapeutics, Volume 128, Issue 2, 2010, Pages 324-335, ISSN 0163-7258, http://dx.doi.org/10.1016/j.pharmthera.2010.07.007.

170. Sandipan Ray, Harini Chandra, Sanjeeva Srivastava, Nanotechniques in proteomics: Current status, promises and challenges, Biosensors and Bioelectronics, Volume 25, Issue 11, 2010, Pages 2389-2401, ISSN 0956-5663, http://dx.doi.org/10.1016/j.bios.2010.04.010.

171. B. Mishra, Bhavesh B. Patel, Sanjay Tiwari, Colloidal nanocarriers: a review on formulation technology, types and applications toward targeted drug delivery, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 6, Issue 1, 2010, Pages 9-24, ISSN 1549-9634, http://dx.doi.org/10.1016/j.nano.2009.04.008.

172. Contents, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 4, Issue 4, 2008, Pages A3-A4, ISSN 1549-9634, http://dx.doi.org/10.1016/S1549-9634(08)00178-0.

173. Vladimir Torchilin, Multifunctional and stimuli-sensitive pharmaceutical nanocarriers, European Journal of Pharmaceutics and Biopharmaceutics, Volume 71, Issue 3, 2009, Pages 431-444, ISSN 0939-6411, http://dx.doi.org/10.1016/j.ejpb.2008.09.026.

174. Francesca A. Cupaioli, Fabio A. Zucca, Diana Boraschi, Luigi Zecca, Engineered nanoparticles. How brain friendly is this new guest?, Progress in Neurobiology, Volume 119, 2014, Pages 20-38, ISSN 0301-0082, http://dx.doi.org/10.1016/j.pneurobio.2014.05.002.

175. Alejandro Sosnik, Angel M. Carcaboso, Nanomedicines in the future of pediatric therapy, Advanced Drug Delivery Reviews, Volume 73, 2014, Pages 140-161, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2014.05.004.

176. Table of Contents, Nanomedicine: Nanotechnology, Biology and Medicine, Volume 10, Issue 1, 2014, Pages A4-A7, ISSN 1549-9634, http://dx.doi.org/10.1016/S1549-9634(13)00599-6.

177. Jiancheng Guan, Qingjun Zhao, The impact of university–industry collaboration networks on innovation in nanobiopharmaceuticals, Technological Forecasting and Social Change, Volume 80, Issue 7, 2013, Pages 1271-1286, ISSN 0040-1625, http://dx.doi.org/10.1016/j.techfore.2012.11.013.

178. Lisa C. Du Toit, Thirumala Govender, Trevor Carmichael, Pradeep Kumar, Yahya E. Choonara, Viness Pillay, Design of an Anti-Inflammatory Composite Nanosystem and Evaluation of Its Potential for Ocular Drug Delivery, Journal of Pharmaceutical Sciences, Volume 102, Issue 8, 2013, Pages 2780-2805, ISSN 0022-3549, http://dx.doi.org/10.1002/jps.23650.

179. Emerging Fields, Free Radical Biology and Medicine, Volume 43, 2007, Pages S67-S74, ISSN 0891-5849, http://dx.doi.org/10.1016/j.freeradbiomed.2007.10.018.

180. Xue-Qing Zhang, Xiaoyang Xu, Nicolas Bertrand, Eric Pridgen, Archana Swami, Omid C. Farokhzad, Interactions of nanomaterials and biological systems: Implications to personalized nanomedicine, Advanced Drug Delivery Reviews, Volume 64, Issue 13, 2012, Pages 1363-1384, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2012.08.005.

181. Arunachalam Muthaiyan, Alya Limayem, Steven C. Ricke, Antimicrobial strategies for limiting bacterial contaminants in fuel bioethanol fermentations, Progress in Energy and Combustion Science, Volume 37, Issue 3, 2011, Pages 351-370, ISSN 0360-1285, http://dx.doi.org/10.1016/j.pecs.2010.06.005.

182. Scientific Programme – Details, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Pages xxiv-lxvi, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)71697-9.

183. Subject Index, European Journal of Cancer Supplements, Volume 8, Issue 7, 2010, Pages 233-243, ISSN 1359-6349, http://dx.doi.org/10.1016/S1359-6349(10)72373-9.

184. Ruth Duncan, Development of HPMA copolymer–anticancer conjugates: Clinical experience and lessons learnt, Advanced Drug Delivery Reviews, Volume 61, Issue 13, 2009, Pages 1131-1148, ISSN 0169-409X, http://dx.doi.org/10.1016/j.addr.2009.05.007.

185. R. Palao-Suay, L.G. Gómez-Mascaraque, M.R. Aguilar, B. Vázquez-Lasa, J. San Román, Self-assembling polymer systems for advanced treatment of cancer and inflammation, Progress in Polymer Science, Volume 53, 2016, Pages 207-248, ISSN 0079-6700, http://dx.doi.org/10.1016/j.progpolymsci.2015.07.005.

186. K. John Morrow, Raj Bawa, Chiming Wei, Recent Advances in Basic and Clinical Nanomedicine, Medical Clinics of North America, Volume 91, Issue 5, 2007, Pages 805-843, ISSN 0025-7125, http://dx.doi.org/10.1016/j.mcna.2007.05.009.

187. Tissue/Cell Targets and Reactions, Free Radical Biology and Medicine, Volume 41, 2006, Pages S144-S154, ISSN 0891-5849, http://dx.doi.org/10.1016/j.freeradbiomed.2006.10.015.

188. Inflammation, Free Radical Biology and Medicine, Volume 41, 2006, Pages S68-S78, ISSN 0891-5849, http://dx.doi.org/10.1016/j.freeradbiomed.2006.10.008.

189. Vinay Deep Punetha, Sravendra Rana, Hye Jin Yoo, Alok Chaurasia, James T. McLeskey, Madeshwaran Sekkarapatti Ramasamy, Nanda Gopal Sahoo, Jae Whan Cho, Functionalization of carbon nanomaterials for advanced polymer nanocomposites: A comparison study between CNT and graphene, Progress in Polymer Science, Volume 67, 2017, Pages 1-47, ISSN 0079-6700, http://dx.doi.org/10.1016/j.progpolymsci.2016.12.010.

190. Antioxidants, Nutrition & Health, Free Radical Biology and Medicine, Volume 41, 2006, Pages S18-S31, ISSN 0891-5849, http://dx.doi.org/10.1016/j.freeradbiomed.2006.10.002.

191. Scientific Programme – Proffered Papers, European Journal of Cancer, Volume 49, 2013, Pages S97-S153, ISSN 0959-8049, http://dx.doi.org/10.1016/S0959-8049(13)70060-1.

192. Subject Index, European Journal of Cancer, Volume 49, 2013, Pages S975-S1028, ISSN 0959-8049, http://dx.doi.org/10.1016/S0959-8049(13)70067-4.

193. Goldschmidt Abstracts 2010 – H, Geochimica et Cosmochimica Acta, Volume 74, Issue 12, 2010, Pages A369-A440, ISSN 0016-7037, http://dx.doi.org/10.1016/j.gca.2010.04.033.

194. Sivakumar Manickam, Editorial Note, Ultrasonics Sonochemistry, Volume 35, 2017, Pages 529-530, ISSN 1350-4177, http://dx.doi.org/10.1016/j.ultsonch.2016.06.028.

195. Juan G. Osorio, Fernando J. Muzzio, Evaluation of resonant acoustic mixing performance, Powder Technology, Volume 278, 2015, Pages 46-56, ISSN 0032-5910, http://dx.doi.org/10.1016/j.powtec.2015.02.033.

196. Zahra Karami, Mehrdad Hamidi, Cubosomes: remarkable drug delivery potential, Drug Discovery Today, Volume 21, Issue 5, 2016, Pages 789-801, ISSN 1359-6446, http://dx.doi.org/10.1016/j.drudis.2016.01.004.

197. Jungil Park, Hyunwook Nam, Sun Young Ahn, Youngmi Kim Pak, James Jungho Pak, A reservoir-type oxygen sensor with 2×3 array for measuring cellular respiration levels, Sensors and Actuators B: Chemical, Volume 176, 2013, Pages 913-920, ISSN 0925-4005, http://dx.doi.org/10.1016/j.snb.2012.09.037.

198. Alireza Heidari, Vibrational Spectroscopy of Nucleic Acids, Wahid Ali Khan (Editor), "Basic Biochemistry", Austin Publishing Group (APG)/ Austin Publications LLC, Pages 1-18, Jersey City, New Jersey, USA, 2016, ISBN: 978-0-9971499-2-0.

199. Alireza Heidari, Christopher Brown, "Study of Composition and Morphology of Cadmium Oxide (CdO) Nanoparticles for Eliminating Cancer Cells", Journal of Nanomedicine Research, Volume 2, Issue 5, 20 Pages, 2015.

200. Alireza Heidari, Christopher Brown, "Study of Surface Morphological, Phytochemical and Structural Characteristics of Rhodium (III) Oxide (Rh2O3) Nanoparticles", International Journal of Pharmacology, Phytochemistry and Ethnomedicine, Volume 1, Pages 15–19, 2015.

201. Alireza Heidari, "An Experimental Biospectroscopic Study on Seminal Plasma in Determination of Semen Quality for Evaluation of Male Infertility", Int J Adv Technol 7: e007, 2016.

202. Alireza Heidari, "Extraction and Preconcentration of N–Tolyl–Sulfonyl–Phosphoramid–Saeure–Dichlorid as an Anti–Cancer Drug from Plants: A Pharmacognosy Study", J Pharmacogn Nat Prod 2: e103, 2016.

203. Alireza Heidari, "A Thermodynamic Study on Hydration and Dehydration of DNA and RNA−Amphiphile Complexes", J Bioeng Biomed Sci S: 006, 2016.

204. Alireza Heidari, "Computational Studies on Molecular Structures and Carbonyl and Ketene Groups' Effects of Singlet and Triplet Energies of Azidoketene O=C=CH–NNN and Isocyanatoketene O=C=CH–N=C=O", J Appl Computat Math 5: e142, 2016.

205. Alireza Heidari, "Study of Irradiations to Enhance the Induces the Dissociation of Hydrogen Bonds between Peptide Chains and Transition from Helix Structure to Random Coil Structure Using ATR–FTIR, Raman and 1HNMR Spectroscopies", J Biomol Res Ther 5: e146, 2016.

206. Alireza Heidari, "Future Prospects of Point Fluorescence Spectroscopy, Fluorescence Imaging and Fluorescence Endoscopy in Photodynamic Therapy (PDT) for Cancer Cells", J Bioanal Biomed 8: e135, 2016.

207. Alireza Heidari, "A Bio–Spectroscopic Study of DNA Density and Color Role as Determining Factor for Absorbed Irradiation in Cancer Cells", Adv Cancer Prev 1: e102, 2016.

208. Alireza Heidari, "Manufacturing Process of Solar Cells Using Cadmium Oxide (CdO) and Rhodium (III) Oxide (Rh2O3) Nanoparticles", J Biotechnol Biomater 6: e125, 2016.

209. Alireza Heidari, "A Novel Experimental and Computational Approach to Photobiosimulation of Telomeric DNA/RNA: A Biospectroscopic and Photobiological Study", J Res Development 4: 144, 2016.

210. Alireza Heidari, "Biochemical and Pharmacodynamical Study of Microporous Molecularly Imprinted Polymer Selective for Vancomycin, Teicoplanin, Oritavancin, Telavancin and Dalbavancin Binding", Biochem Physiol 5: e146, 2016.

211. Alireza Heidari, "Anti–Cancer Effect of UV Irradiation at Presence of Cadmium Oxide (CdO) Nanoparticles on DNA of Cancer Cells: A Photodynamic Therapy Study", Arch Cancer Res. 4: 1, 2016.

212. Alireza Heidari, "Biospectroscopic Study on Multi–Component Reactions (MCRs) in Two A–Type and B–Type Conformations of Nucleic Acids to Determine Ligand Binding Modes, Binding Constant and Stability of Nucleic Acids in Cadmium Oxide (CdO) Nanoparticles–Nucleic Acids Complexes as Anti–Cancer Drugs", Arch Cancer Res. 4: 2, 2016.

213. Alireza Heidari, "Simulation of Temperature Distribution of DNA/RNA of Human Cancer Cells Using Time–Dependent Bio–Heat Equation and Nd: YAG Lasers", Arch Cancer Res. 4: 2, 2016.

214. Alireza Heidari, "Quantitative Structure–Activity Relationship (QSAR) Approximation for Cadmium Oxide (CdO) and Rhodium (III) Oxide (Rh2O3) Nanoparticles as Anti–Cancer Drugs for the Catalytic Formation of Proviral DNA from Viral RNA Using Multiple Linear and Non–Linear Correlation Approach", Ann Clin Lab Res. 4: 1, 2016.

215. Alireza Heidari, "Biomedical Study of Cancer Cells DNA Therapy Using Laser Irradiations at Presence of Intelligent Nanoparticles", J Biomedical Sci. 5: 2, 2016.

216. Alireza Heidari, "Measurement the Amount of Vitamin D2 (Ergocalciferol), Vitamin D3 (Cholecalciferol) and Absorbable Calcium (Ca2+), Iron (II) (Fe2+), Magnesium (Mg2+), Phosphate (PO4–) and Zinc (Zn2+) in Apricot Using High–Performance Liquid Chromatography (HPLC) and Spectroscopic Techniques", J Biom Biostat 7: 292, 2016.

217. Alireza Heidari, "Spectroscopy and Quantum Mechanics of the Helium Dimer (He2+), Neon Dimer (Ne2+), Argon Dimer (Ar2+), Krypton Dimer (Kr2+), Xenon Dimer (Xe2+), Radon Dimer(Rn2+) and Ununoctium Dimer (Uuo2+) Molecular Cations", Chem Sci J 7: e112, 2016.

218. Alireza Heidari, "Human Toxicity Photodynamic Therapy Studies on DNA/RNA Complexes as a Promising New Sensitizer for the Treatment of Malignant Tumors Using Bio–Spectroscopic Techniques", J Drug Metab Toxicol 7: e129, 2016.

219. Alireza Heidari, "Novel and Stable Modifications of Intelligent Cadmium Oxide (CdO) Nanoparticles as Anti–Cancer Drug in Formation of Nucleic Acids Complexes for Human Cancer Cells' Treatment", Biochem Pharmacol (Los Angel) 5: 207, 2016.

220. Alireza Heidari, "A Combined Computational and QM/MM Molecular Dynamics Study on Boron Nitride Nanotubes (BNNTs), Amorphous Boron Nitride Nanotubes (a–BNNTs) and Hexagonal Boron Nitride Nanotubes (h–BNNTs) as Hydrogen Storage", Struct Chem Crystallogr Commun 2: 1, 2016.

221. Alireza Heidari, "Pharmaceutical and Analytical Chemistry Study of Cadmium Oxide (CdO) Nanoparticles Synthesis Methods and Properties as Anti–Cancer Drug and its Effect on Human Cancer Cells", Pharm Anal Chem Open Access 2: 113, 2016.

222. Alireza Heidari, "A Chemotherapeutic and Biospectroscopic Investigation of the Interaction of Double–Standard DNA/RNA–Binding Molecules with Cadmium Oxide (CdO) and Rhodium (III) Oxide (Rh2O3) Nanoparticles as Anti–Cancer Drugs for Cancer Cells' Treatment", Chemo Open Access 5: e129, 2016.

223. Alireza Heidari, "Pharmacokinetics and Experimental Therapeutic Study of DNA and Other Biomolecules Using Lasers: Advantages and Applications", J Pharmacokinet Exp Ther 1: e005, 2016.

224. Alireza Heidari, "Determination of Ratio and Stability Constant of DNA/RNA in Human Cancer Cells and Cadmium Oxide (CdO) Nanoparticles Complexes Using Analytical Electrochemical and Spectroscopic Techniques", Insights Anal Electrochem 2: 1, 2016.

225. Alireza Heidari, "Discriminate between Antibacterial and Non–Antibacterial Drugs Artificial Neutral Networks of a Multilayer Perceptron (MLP) Type Using a Set of Topological Descriptors", J Heavy Met Toxicity Dis. 1: 2, 2016.

226. Alireza Heidari, "Combined Theoretical and Computational Study of the Belousov–Zhabotinsky Chaotic Reaction and Curtius Rearrangement for Synthesis of Mechlorethamine, Cisplatin, Streptozotocin, Cyclophosphamide, Melphalan, Busulphan and BCNU as Anti–Cancer Drugs", Insights Med Phys. 1: 2, 2016.

227. Alireza Heidari, "A Translational Biomedical Approach to Structural Arrangement of Amino Acids' Complexes: A Combined Theoretical and Computational Study", Transl Biomed. 7: 2, 2016.

228. Alireza Heidari, "Ab Initio and Density Functional Theory (DFT) Studies of Dynamic NMR Shielding Tensors and Vibrational Frequencies of DNA/RNA and Cadmium Oxide (CdO) Nanoparticles Complexes in Human Cancer Cells", J Nanomedine Biotherapeutic Discov 6: e144, 2016.

229. Alireza Heidari, "Molecular Dynamics and Monte–Carlo Simulations for Replacement Sugars in Insulin Resistance, Obesity, LDL Cholesterol, Triglycerides, Metabolic Syndrome, Type 2 Diabetes and Cardiovascular Disease: A Glycobiological Study", J Glycobiol 5: e111, 2016.

230. Alireza Heidari, "Synthesis and Study of 5–(Phenylsulfonyl)Amino.–1,3,4–Thiadiazole–2–Sulfonamide as Potential Anti–Pertussis Drug Using Chromatography and Spectroscopy Techniques", Transl Med (Sunnyvale) 6: e138, 2016.

231. Alireza Heidari, "Nitrogen, Oxygen, Phosphorus and Sulphur Heterocyclic Anti–Cancer Nano Drugs Separation in the Supercritical Fluid of Ozone (O3) Using Soave–Redlich–Kwong (SRK) and Pang–Robinson (PR) Equations", Electronic J Biol 12: 4, 2016.

232. Alireza Heidari, "An Analytical and Computational Infrared Spectroscopic Review of Vibrational Modes in Nucleic Acids", Austin J Anal Pharm Chem. 3 (1): 1058, 2016.

233. Alireza Heidari, Christopher Brown, "Phase, Composition and Morphology Study and Analysis of Os–Pd/HfC Nanocomposites", Nano Res Appl. 2: 1, 2016.

234. Alireza Heidari, Christopher Brown, "Vibrational Spectroscopic Study of Intensities and Shifts of Symmetric Vibration Modes of Ozone Diluted by Cumene", International Journal of Advanced Chemistry, 4 (1) 5–9, 2016.

235. Alireza Heidari, "Study of the Role of Anti–Cancer Molecules with Different Sizes for Decreasing Corresponding Bulk Tumor Multiple Organs or Tissues", Arch Can Res. 4: 2, 2016.

236. Alireza Heidari, "Genomics and Proteomics Studies of Zolpidem, Necopidem, Alpidem, Saripidem, Miroprofen, Zolimidine, Olprinone and Abafungin as Anti–Tumor, Peptide Antibiotics, Antiviral and Central Nervous System (CNS) Drugs", J Data Mining Genomics & Proteomics 7: e125, 2016.

237. Alireza Heidari, "Pharmacogenomics and Pharmacoproteomics Studies of Phosphodiesterase–5 (PDE5) Inhibitors and Paclitaxel Albumin–Stabilized Nanoparticles as Sandwiched Anti–Cancer Nano Drugs between Two DNA/RNA Molecules of Human Cancer Cells", J Pharmacogenomics Pharmacoproteomics 7: e153, 2016.

238. Alireza Heidari, "Biotranslational Medical and Biospectroscopic Studies of Cadmium Oxide (CdO) Nanoparticles–DNA/RNA Straight and Cycle Chain Complexes as Potent Anti–Viral, Anti–Tumor and Anti–Microbial Drugs: A Clinical Approach", Transl Biomed. 7: 2, 2016.

239. Alireza Heidari, "A Comparative Study on Simultaneous Determination and Separation of Adsorbed Cadmium Oxide (CdO) Nanoparticles on DNA/RNA of Human Cancer Cells Using Biospectroscopic Techniques and Dielectrophoresis (DEP) Method", Arch Can Res. 4: 2, 2016.

240. Alireza Heidari, "Cheminformatics and System Chemistry of Cisplatin, Carboplatin, Nedaplatin, Oxaliplatin, Heptaplatin and Lobaplatin as Anti–Cancer Nano Drugs: A Combined Computational and Experimental Study", J Inform Data Min 1: 3, 2016.

241. Alireza Heidari, "Linear and Non–Linear Quantitative Structure–Anti–Cancer–Activity Relationship (QSACAR) Study of Hydrous Ruthenium (IV) Oxide (RuO2) Nanoparticles as Non–Nucleoside Reverse Transcriptase Inhibitors (NNRTIs) and Anti–Cancer Nano Drugs", J Integr Oncol 5: e110, 2016.

242. Alireza Heidari, "Synthesis, Characterization and Biospectroscopic Studies of Cadmium Oxide (CdO) Nanoparticles–Nucleic Acids Complexes Absence of Soluble Polymer as a Protective Agent Using Nucleic Acids Condensation and Solution Reduction Method", J Nanosci Curr Res 1: e101, 2016.

243. Alireza Heidari, "Coplanarity and Collinearity of 4'–Dinonyl–2,2'–Bithiazole in One Domain of Bleomycin and Pingyangmycin to be Responsible for Binding of Cadmium Oxide (CdO) Nanoparticles to DNA/RNA Bidentate Ligands as Anti–Tumor Nano Drug", Int J Drug Dev & Res 8: 007–008, 2016.

244. Alireza Heidari, "A Pharmacovigilance Study on Linear and Non–Linear Quantitative Structure (Chromatographic) Retention Relationships (QSRR) Models for the Prediction of Retention Time of Anti–Cancer Nano Drugs under Synchrotron Radiations", J Pharmacovigil 4: e161, 2016.

245. Alireza Heidari, "Nanotechnology in Preparation of Semipermeable Polymers", J Adv Chem Eng 6: 157, 2016.

246. Alireza Heidari, "A Gastrointestinal Study on Linear and Non–Linear Quantitative Structure (Chromatographic) Retention Relationships (QSRR) Models for Analysis 5–Aminosalicylates Nano Particles as Digestive System Nano Drugs under Synchrotron Radiations", J Gastrointest Dig Syst 6: e119, 2016.

247. Alireza Heidari, "DNA/RNA Fragmentation and Cytolysis in Human Cancer Cells Treated with Diphthamide Nano Particles Derivatives", Biomedical Data Mining 5: e102, 2016.

248. Alireza Heidari, "A Successful Strategy for the Prediction of Solubility in the Construction of Quantitative Structure–Activity Relationship (QSAR) and Quantitative Structure–Property Relationship (QSPR) under Synchrotron Radiations Using Genetic Function Approximation (GFA) Algorithm", J Mol Biol Biotechnol 1: 1, 2016.

249. Alireza Heidari, "Computational Study on Molecular Structures of C20, C60, C240, C540, C960, C2160 and C3840 Fullerene Nano Molecules under Synchrotron Radiations Using Fuzzy Logic", J Material Sci Eng 5: 282, 2016.

250. Alireza Heidari, "Graph Theoretical Analysis of Zigzag Polyhexamethylene Biguanide, Polyhexamethylene Adipamide, Polyhexamethylene Biguanide Gauze and Polyhexamethylene Biguanide Hydrochloride (PHMB) Boron Nitride Nanotubes (BNNTs), Amorphous Boron Nitride Nanotubes (a–BNNTs) and Hexagonal Boron Nitride Nanotubes (h–BNNTs)", J Appl Computat Math 5: e143, 2016.

251. Alireza Heidari, "The Impact of High Resolution Imaging on Diagnosis", Int J Clin Med Imaging 3: 1000e101, 2016.

252. Alireza Heidari, "A Comparative Study of Conformational Behavior of Isotretinoin (13–Cis Retinoic Acid) and Tretinoin (All–Trans Retinoic Acid (ATRA)) Nano Particles as Anti–Cancer Nano Drugs under Synchrotron Radiations Using Hartree–Fock (HF) and Density Functional Theory (DFT) Methods", Insights in Biomed 1: 2, 2016.

253. Alireza Heidari, "Advances in Logic, Operations and Computational Mathematics", J Appl Computat Math 5: 5, 2016.

254. Alireza Heidari, "Mathematical Equations in Predicting Physical Behavior", J Appl Computat Math 5: 5, 2016.

255. Alireza Heidari, "Chemotherapy a Last Resort for Cancer Treatment", Chemo Open Access 5: 4, 2016.

256. Alireza Heidari, "Separation and Pre–Concentration of Metal Cations–DNA/RNA Chelates Using Molecular Beam Mass Spectrometry with Tunable Vacuum Ultraviolet (VUV) Synchrotron Radiation and Various Analytical Methods", Mass Spectrom Purif Tech 2: e101, 2016.

257. Alireza Heidari, "Yoctosecond Quantitative Structure–Activity Relationship (QSAR) and Quantitative Structure–Property Relationship

(QSPR) under Synchrotron Radiations Studies for Prediction of Solubility of Anti–Cancer Nano Drugs in Aqueous Solutions Using Genetic Function Approximation (GFA) Algorithm", Insight Pharm Res. 1: 1, 2016.

258. Alireza Heidari, "Cancer Risk Prediction and Assessment in Human Cells under Synchrotron Radiations Using Quantitative Structure Activity Relationship (QSAR) and Quantitative Structure Properties Relationship (QSPR) Studies", Int J Clin Med Imaging 3: 516, 2016.

259. Alireza Heidari, "A Novel Approach to Biology", Electronic J Biol 12: 4, 2016.

260. Alireza Heidari, "Innovative Biomedical Equipment's for Diagnosis and Treatment", J Bioengineer & Biomedical Sci 6: 2, 2016.

261. Alireza Heidari, "Integrating Precision Cancer Medicine into Healthcare, Medicare Reimbursement Changes and the Practice of Oncology: Trends in Oncology Medicine and Practices", J Oncol Med & Pract 1: 2, 2016.

262. Alireza Heidari, "Promoting Convergence in Biomedical and Biomaterials Sciences and Silk Proteins for Biomedical and Biomaterials Applications: An Introduction to Materials in Medicine and Bioengineering Perspectives", J Bioengineer & Biomedical Sci 6: 3, 2016.

263. Alireza Heidari, "X–Ray Fluorescence and X–Ray Diffraction Analysis on Discrete Element Modeling of Nano Powder Metallurgy Processes in Optimal Container Design", J Powder Metall Min 6: 1, 2017.

264. Alireza Heidari, "Biomolecular Spectroscopy and Dynamics of Nano–Sized Molecules and Clusters as Cross–Linking–Induced Anti–Cancer and Immune–Oncology Nano Drugs Delivery in DNA/RNA of Human Cancer Cells' Membranes under Synchrotron Radiations: A Payload–Based Perspective", Arch Chem Res. 1: 2, 2017.

265. Alireza Heidari, "Deficiencies in Repair of Double–Standard DNA/RNA–Binding Molecules Identified in Many Types of Solid and Liquid Tumors Oncology in Human Body for Advancing Cancer Immunotherapy Using Computer Simulations and Data Analysis", J Appl Bioinforma Comput Biol, 6: 1, 2017.

266. Alireza Heidari, "Electronic Coupling among the Five Nanomolecules Shuts Down Quantum Tunneling in the Presence and Absence of an Applied Magnetic Field for Indication of the Dimer or other Provide Different Influences on the Magnetic Behavior of Single Molecular Magnets (SMMs) as Qubits for Quantum Computing", Glob J Res Rev. 4: 2, 2017.

267. Alireza Heidari, "Polymorphism in Nano–Sized Graphene Ligand–Induced Transformation of Au38–xAgx/xCux(SPh–tBu)24 to Au36–xAgx/xCux(SPh–tBu)24 (x = 1–12) Nanomolecules for Synthesis of Au144–xAgx/xCux (SR)60, (SC4)60, (SC6)60, (SC12)60, (PET)60, (p–MBA)60, (F)60, (Cl)60, (Br)60, (I)60, (At)60, (Uus)60 and (SC6H13)60. Nano Clusters as Anti–Cancer Nano Drugs", J Nanomater Mol Nanotechnol, 6: 3, 2017.

268. Alireza Heidari, "Biomedical Resource Oncology and Data Mining to Enable Resource Discovery in Medical, Medicinal, Clinical, Pharmaceutical, Chemical and Translational Research and Their Applications in Cancer Research", Int J Biomed Data Min 6: e103, 2017.

269. Alireza Heidari, "Study of Synthesis, Pharmacokinetics, Pharmacodynamics, Dosing, Stability, Safety and Efficacy of Olympiadane Nanomolecules as Agent for Cancer Enzymotherapy, Immunotherapy, Chemotherapy, Radiotherapy, Hormone Therapy and Targeted Therapy under Synchrotorn Radiation", J Dev Drugs 6: e154, 2017.

270. Alireza Heidari, "A Novel Approach to Future Horizon of Top Seven Biomedical Research Topics to Watch in 2017: Alzheimer's, Ebola, Hypersomnia, Human Immunodeficiency Virus (HIV), Tuberculosis (TB), Microbiome/Antibiotic Resistance and Endovascular Stroke", J Bioengineer & Biomedical Sci 7: e127, 2017.

271. Alireza Heidari, "Opinion on Computational Fluid Dynamics (CFD) Technique", Fluid Mech Open Acc 4: 157, 2017.

272. Alireza Heidari, "Concurrent Diagnosis of Oncology Influence Outcomes in Emergency General Surgery for Colorectal Cancer and Multiple Sclerosis (MS) Treatment Using Magnetic Resonance Imaging (MRI) and Au329(SR)84, Au329–xAgx(SR)84, Au144(SR)60, Au68(SR)36, Au30(SR)18, Au102(SPh)44, Au38(SPh)24, Au38(SC2H4Ph)24, Au21S(SAdm)15, Au36(pMBA)24 and Au25(pMBA)18 Nano Clusters", J Surgery Emerg Med 1: 21, 2017.

273. Alireza Heidari, "Developmental Cell Biology in Adult Stem Cells Death and Autophagy to Trigger a Preventive Allergic Reaction to Common Airborne Allergens under Synchrotron Radiation Using Nanotechnology for Therapeutic Goals in Particular Allergy Shots (Immunotherapy)", Cell Biol (Henderson, NV) 6: 1, 2017.

274. Alireza Heidari, "Changing Metal Powder Characteristics for Elimination of the Heavy Metals Toxicity and Diseases in Disruption of Extracellular Matrix (ECM) Proteins Adjustment in Cancer Metastases Induced by Osteosarcoma, Chondrosarcoma, Carcinoid, Carcinoma, Ewing's Sarcoma, Fibrosarcoma and Secondary Hematopoietic Solid or Soft Tissue Tumors", J Powder Metall Min 6: 170, 2017.

275. Alireza Heidari, "Nanomedicine–Based Combination Anti–Cancer Therapy between Nucleic Acids and Anti–Cancer Nano Drugs in Covalent Nano Drugs Delivery Systems for Selective Imaging and Treatment of Human Brain Tumors Using Hyaluronic Acid, Alguronic Acid and Sodium Hyaluronate as Anti–Cancer Nano Drugs and Nucleic Acids Delivery under Synchrotron Radiation", Am J Drug Deliv 5: 2, 2017.

276. Alireza Heidari, "Clinical Trials of Dendritic Cell Therapies for Cancer Exposing Vulnerabilities in Human Cancer Cells' Metabolism and Metabolomics: New Discoveries, Unique Features Inform New Therapeutic Opportunities, Biotech's Bumpy Road to the Market and Elucidating the Biochemical Programs that Support Cancer Initiation and Progression", J Biol Med Science 1: e103, 2017.

277. Alireza Heidari, "The Design Graphene–Based Nanosheets as a New Nanomaterial in Anti–Cancer Therapy and Delivery of Chemotherapeutics and Biological Nano Drugs for Liposomal Anti–Cancer Nano Drugs and Gene Delivery", Br Biomed Bull 5: 305, 2017.

278. Alireza Heidari, "Integrative Approach to Biological Networks for Emerging Roles of Proteomics, Genomics and Transcriptomics in the Discovery and Validation of Human Colorectal Cancer Biomarkers from DNA/RNA Sequencing Data under Synchrotron Radiation", Transcriptomics 5: e117, 2017.

279. Alireza Heidari, "Elimination of the Heavy Metals Toxicity and Diseases in Disruption of Extracellular Matrix (ECM) Proteins and Cell Adhesion Intelligent Nanomolecules Adjustment in Cancer Metastases Using Metalloenzymes and under Synchrotron Radiation", Lett Health Biol Sci 2 (2): 1–4, 2017.

280. Alireza Heidari, "Treatment of Breast Cancer Brain Metastases through a Targeted Nanomolecule Drug Delivery System Based on Dopamine Functionalized Multi–Wall Carbon Nanotubes (MWCNTs) Coated with Nano Graphene Oxide (GO) and Protonated Polyaniline (PANI) in Situ During the Polymerization of Aniline Autogenic Nanoparticles for the Delivery of Anti–Cancer Nano Drugs under Synchrotron Radiation", Br J Res, 4 (3): 16, 2017.

281. Alireza Heidari, "Sedative, Analgesic and Ultrasound–Mediated Gastrointestinal Nano Drugs Delivery for Gastrointestinal Endoscopic Procedure, Nano Drug–Induced Gastrointestinal Disorders and Nano Drug Treatment of Gastric Acidity", Res Rep Gastroenterol, 1: 1, 2017.

282. Alireza Heidari, "Synthesis, Pharmacokinetics, Pharmacodynamics, Dosing, Stability, Safety and Efficacy of Orphan Nano Drugs to Treat High Cholesterol and Related Conditions and to Prevent Cardiovascular Disease under Synchrotron Radiation", J Pharm Sci Emerg Drugs 5: 1, 2017.

283. Alireza Heidari, "Non–Linear Compact Proton Synchrotrons to Improve Human Cancer Cells and Tissues Treatments and Diagnostics through Particle Therapy Accelerators with Monochromatic Microbeams", J Cell Biol Mol Sci 2 (1): 1–5, 2017.

284. Alireza Heidari, "Design of Targeted Metal Chelation Therapeutics Nanocapsules as Colloidal Carriers and Blood–Brain Barrier (BBB) Translocation to Targeted Deliver Anti–Cancer Nano Drugs into the Human Brain to Treat Alzheimer's Disease under Synchrotron Radiation", J Nanotechnol Material Sci 4 (2): 1–5, 2017.

285. Ricardo Gobato, Alireza Heidari, "Calculations Using Quantum Chemistry for Inorganic Molecule Simulation BeLi2SeSi", Science Journal of Analytical Chemistry, Vol. 5, No. 6, Pages 76–85, 2017.

286. Alireza Heidari, "Different High–Resolution Simulations of Medical, Medicinal, Clinical, Pharmaceutical and Therapeutics Oncology of Human Lung Cancer Translational Anti–Cancer Nano Drugs Delivery Treatment Process under Synchrotron and X–Ray Radiations", J Med Oncol. Vol. 1 No. 1: 1, 2017.

287. Alireza Heidari, "A Modern Ethnomedicinal Technique for Transformation, Prevention and Treatment of Human Malignant Gliomas Tumors into Human Benign Gliomas Tumors under Synchrotron Radiation", Am J Ethnomed, Vol. 4 No. 1: 10, 2017.

288. Alireza Heidari, "Active Targeted Nanoparticles for Anti–Cancer Nano Drugs Delivery across the Blood–Brain Barrier for Human Brain Cancer Treatment, Multiple Sclerosis (MS) and Alzheimer's Diseases Using Chemical Modifications of Anti–Cancer Nano Drugs or Drug–Nanoparticles through Zika Virus (ZIKV) Nanocarriers under Synchrotron Radiation", J Med Chem Toxicol, 2 (3): 1–5, 2017.

289. Alireza Heidari, "Investigation of Medical, Medicinal, Clinical and Pharmaceutical Applications of Estradiol, Mestranol (Norlutin), Norethindrone (NET), Norethisterone Acetate (NETA), Norethisterone Enanthate (NETE) and Testosterone Nanoparticles as Biological Imaging, Cell Labeling, Anti–Microbial Agents and Anti–Cancer Nano Drugs in Nanomedicines Based Drug Delivery Systems for Anti–Cancer Targeting and Treatment", Parana Journal of Science and Education (PJSE)–V.3, n.4, (10–19) October 12, 2017.

290. Alireza Heidari, "A Comparative Computational and Experimental Study on Different Vibrational Biospectroscopy Methods, Techniques and Applications for Human Cancer Cells in Tumor Tissues Simulation, Modeling, Research, Diagnosis and Treatment", Open J Anal Bioanal Chem 1 (1): 014–020, 2017.

291. Alireza Heidari, "Combination of DNA/RNA Ligands and Linear/Non–Linear Visible–Synchrotron Radiation–Driven N–Doped Ordered Mesoporous Cadmium Oxide (CdO) Nanoparticles Photocatalysts Channels Resulted in an Interesting Synergistic Effect Enhancing Catalytic Anti–Cancer Activity", Enz Eng 6: 1, 2017.

292. Alireza Heidari, "Modern Approaches in Designing Ferritin, Ferritin Light Chain, Transferrin, Beta–2 Transferrin and Bacterioferritin–Based Anti–Cancer Nano Drugs Encapsulating Nanosphere as DNA–Binding Proteins from Starved Cells (DPS)", Mod Appro Drug Des. 1 (1). MADD.000504. 2017.

293. Alireza Heidari, "Potency of Human Interferon β–1a and Human Interferon β–1b in Enzymotherapy, Immunotherapy, Chemotherapy, Radiotherapy, Hormone Therapy and Targeted Therapy of Encephalomyelitis Disseminate/ Multiple Sclerosis (MS) and Hepatitis A, B, C, D, E, F and G Virus Enter and Targets Liver Cells", J Proteomics Enzymol 6: 1, 2017.

294. Alireza Heidari, "Transport Therapeutic Active Targeting of Human Brain Tumors Enable Anti–Cancer Nanodrugs Delivery across the Blood–Brain Barrier (BBB) to Treat Brain Diseases Using Nanoparticles and Nanocarriers under Synchrotron Radiation", J Pharm Pharmaceutics 4 (2): 1–5, 2017.

295. Alireza Heidari, Christopher Brown, "Combinatorial Therapeutic Approaches to DNA/RNA and Benzylpenicillin (Penicillin G), Fluoxetine Hydrochloride (Prozac and Sarafem), Propofol (Diprivan), Acetylsalicylic Acid (ASA) (Aspirin), Naproxen Sodium (Aleve and Naprosyn) and Dextromethamphetamine Nanocapsules with Surface Conjugated DNA/RNA to Targeted Nano Drugs for Enhanced Anti–Cancer Efficacy and Targeted Cancer Therapy Using Nano Drugs Delivery Systems", Ann Adv Chem. 1 (2): 061–069, 2017.

296. Alireza Heidari, "High–Resolution Simulations of Human Brain Cancer Translational Nano Drugs Delivery Treatment Process under Synchrotron Radiation", J Transl Res. 1 (1): 1–3, 2017.

297. Alireza Heidari, "Investigation of Anti–Cancer Nano Drugs' Effects' Trend on Human Pancreas Cancer Cells and Tissues Prevention, Diagnosis and Treatment Process under Synchrotron and X–Ray Radiations with the Passage of Time Using Mathematica", Current Trends Anal Bioanal Chem, 1 (1): 36–41, 2017.

298. Alireza Heidari, "Pros and Cons Controversy on Molecular Imaging and Dynamics of Double–Standard DNA/RNA of Human Preserving Stem Cells–Binding Nano Molecules with Androgens/Anabolic Steroids (AAS) or Testosterone Derivatives through Tracking of Helium–4 Nucleus (Alpha Particle) Using Synchrotron Radiation", Arch Biotechnol Biomed. 1 (1): 067–0100, 2017.

299. Alireza Heidari, "Visualizing Metabolic Changes in Probing Human Cancer Cells and Tissues Metabolism Using Vivo 1H or Proton NMR, 13C NMR, 15N NMR and 31P NMR Spectroscopy and Self–Organizing Maps under Synchrotron Radiation", SOJ Mater Sci Eng 5 (2): 1–6, 2017.

300. Alireza Heidari, "Cavity Ring–Down Spectroscopy (CRDS), Circular Dichroism Spectroscopy, Cold Vapour Atomic Fluorescence Spectroscopy and Correlation Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Enliven: Challenges Cancer Detect Ther 4 (2): e001, 2017.

301. Alireza Heidari, "Laser Spectroscopy, Laser–Induced Breakdown Spectroscopy and Laser–Induced Plasma Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Int J Hepatol Gastroenterol, 3 (4): 079–084, 2017.

302. Alireza Heidari, "Time–Resolved Spectroscopy and Time–Stretch Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Enliven: Pharmacovigilance and Drug Safety 4 (2): e001, 2017.

303. Alireza Heidari, "Overview of the Role of Vitamins in Reducing Negative Effect of Decapeptyl (Triptorelin Acetate or Pamoate Salts) on Prostate Cancer Cells and Tissues in Prostate Cancer Treatment Process through Transformation of Malignant Prostate Tumors into Benign Prostate Tumors under Synchrotron Radiation", Open J Anal Bioanal Chem 1 (1): 021–026, 2017.

304. Alireza Heidari, "Electron Phenomenological Spectroscopy, Electron Paramagnetic Resonance (EPR) Spectroscopy and Electron Spin Resonance (ESR) Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Austin J Anal Pharm Chem. 4 (3): 1091, 2017.

305. Alireza Heidari, "Therapeutic Nanomedicine Different High–Resolution Experimental Images and Computational Simulations for Human Brain Cancer Cells and Tissues Using Nanocarriers Deliver DNA/RNA to Brain Tumors under Synchrotron Radiation with the Passage of Time Using Mathematica and MATLAB", Madridge J Nano Tech. Sci. 2 (2): 77–83, 2017.

306. Alireza Heidari, "A Consensus and Prospective Study on Restoring Cadmium Oxide (CdO) Nanoparticles Sensitivity in Recurrent Ovarian Cancer by Extending the Cadmium Oxide (CdO) Nanoparticles–Free Interval Using Synchrotron Radiation Therapy as Antibody–Drug Conjugate

for the Treatment of Limited–Stage Small Cell Diverse Epithelial Cancers", Cancer Clin Res Rep, 1: 2, e001, 2017.

307. Alireza Heidari, "A Novel and Modern Experimental Imaging and Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under White Synchrotron Radiation", Cancer Sci Res Open Access 4 (2): 1–8, 2017.

308. Alireza Heidari, "Different High–Resolution Simulations of Medical, Medicinal, Clinical, Pharmaceutical and Therapeutics Oncology of Human Breast Cancer Translational Nano Drugs Delivery Treatment Process under Synchrotron and X–Ray Radiations", J Oral Cancer Res 1 (1): 12–17, 2017.

309. Alireza Heidari, "Vibrational Decihertz (dHz), Centihertz (cHz), Millihertz (mHz), Microhertz (μHz), Nanohertz (nHz), Picohertz (pHz), Femtohertz (fHz), Attohertz (aHz), Zeptohertz (zHz) and Yoctohertz (yHz) Imaging and Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", International Journal of Biomedicine, 7 (4), 335–340, 2017.

310. Alireza Heidari, "Force Spectroscopy and Fluorescence Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", EC Cancer, 2 (5), 239–246, 2017.

311. Alireza Heidari, "Photoacoustic Spectroscopy, Photoemission Spectroscopy and Photothermal Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", BAOJ Cancer Res Ther, 3: 3, 045–052, 2017.

312. Alireza Heidari, "J–Spectroscopy, Exchange Spectroscopy (EXSY), Nucle¬ar Overhauser Effect Spectroscopy (NOESY) and Total Correlation Spectroscopy (TOCSY) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", EMS Eng Sci J, 1 (2): 006–013, 2017.

313. Alireza Heidari, "Neutron Spin Echo Spectroscopy and Spin Noise Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Int J Biopharm Sci, 1: 103–107, 2017.

314. Alireza Heidari, "Vibrational Decahertz (daHz), Hectohertz (hHz), Kilohertz (kHz), Megahertz (MHz), Gigahertz (GHz), Terahertz (THz), Petahertz (PHz), Exahertz (EHz), Zettahertz (ZHz) and Yottahertz (YHz) Imaging and Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Madridge J Anal Sci Instrum, 2 (1): 41–46, 2017.

315. Alireza Heidari, "Two–Dimensional Infrared Correlation Spectroscopy, Linear Two–Dimensional Infrared Spectroscopy and Non–Linear Two–Dimensional Infrared Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation with the Passage of Time", J Mater Sci Nanotechnol 6 (1): 101, 2018.

316. Alireza Heidari, "Fourier Transform Infrared (FTIR) Spectroscopy, Near–Infrared Spectroscopy (NIRS) and Mid–Infrared Spectroscopy (MIRS) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation with the Passage of Time", Int J Nanotechnol Nanomed, Volume 3, Issue 1, Pages 1–6, 2018.

317. Alireza Heidari, "Infrared Photo Dissociation Spectroscopy and Infrared Correlation Table Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation with the Passage of Time", Austin Pharmacol Pharm, 3 (1): 1011, 2018.

318. Alireza Heidari, "Novel and Transcendental Prevention, Diagnosis and Treatment Strategies for Investigation of Interaction among Human Blood Cancer Cells, Tissues, Tumors and Metastases with Synchrotron Radiation under Anti–Cancer Nano Drugs Delivery Efficacy Using MATLAB Modeling and Simulation", Madridge J Nov Drug Res, 1 (1): 18–24, 2017.

319. Alireza Heidari, "Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Open Access J Trans Med Res, 2 (1): 00026–00032, 2018.

320. Marcia Regina Risso Gobato, Ricardo Gobato, Alireza Heidari, "Planting of Jaboticaba Trees for Landscape Repair of Degraded Area", Landscape Architecture and Regional Planning, Vol. 3, No. 1, 2018, Pages 1–9, 2018.

321. Alireza Heidari, "Fluorescence Spectroscopy, Phosphorescence Spectroscopy and Luminescence Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation with the Passage of Time", SM J Clin. Med. Imaging, 4 (1): 1018, 2018.

322. Alireza Heidari, "Nuclear Inelastic Scattering Spectroscopy (NISS) and Nuclear Inelastic Absorption Spectroscopy (NIAS) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Int J Pharm Sci, 2 (1): 1–14, 2018.

323. Alireza Heidari, "X–Ray Diffraction (XRD), Powder X–Ray Diffraction (PXRD) and Energy–Dispersive X–Ray Diffraction (EDXRD) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", J Oncol Res; 2 (1): 1–14, 2018.

324. Alireza Heidari, "Correlation Two–Dimensional Nuclear Magnetic Reso-nance (NMR) (2D–NMR) (COSY) Imaging and Spectrosco¬py Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", EMS Can Sci, 1–1–001, 2018.

325. Alireza Heidari, "Thermal Spectroscopy, Photothermal Spectroscopy, Thermal Microspectroscopy, Photothermal Microspectroscopy, Thermal Macrospectroscopy and Photothermal Macrospectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", SM J Biometrics Biostat, 3 (1): 1024, 2018.

326. Alireza Heidari, "A Modern and Comprehensive Experimental Biospectroscopic Comparative Study on Human Common Cancers' Cells, Tissues and Tumors before and after Synchrotron Radiation Therapy", Open Acc J Oncol Med. 1 (1), 2018.

327. Alireza Heidari, "Heteronuclear Correlation Experiments such as Heteronuclear Single–Quantum Correlation Spectroscopy (HSQC), Heteronuclear Multiple–Quantum Correlation Spectroscopy (HMQC) and Heteronuclear Multiple–Bond Correlation Spectroscopy (HMBC) Comparative Study on Malignant and Benign Human Endocrinology and Thyroid Cancer Cells and Tissues under Synchrotron Radiation", J Endocrinol Thyroid Res, 3 (1): 555603, 2018.

328. Alireza Heidari, "Nuclear Resonance Vibrational Spectroscopy (NRVS), Nuclear Inelastic Scattering Spectroscopy (NISS), Nuclear Inelastic Absorption Spectroscopy (NIAS) and Nuclear Resonant Inelastic X–Ray Scattering Spectroscopy (NRIXSS) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Int J Bioorg Chem Mol Biol. 6 (1e): 1–5, 2018.

329. Alireza Heidari, "A Novel and Modern Experimental Approach to Vibrational Circular Dichroism Spectroscopy and Video Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under White and Monochromatic Synchrotron Radiation", Glob J Endocrinol Metab. 1 (3). GJEM. 000514–000519, 2018.

330. Alireza Heidari, "Pros and Cons Controversy on Heteronuclear Correlation Experiments such as Heteronuclear Single–Quantum Correlation Spectroscopy (HSQC), Heteronuclear Multiple–Quantum Correlation Spectroscopy (HMQC) and Heteronuclear Multiple–Bond Correlation Spectroscopy (HMBC) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", EMS Pharma J. 1 (1): 002, 2018.

331. Alireza Heidari, "A Modern Comparative and Comprehensive Experimental Biospectroscopic Study on Different Types of Infrared Spectroscopy of Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", J Analyt Molecul Tech. 3 (1): 8, 2018.

332. Alireza Heidari, "Investigation of Cancer Types Using Synchrotron Technology for Proton Beam Therapy: An Experimental Biospectroscopic Comparative Study", European Modern Studies Journal, Vol. 2, No. 1, 13–29, 2018.

333. Alireza Heidari, "Saturated Spectroscopy and Unsaturated Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Imaging J Clin Medical Sci. 5 (1): 001–007, 2018.

334. A. Heidari, "Small–Angle Neutron Scattering (SANS) and Wide–Angle X–Ray Diffraction (WAXD) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Int J Bioorg Chem Mol Biol. 6 (2e): 1–6, 2018.

335. Alireza Heidari, "Investigation of Bladder Cancer, Breast Cancer, Colorectal Cancer, Endometrial Cancer, Kidney Cancer, Leukemia, Liver, Lung Cancer, Melanoma, Non–Hodgkin Lymphoma, Pancreatic Cancer, Prostate Cancer, Thyroid Cancer and Non–Melanoma Skin Cancer Using Synchrotron Technology for Proton Beam Therapy: An Experimental Biospectroscopic Comparative Study", Ther Res Skin Dis 1 (1), 2018.

336. Alireza Heidari, "Attenuated Total Reflectance Fourier Transform Infrared (ATR–FTIR) Spectroscopy, Micro–Attenuated Total Reflectance Fourier Transform Infrared (Micro–ATR–FTIR) Spectroscopy and Macro–Attenuated Total Reflectance Fourier Transform Infrared (Macro–ATR–FTIR) Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation with the Passage of Time", International Journal of Chemistry Papers, 2 (1): 1–12, 2018.

337. Alireza Heidari, "Mössbauer Spectroscopy, Mössbauer Emission Spectroscopy and 57Fe Mössbauer Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Acta Scientific Cancer Biology 2.3: 17–20, 2018.

338. Alireza Heidari, "Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation with the Passage of Time", Organic & Medicinal Chem IJ. 6 (1): 555676, 2018.

339. Alireza Heidari, "Correlation Spectroscopy, Exclusive Correlation Spectroscopy and Total Correlation Spectroscopy Comparative Study on Malignant and Benign Human AIDS–Related Cancers Cells and Tissues with the Passage of Time under Synchrotron Radiation", Int J Bioanal Biomed. 2 (1): 001–007, 2018.

340. Alireza Heidari, "Biomedical Instrumentation and Applications of Biospectroscopic Methods and Techniques in Malignant and Benign Human Cancer Cells and Tissues Studies under Synchrotron Radiation and Anti–Cancer Nano Drugs Delivery", Am J Nanotechnol Nanomed. 1 (1): 001–009, 2018.

341. Alireza Heidari, "Vivo 1H or Proton NMR, 13C NMR, 15N NMR and 31P NMR Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Ann Biomet Biostat. 1 (1): 1001, 2018.

342. Alireza Heidari, "Grazing–Incidence Small–Angle Neutron Scattering (GISANS) and Grazing–Incidence X–Ray Diffraction (GIXD) Comparative Study on Malignant and Benign Human Cancer Cells, Tissues and Tumors under Synchrotron Radiation", Ann Cardiovasc Surg. 1 (2): 1006, 2018.

343. Alireza Heidari, "Adsorption Isotherms and Kinetics of Multi–Walled Carbon Nanotubes (MWCNTs), Boron Nitride Nanotubes (BNNTs), Amorphous Boron Nitride Nanotubes (a–BNNTs) and Hexagonal Boron Nitride Nanotubes (h–BNNTs) for Eliminating Carcinoma, Sarcoma, Lymphoma, Leukemia, Germ Cell Tumor and Blastoma Cancer Cells and Tissues", Clin Med Rev Case Rep 5: 201, 2018.

344. Alireza Heidari, "Correlation Spectroscopy (COSY), Exclusive Correlation Spectroscopy (ECOSY), Total Correlation Spectroscopy (TOCSY), Incredible Natural–Abundance Double–Quantum Transfer Experiment (INADEQUATE), Heteronuclear Single–Quantum Correlation Spectroscopy (HSQC), Heteronuclear Multiple–Bond Correlation Spectroscopy (HMBC), Nuclear Overhauser Effect Spectroscopy (NOESY) and Rotating Frame Nuclear Overhauser Effect Spectroscopy (ROESY) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Acta Scientific Pharmaceutical Sciences 2.5: 30–35, 2018.

345. Alireza Heidari, "Small–Angle X–Ray Scattering (SAXS), Ultra–Small Angle X–Ray Scattering (USAXS), Fluctuation X–Ray Scattering (FXS), Wide–Angle X–Ray Scattering (WAXS), Grazing–Incidence Small–Angle X–Ray Scattering (GISAXS), Grazing–Incidence Wide–Angle X–Ray Scattering (GIWAXS), Small–Angle Neutron Scattering (SANS), Grazing–Incidence Small–Angle Neutron Scattering (GISANS), X–Ray Diffraction (XRD), Powder X–Ray Diffraction (PXRD), Wide–Angle X–Ray Diffraction (WAXD), Grazing–Incidence X–Ray Diffraction (GIXD) and Energy–Dispersive X–Ray Diffraction (EDXRD) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Oncol Res Rev, Volume 1 (1): 1–10, 2018.

346. Alireza Heidari, "Pump–Probe Spectroscopy and Transient Grating Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Adv Material Sci Engg, Volume 2, Issue 1, Pages 1–7, 2018.

347. Alireza Heidari, "Grazing–Incidence Small–Angle X–Ray Scattering (GISAXS) and Grazing–Incidence Wide–Angle X–Ray Scattering (GIWAXS) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Insights Pharmacol Pharm Sci 1 (1): 1–8, 2018.

348. Alireza Heidari, "Acoustic Spectroscopy, Acoustic Resonance Spectroscopy and Auger Spectroscopy Comparative Study on Anti–Cancer Nano Drugs Delivery in Malignant and Benign Human Cancer Cells and Tissues with the Passage of Time under Synchrotron Radiation", Nanosci Technol 5 (1): 1–9, 2018.

349. Alireza Heidari, "Niobium, Technetium, Ruthenium, Rhodium, Hafnium, Rhenium, Osmium and Iridium Ions Incorporation into the Nano Polymeric Matrix (NPM) by Immersion of the Nano Polymeric Modified Electrode (NPME) as Molecular Enzymes and Drug Targets for Human Cancer Cells, Tissues and Tumors Treatment under Synchrotron and Synchrocyclotron Radiations", Nanomed Nanotechnol, 3 (2): 000138, 2018.

350. Alireza Heidari, "Homonuclear Correlation Experiments such as Homonuclear Single–Quantum Correlation Spectroscopy (HSQC), Homonuclear Multiple–Quantum Correlation Spectroscopy (HMQC) and Homonuclear Multiple–Bond Correlation Spectroscopy (HMBC) Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", Austin J Proteomics Bioinform & Genomics. 5 (1): 1024, 2018.

351. Alireza Heidari, "Atomic Force Microscopy Based Infrared (AFM–IR) Spectroscopy and Nuclear Resonance Vibrational Spectroscopy Comparative Study on Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation with the Passage of Time. J Appl Biotechnol Bioeng. 5 (3): 142–148, 2018.

352. Alireza Heidari, "Time–Dependent Vibrational Spectral Analysis of Malignant and Benign Human Cancer Cells and Tissues under Synchrotron Radiation", J Cancer Oncol, 2 (2): 000124, 2018.

353. Alireza Heidari, "Palauamine and Olympiadane Nano Molecules Incorporation into the Nano Polymeric Matrix (NPM) by Immersion of the Nano Polymeric Modified Electrode (NPME) as Molecular Enzymes and Drug Targets for Human Cancer Cells, Tissues and Tumors Treatment under Synchrotron and Synchrocyclotron Radiations", Arc Org Inorg Chem Sci 3(1), 2018.

354. Ricardo Gobato, Alireza Heidari, "Infrared Spectrum and Sites of Action of Sanguinarine by Molecular Mechanics and ab initio Methods", International Journal of Atmospheric and Oceanic Sciences. Vol. 2, No. 1, pp. 1–9, 2018.

355. Alireza Heidari, "Gamma Linolenic Methyl Ester, 5–Heptadeca–5,8,11–Trienyl 1,3,4–Oxadiazole–2–Thiol, Sulphoquinovosyl Diacyl Glycerol, Ruscogenin, Nocturnoside B, Protodioscine B, Parquisoside–B, Leiocarposide, Narangenin, 7–Methoxy Hespertin, Lupeol, Rosemariquinone, Rosmanol and Rosemadiol Nano Molecules Incorporation into the Nano Polymeric Matrix (NPM) by Immersion of the Nano Polymeric Modifi ed Electrode (NPME) as Molecular Enzymes and Drug Targets for Human Cancer Cells, Tissues and Tumors Treatment under Synchrotron and Synchrocyclotron Radiations", Int J Pharma Anal Acta. 2 (1): 007–014, 2018.

356. Alireza Heidari, "Angelic Acid, Diabolic Acids, Draculin and Miraculin Nano Molecules Incorporation into the Nano Polymeric Matrix (NPM) by Immersion of the Nano Polymeric Modified Electrode (NPME) as Molecular Enzymes and Drug Targets for Human Cancer Cells, Tissues and Tumors Treatment Under Synchrotron and Synchrocyclotron Radiations", Med & Analy Chem Int J, 2 (1): 000111, 2018.

357. Alireza Heidari, Pros and Cons Controversy on Future Pros¬pects of Point Fluorescence Spectroscopy, X–Ray Fluorescence (XRF) Spectroscopy, Cold Vapour Atomic Fluorescence (CVAF) Spectroscopy, Fluorescence Imaging and Fluorescence Endoscopy in Photodynamic Therapy (PDT) for Human Cancer Cells and Tissues Prevention, Diagnosis and Treatment, "Pharmaceutical Sciences", 2nd Edition, Avid Science, Pages 2–29, 2018, India.