International Journal of Electrical, Electronic and Communication Sciences
ISSN: 2517-9438
Vol:14, No:6, 2020

Engineering Photodynamic with Radioactive Therapeutic Systems for Sustainable Molecular Polarity: Autopoiesis Systems

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***Abstract*—**This paper introduces Luhmann's autopoietic social systems starting with the original concept of autopoiesis by biologists and scientists, including the modification of general systems based on socialized medicine. A specific type of autopoietic system is explained in the three existing groups of the ecological phenomena: interaction, social and medical sciences. This hypothesis model, nevertheless, has a nonlinear interaction with its natural environment 'interactional cycle' for the exchange of photon energy with molecular without any changes in topology. The external forces in the systems environment might be concomitant with the natural fluctuations' influence (e.g. radioactive radiation, electromagnetic waves). The cantilever sensor deploys insights to the future chip processor for prevention of social metabolic systems. Thus, the circuits with resonant electric and optical properties are prototyped on board as an intra–chip inter–chip transmission for producing electromagnetic energy approximately ranges from 1.7 mA at 3.3 V to service the detection in locomotion with the least significant power losses. Nowadays, therapeutic systems are assimilated materials from embryonic stem cells to aggregate multiple functions of the vessels nature de-cellular structure for replenishment. While, the interior actuators deploy base-pair complementarity of nucleotides for the symmetric arrangement in particular bacterial nanonetworks of the sequence cycle creating double-stranded DNA strings. The DNA strands must be sequenced, assembled, and decoded in order to reconstruct the original source reliably. The design of exterior actuators have the ability in sensing different variations in the corresponding patterns regarding beat-to-beat heart rate variability (HRV) for spatial autocorrelation of molecular communication, which consists of human electromagnetic, piezoelectric, electrostatic and electrothermal energy to monitor and transfer the dynamic changes of all the cantilevers simultaneously in real-time workspace with high precision. A prototype-enabled dynamic energy sensor has been investigated in the laboratory for inclusion of nanoscale devices in the architecture with a fuzzy logic control for detection of thermal and electrostatic changes with optoelectronic devices to interpret uncertainty associated with signal interference. Ultimately, the controversial aspect of molecular frictional properties is adjusted to each other and forms its unique spatial structure modules for providing the environment mutual contribution in the investigation of mass temperature changes due to pathogenic archival architecture of clusters.

***Keywords*—**Autopoiesis, quantum photonics, portable energy, photonic structure, photodynamic therapeutic system.

This work is supported the partial fulfillment of undergraduate course in electrical engineering faculty at Alexandria University.

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I. Introduction

INTERDISCIPLINARY approaches in recent decade go through the rapid growth of electronics for manipulation of communication technology in monitoring social environment and health. While the technology is providing enormous applications (e.g., electronics, semiconductors, textiles and pharmaceuticals), but due to their spectral and physical properties, particularly antimicrobial, anticancer, antibacterial, anti-inflammatory properties, nanoparticles have a unique application in diagnosis as well as in the treatment of various diseases in medical therapy [1]. The extensive usage of model is investigated on their response in the neuronal cells. The nanoparticles cause stem cells to differentiate into neuronal cells and promote neuronal cell survivability and neuronal cell growth and expansion [2]. This recent guide is anticipated to approach nanotechnology in prevention and social medicine for improvement in the academic community with internal tendency of the Drug Debit System [3]. The prototype is executed protocol with monitoring molecular positioning system in specific location for DNA-Chip nanonetworks (i.e., often inspired instrumentation of biological systems with nanotechnology) [4]. The required healthy–carrier is used for insertion sensing, control, actuation and propulsion of communications signal to interface programme in platform [5]. These promote nanoparticle model in other therapeutic systems to improve methods of effective and safe drug/gene dosage debit of small-molecule drugs and gene-based therapies to their intended target tissues [6]. The nature and synthetic structure of nanoparticles is dependent on a multitude of factors such as the chemical nature, the physical capacity of the nanoparticle, and relevant feedback dynamics control of the nanoparticle kinetic properties [7].

Social systems are structurally communicating for each other to reproduce themselves on the basis of their functions as an organizational environment. The physical presence of their adjusted structure reacts to 'exchange' social elements and realize material unity in intra–organizational social networks by mimicking the observed relational behaviors. So, the hypothesis expected the reactions into their network roles model (i.e., the network functions and positions would behave like similar others in the system environment as affect organization individuals' satisfaction with their social networks) [8].

The philosophy of prevention and social medicine systems is using unique cross-values in the sectional and longitudinal

sociometric data from a large professional services firm and in ethics manner for evolution of the impact on the other exert systems ecology. The values are adopted in broad generic terms such as engineering, chemistry, biology and physician as well as the ethics of medication that concomitant medical with social culture anthropology in ecosystems as preliminary traced in Fig. 1 [9]. The health and the social environment base as cultural anthropology of feeling/thinking is controlling the genotype in social medicine. The prevention and security standing from 'function defects' point to hypotheses that quantify molecular morbidity. The behaviour factor is attributed to human organisms in a normal scale and unified in molecule's ecology (e.g. unifying, stabilization, production, innovation and destination etc.) [10]. The nutrition circumference is scaling the impact of spatial genetic structure of molecular biology and biochemistry in consistent standard for deployments of physical anthropology in discovering molecular behaviour in 'behavioural science' [11], [12].

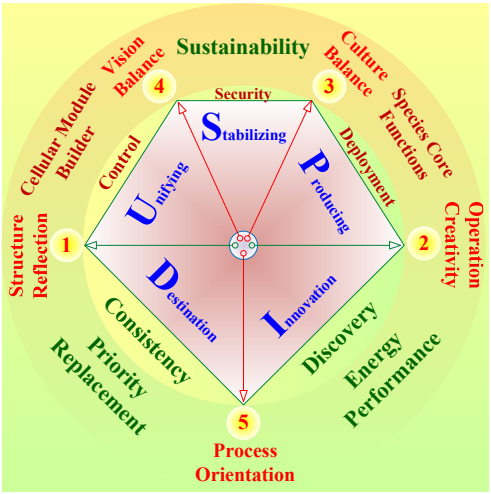

Fig. 1 The Social Culture of Molecular Ecology [9], [13]

Instead of populated molecular internal functions, such as 'destination' to yield information of outcome consistency or the other social replacement, the analysis of boundaries is stated in measurable levels for direct manipulation of 'cause and effect' under some action/intervention to control functions in the suspected groups. The simulation is modeling function to quantify or equate random frequency as 'scientific proof of aetiological factors in a blind method of health therapeutic services' in efficient measures [14]. The simulation is cascading social life (i.e. social anthropology) to model contemporary thinking/feeling actions (i.e. culture anthropology) in common interaction of a particular species of a broad generic term. The social life predicted in species culture balances communication of both formal and informal public groups in social mechanisms. Social security furnishes its members at critical times and events to tide over crises faced by communication or prevention (e.g. accident, maternity, old age, unemployment, sickness, destitution, etc.) [15]. There are two approaches to social security system: 'Social assistance', in which individuals do not contribute in security provision, (e.g. old age pension, unemployment allowance (Dole)); and 'Social insurance', as life insurance, gratuity, and provident fund schemes. The social defences are generic measures a society adopts to enable itself to handle social issues in prevention and control juvenile delinquency/ gambling/suicide/drug addiction. The social defence is a system developed to defend society against criminality not merely by treating and defending the offended but also by creating such conditions in a community which are conducive for healthy and wholesome growth of human life. The provision of individual relief system at critical times of need in lieu of intimately contributions is made by innovation practice of the social science [16].

The social science of the human organisms has a common boundary (i.e. physical anthropology or medical anthropology to extend the social culture in the ecology of health and diseases) that creates certain norms, synchronizes ethic values in reflection species structure of cellular process in a pattern to balance the function and culture vision as a border orientation system of sustainability condominium group [17].

The social culture is assimilated in nanoparticles structure for triggering all preventive actions related to social and healthcare environment in border of biomedical engineering. The nanoparticle is bonding in less than 50 nanometers and replenishes the vessel in a smaller scale less than most bacteria and viruses [18]. Yet, therapies and cures of nanoparticles are beyond the research of present–day physicians, so that quantitative methods will be applied to match keywords with the content of scientific knowledge in order to determine the patterns of correlation between scientific impacts of outcomes articulated policy strategies [19]. The qualitative discourse analysis will assist us to understand the species of security preferences in relation to knowledge production within the basis of systems ecology. The therapy is the greater investment in observation molecular polarity with the evolution in nanoparticle synthetic structure for insertion into conventional medications. Thus, this hypothesis concept simply screens 'preventive measure' by evaluation in ecological factors on social medicine [20], [21].

II. Engineering Therapeutic Systems

The role of engineering therapeutic systems is concomitant nanoparticles with radiotherapy for detection, diagnosis and pervasive patient monitoring in high precision nontoxic nature by designing a dynamic platform of nanoparticles on a wider scale for controlling molecular infection in a particular target or destination [22]. Consequently, the ability to classify (or distinguish between) physiological and pathological frequency patterns are critically important for the development of new diagnostic models in identification of spatial genetic structure (SGS) [23], [24]. The frequency domain parameters focus on periodic components in the heart rate time series [25].

The different techniques of spectral analysis are based on

mathematical methods such as the Fast Fourier Transform (FFT), parametric autoregressive modeling, or wavelet decompositions that applied time series in correlation data of beat-to-beat intervals. However, the value strongly depends on the availability of significant features [26]-[35] based on ordinal pattern statistics and compared with conventional parameters (i.e., HRV, temperature and chemical signature) [26] as well as features based on symbolic dynamics [29]-[31]. The features of symbolic dynamic are transforming a class of the time series ($x_1, x_2, \ldots, x_N$) into a sequence of symbols ($s_1, s_2, \ldots, s_N$) from an infinite alphabet to sequence characterized statistically in codes [30]-[35] or as adopted by Moore et al., techniques in the programmable molecular coding and decoding [36], [37].

Our proposal relies on designing a dynamic platform in terms of sensors and actuators [38], [39] which has the ability in sensing variations and detection the correspondence different patterns of beat-to-beat HRV for autocorrelation of molecular ecology, (i.e., the SGS, the chemicals concentration and the temperature gradient of bloodstream) towards various infection points, (i.e., the temperature of inflamed tissues and the area surrounding the tumor cells can be up to 2 °C higher for a malignant tumor, the lower pH of the area surrounding the cell can be used for identifying tumors) [40]. The information of infection location is picked up through electrochemical signals for nearby communication among molecular machines where the high frequency power reflects modulation of vagal activity by respiration or other physiology deviation, whereas the low frequency power represents vagal and sympathetic activity via the baroreflex loop. The physical variations from low-to-high frequency ratio can be used as an index of sympathovagal balance [41].

A. The Spatial Architectural of Autopoiesis Model

The model incorporates main layer properties from optical, biologic and electronic functions to constitute a self-hazard defence of microbiological pathogens along magnetic and chemical (i.e., protein expressions or pH) sensing and coupling a genetic programme in a substrate as an ideal method for the effective diagnosis of malignant tumors [42]. The nanoparticle structure, size, and the metabolic profiles do not allow the utilization of the electrical signals properly in the same mode as regular ones. The electrical frequency of the infected cells has lower disrupted electrical connections than healthy cells [43]. The embedded sensor addresses current frequency for triggering an ASIC code (application-specific integrated circuit) and controls a complete set of functions that interacts the physical and chemical manipulation of biological systems [44]. The dynamic platform operates at virtual environment in asynchronous interface of antenna, sensor, and a logic chip to communicate actuator when appropriate activation is kept in the same sensors structures in regard to propulsion a molecular machine inside vascularity system [45]-[49]. The analysis of the self-sustained oscillation (SSO) is significant in defining limitations to understand the multi-cantilever system, and provides conscious operation designs by modification the limits of control and the components specifications in regular standard [50]-[52].

Fig. 2 [53]-[56] shows a schematic diagram overview of a sensor array using multiple cantilevers with SSO. The inputs can be biochemical, optical or electrical and the outputs are the oscillation frequencies of the cantilevers in the array. As it will be discussed in Section IV *A*, different critical gain for each oscillator would be required for multiple cantilever SSO operation. This can be accomplished using a different detector and amplifier for each cantilever [57]-[59].

The schematic diagram proposes a model of the universe layer, when using cantilever resonance frequency of human workspace electromagnetic, piezoelectric, electrostatic and electrothermal workspace to monitor the dynamic changes of mass temperature, simultaneously in real-time with high precision. High precision measurements are obtained using a compact optical read-out based on a fiber array and custom digital multichannel lock-in amplifier for real-time monitoring. The cantilever real-time resonant frequency is detected remotely with diffraction gratings fabricated at the tip of the dynamic cantilevers. The cantilever deflections are sufficient due to the interferometric sensitivity of the readout detections. The cantilever resonant frequency is traced with integrated control circuit as a phase lock loop (PLL) system [60]-[64].

Eventually, the model has been triggered optically through the use of chromophores, but direct electronic control over molecular ‘machinery’ in a specific and fully reversible manner has not yet been achieved [65], [66]. The integration of optical with nanotechnology and biology creates alternative energy levels in the observation of the ultrasensitive variations of the optical spectrum, electrical signals, and biochemical properties into other nanoparticles. This unique property has potential in a broader range of photo-mediated applications in bio-imaging, sensing and therapy [67]-[70].

The mass-sensing capability of micromechanical resonance cantilever detects the lateral forces that influence molecular frictional properties at the circumference due to mass temperature change and hence optical reflections. The frequency index is reflecting lateral forces that influence molecular frictional properties, yet remains a scientific challenge in investigation of surface frictional properties in laboratories, for proponents of surface force apparatus (SFA) and atomic force microscopy (AFM), as off-sensor optical position sensing detection (PSD) of AFM.

B. The Management of Ionization Radiotherapy

Ionizing radiation can be considered as a ‘two-edged sword’ in that it may lead to genetic modifications in exposed, surviving normal tissue, but may lead to loss of clonogenic survival of tumour cells. Each cell exposed to fractionated doses conventionally used in radiotherapy reveals adequate transformation as a result of DNA modifications. Exposure of the cellular DNA to ionizing radiation inflects various type of damage through exposed tumour tissue leading to cell death. The reactive oxygen species (ROS), as a byproduct of aerobic

metabolism, are produced via exposure to ionising radiation [71]-[74], although the identification types of lesion endogenously induced with the free radical formation mechanisms have been described in numerous reviews [75], and an excellent book by von Sonntag [76].

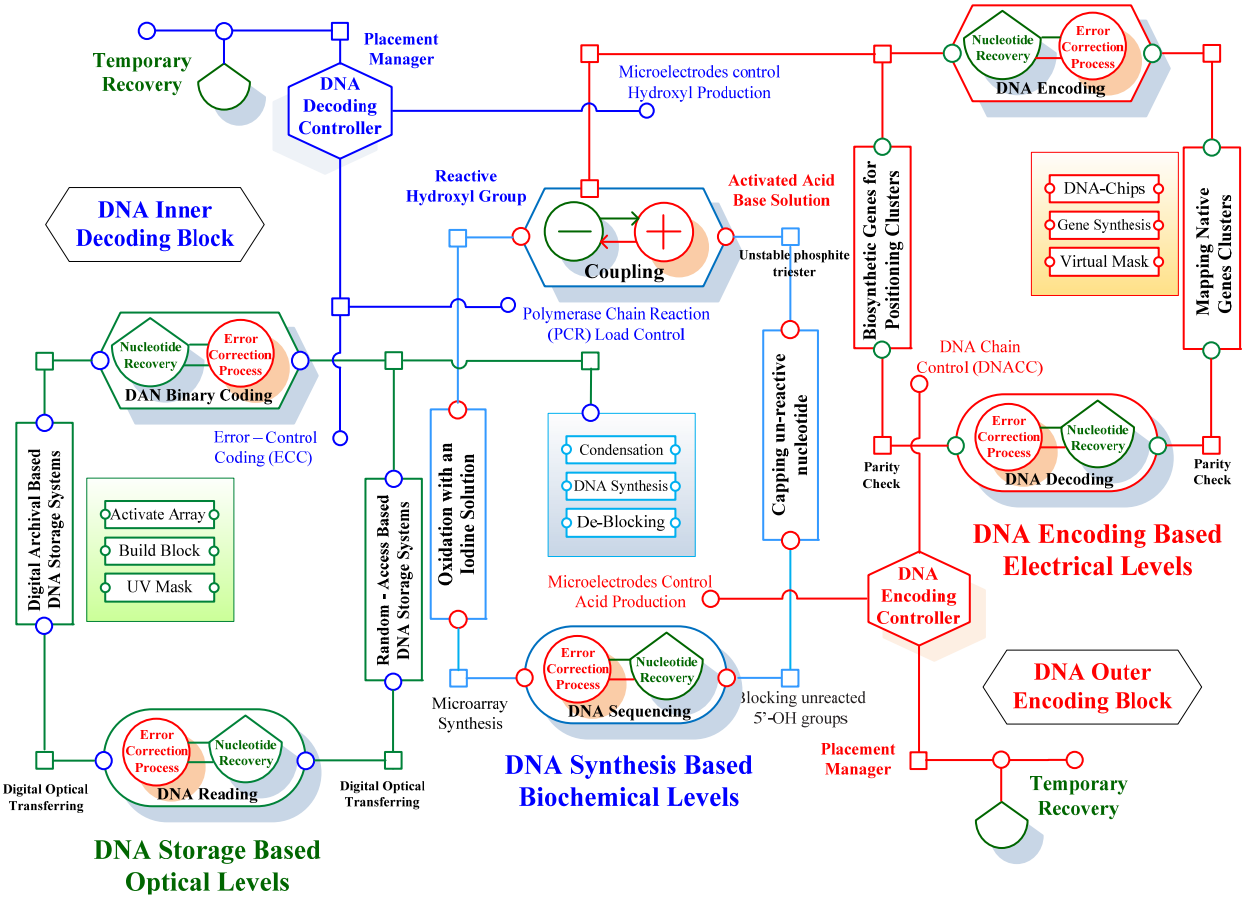

Fig. 2 Schematic diagram of DNA–Chip based molecular encoding and decoding Model [53]-[56]

Ionizing radiation induces in mammalian cells around 850 pyrimidine lesions, 450 purine lesions, 1000 single-strand breaks (SSB) and 20-40 double-strand breaks (DSB)/cell/Gy with low linear energy transfer (LET) γ-radiation Table I shows yields of major lesions induced by radiation [72], [77]. The breaks of DNA double-strand are constituted the most dangerous type of DNA damage and the resistance of cells [78]. The cells' resistance to radiation is defined in modules by three cellular processes: DNA repair, recombination, and replication. Two principal recombinational repair pathways have been recognized, homologous recombination (HR) and nonhomologous end-joining (NHEJ) that employ entirely separate protein complexes. Conversely, concomitant chemotherapeutic drugs with IR can hold great promise for the advancement of human chromosomal stability syndromes, cancer development, or cellular hypersensitivity to DNA-damage agents in the not too distant future. The prevailing theme is that the genetic alterations in concomitant IR with certain chemotherapeutic drugs lead to genomic stability and malignant transformation in determination how tumour cells respond on the molecular mechanisms of genetic HR and NHEJ [79]-[82]. The spectrum of the types of damage and their yields are similar when induced by ion particles as used in hadron therapy, Table I [72].

TABLE I
THE YIELD OF MAJOR LESIONS INDUCED BY IONIZING RADIATIONS OF DIFFERENT QUALITY

Radiation-induced lesions in cellular DNA	Number/Gy/cell γ-radiation	Number/Gy/cell $^{12}C^{6+}$ ions (31.5 keV/ηm)
5,6-thymine glycol (Tg)	582	372
5-(hydroxymethyl)-2'-deoxyuridine	174	72
5-formyl-20-deoxyuridine	132	66
FapyG	234	132
8-oxo-7,8-dihydro-2'-deoxyguanosine	120	60
SSB	1000	

This table is adopted from [72].

These oxidative genome damages induced by ROS include

simple and complex DSB. The oxidizing radiation has a high frequency of oxidizer base modification and apurinic/ apyrimidinic AP sites directly adjacent to DSB ends [83]-[86]. The kinetic DSB repair in base excision repair (BER) with the nucleotide excision repair (NER) is linked to genome replication and transcription as the primary feedback coverage to minimize ROS induction [87]. The BER/NER pathway depends on a specific geometry of the cluster structure, the type of inter-lesion separation, the density of lesions within the cluster for orientation of lesions to each other [88]-[90]. The structural and chemical analysis has been elucidated interactions of enzymes with DNA [91]-[93] to predict the efficiency of cleavage at specific configurations of lesions.

The improvement of target efficiency of the damaged cells with anticancer drugs is one of the dominant frontiers of epidemic cell cycle research. Concomitant chemotherapy with radiotherapy to specify target volume with the aid of novel nanomaterial can be expected for overall drug or radioactive dosages to control inhibition and decrease side effects on patient's life [94]. Both clinical and planning target volumes are managed with linear accelerator wave selection to detect physical variation in the gross tumour volume (GTV) [95]. The precision safety margin is conserved to protect and control GTV, that moderates segment of both clinical and planning targets' volumes as clarified in spatial architecture of dose control volume penetration in GTV, Fig. 3 [96], [97], that predicts the main consistence of the malignant cells, connective tissue with blood vessels, and necrotic areas [98]. Their volumes shape, size and location are determined by means of different methods such as clinical examination (e.g., inspection, palpation, endoscopy) with various scan techniques (e.g., x–ray, CT, ultrasound, MRI, etc.). Individual malignant cells, cell clusters, or micro-extensions, that cannot be detected by the clinical or scan procedures, surrounding the GTV, must be irradiated to ensure local control of the disease. The Clinical Target Volume (CTV) is providing the buffer volume that contains a demonstrable GTV and/or presumed/proven subclinical microscopic malignant disease [99].

In management safety margin, the volume is predicted precisely for irradiation of the highest possible dose and prevents a local recurrence, with the tolerance of the normal tissues included in small proportion defense of the gross target to control the prescribed dose [100]. In general, radiotherapy has a sufficient source of electrons and photons for penetration into the tissues to treat most of the tumours with an adequate physical effect. The ionizing radiation effect is not instantaneous, as so the nanoparticles have longer time effect as necessary into the bloodstream circulation due to its kinetic parameters [101]-[103]. Thus, radiotherapy adjusts the curative treatment of locally advanced disease that approximately accounts to future increase for patient's diagnostic worldwide [104], [105]. Therefore, radiotherapy (RT) is mandatory in local advanced diseases to delineation standard clinical of tumour volume (TV) for curative–intent RT or chemo–RT [106], [107].

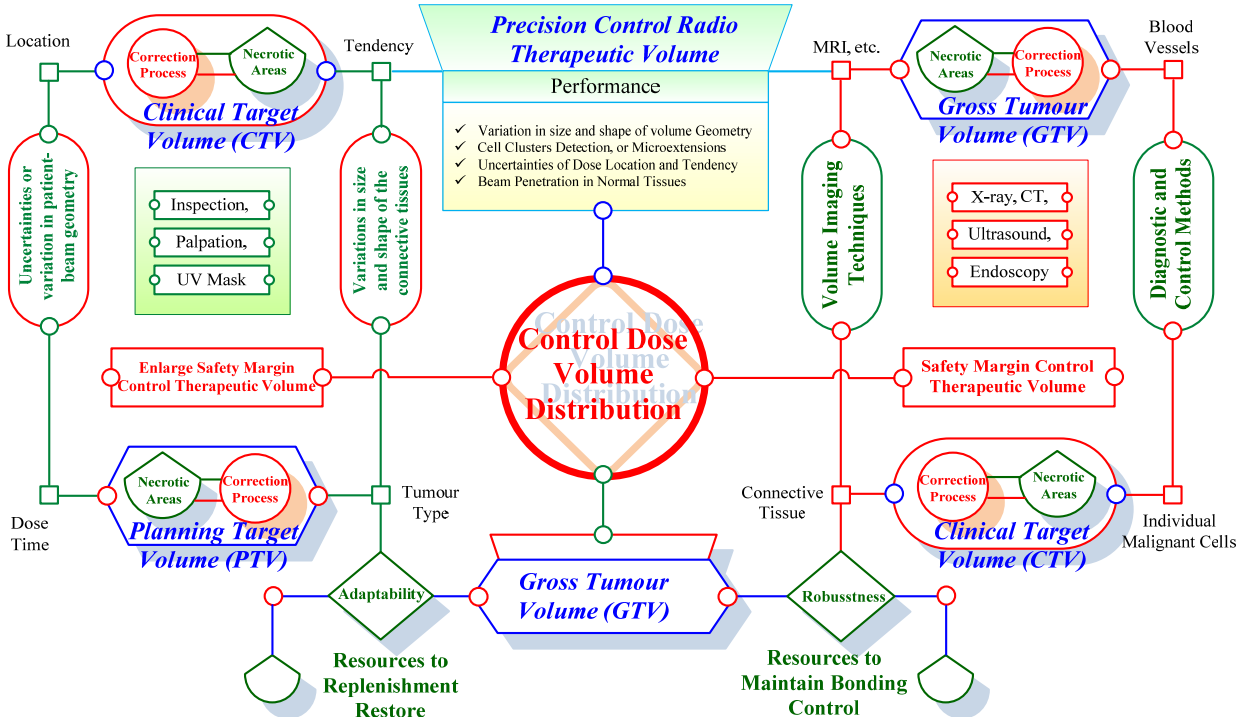

Fig. 3 Simplified planning diagram for management RT with clinical and target volume [96], [97]

In addition to the experimental assay, computer simulations of radiation distribution can determine the effect of the spatial distribution of DNA lesions. The simulation is applied in a particularly model to predict the nature of DNA damage from ionizing radiation-induced in cells cluster and its dependence on LET [108]-[110]. The biophysical modeling confirms that as the ionization density of radiation increases, both complexity and the yield of non-DSB clustered damage increase [111]. The basis processes of clustered DNA damage are comprised and simplified in two main lesions, while further analysis is required to uncover what the outcome will be with more complex clusters. The classification of lesions may reflect the greater complexity of clustered damage sites generated by high-LET radiation, in which the lesions are unable to be processed by means of enzyme metabolic activity and nanoparticles [112]-[116].

III. Navigation Process Control

The kinematics of object is predicted using state equations, positional constraints, inverse kinematics and dynamics, while individual directional components are simulated using control system models in transition with steady-state responses. When the bloodstream trajectory is predefined in a linear state, the system is able to provide alternative scan for all directions by bending a circular movement using the cameras/photodiodes parts of the cell clusters. Otherwise, the molecule replacement can be distinguished by a series of chemotactic sensors whose binding sites have a different affinity of molecule [117].

The navigation process control is detected inside the cluster of cell morphology in the embedded mechanism with cell cluster. The cell cluster is sensing, actuation, transmission, and remotely controlling uploading, and coupling commands of systems and subsystems for the basic operation of medical intervention of invasive surgeries [118]. The systems are using electronics in alternative pathways to achieve Complementary Metal Oxide Semiconductor (CMOS) for constructing circuits with feature sizes less than tens of nanometers to predict invasive species in patients who need constant and steady function for monitoring variations, and improving type of treatment in an efficient manner that support early diagnosis of serious diseases [119], [120].

The most effective and secure model is applied with CMOS of active telemetry and power supply to ensure energy control of the integration of nanoscale operations. The gradient of the bloodstream temperature and chemical concentration are incorporating electromagnetic signals to detect parameters variation in chemically assembly of electronic sensor for diagnostic purposes [121]. The molecular system is operated as a transistor and a memory. The voltage ranges are separated into two channel of the thin front oxide to provide dual function of the device, using two sectors levels. At thin and tiny voltages, the structure operates as a normal transistor, and at higher voltages the structure operates as a memory device. The transducers' capabilities and sensors are configured in external modules to relate specific infections to bio–medication [122].

Other navigation control modules are developed with software design to perform sensing and actuation for assembly prototyping system, serving as a migrant platform for medical investigation. The photodynamic platform is protecting cell clusters and providing the process the capability to control cluster movement with mechatronics simulator that measures physical and numerical information of nanoscale devices' task-based contrast components. The remote electronics devices with contrast components are controlling molecular unique cell-surface protein against virus-infected cells and parasites sorted from biological sensors. The sensors have a controller on the board to collect diagnostic data by self-power neuron detector to make intelligent decision accordingly [123].

A. Powering the Nanoparticles

The approach in supply exogenous energy to a molecular system is demonstrated with possessing embedded system to use of remote energy for powering the implanted medical devices or controlling position of nanoparticle. The embedded system is tracking an object in the bloodstream space to comprise a transponder device connectable to the object for self-detection purposes. The electromagnetic radiation has the ability to determine open workspace of energy generation from light source [124]. The kinetic energy is also generated from the bloodstream due to motion interaction with layers that are designed in embedded nanoscale objects to control stream, but this kinetic process would demand costly control within the photodynamic platform architecture [125], [126].

The practical procedure of usage CMOS in active telemetry and power supply is securing energy as long as necessary to control multitask operations. The techniques are appropriate control for other purposes like digital bit encoded data transfer from inside a human body [127]. Thus, circuits with resonant electric and optical properties are operated on board as a chip processor for producing electromagnetic energy approximately ranges from 1.7 mA at 3.3V and service the locomotion operation in least significant losses during transmission power [128]. The ultimate output power ranged in 0.4 ± 4 W, and measured though upper limits to enable control losses of the exact power inside the molecule (10% input power estimated to be transferred to molecule). The fuzzy logic model in a combination of thermal, electromagnetic and optical nanosensor is interpreting the uncertainty associated with the signal frequency information [129]. The RF-based telemetry is demonstrated in monitoring transmission with the use of inductive coupling [130], [131], using wide techniques in communication of RFID (Radio Frequency Identification Device) applications [132].

B. The Physical Transmission between Nanoparticles

The recent advances of sensors, implanted inside the human body is quite useful in providing the application of acoustic, light, RF, and chemical concentrations for communication and transmission data. The integrated sensors are simply

practicing read and writing data in implant device for monitoring process in specific patterns and structure of biomedical applications. Otherwise, chemical sensors are embedded in nanoscale devices to monitor glucose or other chemical concentration inside bloodstream [133], [134]. The electromagnetic waves are executing logic protocol in commands of current status inside the patient with other transponder device that emits embedded magnetic fields to enable sending and receiving data through electromagnetic frequencies [135]. The frequency ranges from 1 to 20 MHz are successfully applied for biomedical applications without any physical damage [136]. Jacobson et al. [137] demonstrated reversible control of the DNA hairpin-loop oligonucleotide as covalently linked to a nanometer scale antenna. When a Φ~1 GHz radio-frequency magnetic field is transmitted into the tiny antennas, alternating eddy currents induced in the nanoparticle produce highly localized inductive heating, causing the double-stranded DNA to separate into two strands in a matter of seconds in a fully reversible dehybridization process that leaves neighboring molecules untouched. The long term goal is to apply antennas to living systems and control DNA (e.g., gene expression, giving the ability to turn genes (e.g., OPEN/CLOSE)) via remote electronic switching active or inactive and maintain selective control of various functions. Such a tool could give pharmaceutical researchers a model to simulate the effect of potential drugs in randomly scattered cell to attach protein as well as DNA to the nanoparticles. These dipole mechanisms of the induced torque increase the detection of kinetic energy for controlling more complex biological processes such as enzymatic activities, protein folding, and bio-molecular assembly for treatment tumours through a wide range of electromagnetic fields. The physical transmission between objects has not been completely explored in this research, and will be the subject of future investigations [138].

IV. Therapeutic Mechanism in Autopoiesis Systems

The creation of self-assembly structure, pattern and process has species or physical properties in coincidence to the systems ecology, (e.g., as inferred in scientific knowledge of 'autopoiesis mechanism') [139]. The cellular autonomy controls the collective behavior of cell populations, destructive structure and repairs similar elements at molecular levels on the basis species of systems ecology [140], [141]. The related hypothesis 'entropy of population' is employed with the scientific basis of a particular dynamic multivariate pattern to analysis destructive structure with spatial simulation molecules model [142]. The numerous applications of 'eradication' are tuned cessation of infection of genetic morphology (shape) [143], [144], remediation contamination in the environmental or elimination destructive cells for efficient diagnosis and treatment [145]. The destructive structure is found in either molecular polarity or in the proteins functions of DNA chain [146], [147] at the molecular levels of maladies as cancer, viral infections and arteriosclerosis. The referenced model of destructive structure, pattern and process is yet beyond the research of present-day physicians to function as 'internal medicine' in a patient's bloodstream [148]. The theoretical bases of healthy–carrier in solid tumor tissues is highlighting leakiness of tumor vessels in the macromolecular agents that termed the 'enhanced permeability and retention (EPR) effect' as demonstrated and named by [149] for targeting defective genes. These medication properties might lead to manufacture hardware for controlling molecular machines with nanomaterial by production of an excited state of a quantum system at the atomic and molecular scale [150], [151].

A. Therapeutic Photodynamic Model

The clinical human gene therapy, as traced in Fig. 4, contains elements to perform: (1) diseased cell recognition, (2) diagnosis of disease state, (3) drug debit system, (4) reporting location, and (5) reporting outcome of therapy, under identical parameters (i.e. temperature, relative humidity, acoustic and sun bright). In nature, the kinetic and potential energy of excitation electron by absorption photon energy is the physical factors of sinusoidal waves and vibrations (i.e., mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) and resonance of quantum wave functions) that confined surfaces in mechanism to generate light and other short wavelength electromagnetic radiation. The periodic pulses are formed in mechanisms to restore, retrieve or easily transfer energy on an atomic scale to induce reaction by absorption of a photon in accordance with Planck's quantum theory (photo–electrochemical) [152].

The model performs cluster states as 'plasmonic molecules' to interact with each other without interference. The self–assembly is confined and detected the electromagnetic radiation within the distribution of electrons to manipulate a type of bonding or antibonding character between the nanoparticles similarly and molecular orbitals [153]. This mimic is normally found in molecular storage media to encode clusters references with other species. The nanomaterial ranges from using strong acids to function in normal temperature ("top-down" approach) or apply technology as simple as a conventional microwave spectrum ("bottom-up" approach) in conjugation with target molecule [154], [155].

The conceptual design is classified in a dense field function of molecular and coupled to serve other trigger molecules, such as contrast agents or species precipitates. The rectified dynamic platform avoids triggering an immune response, unlike viral vectors commonly employed recently for transfection [156]. The reflection of electromagnetic radiation occurs when the system stores and easily transfers energy between two or more different modes. Upon magnetic field oscillate electrons, certain assessment is performed to alternate current free assembly of the cell's outermost membrane and enclosed mechanism in a tiny model of the nucleotide in the cell's interior morphology [157], [158]. These segments are classified main functions in the network interaction process,

pattern and structure model as confined in:

1) *Production* (*poiesis*): The design structure is specified by photon control standard for governing the basis species of system ecology. The emergence of contrast elements is modified to repair cellular polarity such as complete cycle of production.
2) *Bonding* (*linkage*): The biological systems are association functions that define positions in the basis process and pattern of cellular species in system ecology.
3) *Degradation* (*replenishment*): The termination of process or innovation output or expulsion is a process association to electromagnetic control systems.

These functions are controlling photodynamic healthy-carrier in main platform at the atomic and molecular scale. The system contains the basis source of synthetic nanomaterial for sensors, actuators and polymer with other species [159]. The photonics model is transforming physical light to other radiant energy forms whose quantum unites is photon. The reflected structure is predicted in the motion of photons by scattering, absorbance, and coupling properties based on their geometries and relative positions [160], [161].

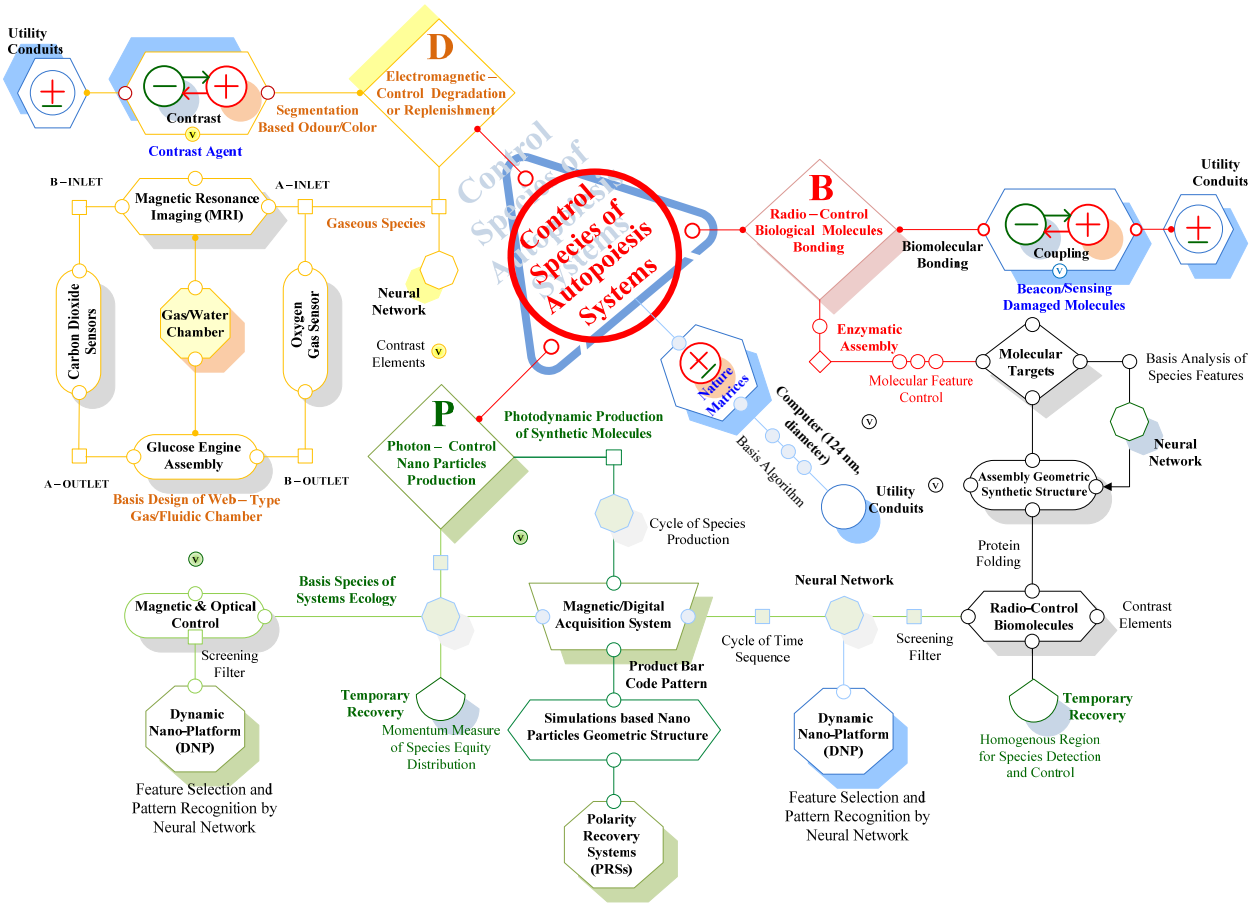

Fig. 4 Photodynamic Platform of Molecular Therapeutics Model [157], [158]

B. Neutralization Portable Energy Systems

A prototype has been investigated in the laboratory for inclusion energy systems. The unified functions are controlled with limitations to fold process first, in flexible structure and second, efficient absorption and emission spectral radiation. The evolution of photodynamic therapy has been applied in controlling surface area and geometry of nanoparticle technology. The physical reaction rate of the particles isotropic etching the different geometries of different-sized quantum dots are increasing cells storage energy [162]. The nature interactive radiant of metrics emit multiple electrons per solar photon, with different absorption and emission spectra depending on the particle size and geometry, thus notably raising the theoretical efficiency limit by adapting to the incoming light spectrum. In these cells, most of the electrons produced are injected on the conduction band of the semiconductor and then, charge separation takes place at the interface between molecules [163]. Thus, the neutralization of oxides is leading to an increase of light harvesting due to the indicted high surface area of the nanoparticles [164]-[170]. The up-to-date design technologies, commonly using composite fuel cells, mix conductive nanomaterial of metal

oxides with high surface areas to increase internal reflections with internal molecules and, consequently, create a dual spectrum. Frequent sequences are organized in moderate expenses in a theoretical efficiency range of 87.462%, achieved in practical applications [171]. As an example, the substitution of liquid electrolyte in classical fuel cell by a polymer-based electrolyte or a hole-transporting polymer leads to flexible fuel cells with lower costs and longer lifetime. In coincidence to the production of hybrid organic/ inorganic fuel cells, the polymer-based electrolyte has notably increased the potential of fuel energy contrast agent and open innovation model with a broad range of nanotechnology. Some investors employed fourth-generation fuel cells for achieving a great scientific effort (i.e., Nanosolar, Nanosys, Konarka Technologies, Inc., etc.). However, not enough efficiency has been achieved yet on the same approach [172].

The poietic processes in Fig. 5 [173] have predicted a dynamic basis of energy self–production for the subsequent processes, not only in the one labeled as so 'production' or 'bonding' but extend to 'degradation' as well. The 'bonding' is biologic process representing autopoiesis in the measureable conditions (i.e., self-sustaining production, bonding and degradation) to control the balance of hematopoietic organization. The production rate does not exceed the replenishment rate and vice versa. The autopoietic system is assimilated in an environment when the common species are organized in closed (loops) cycle as systems ecology [174].

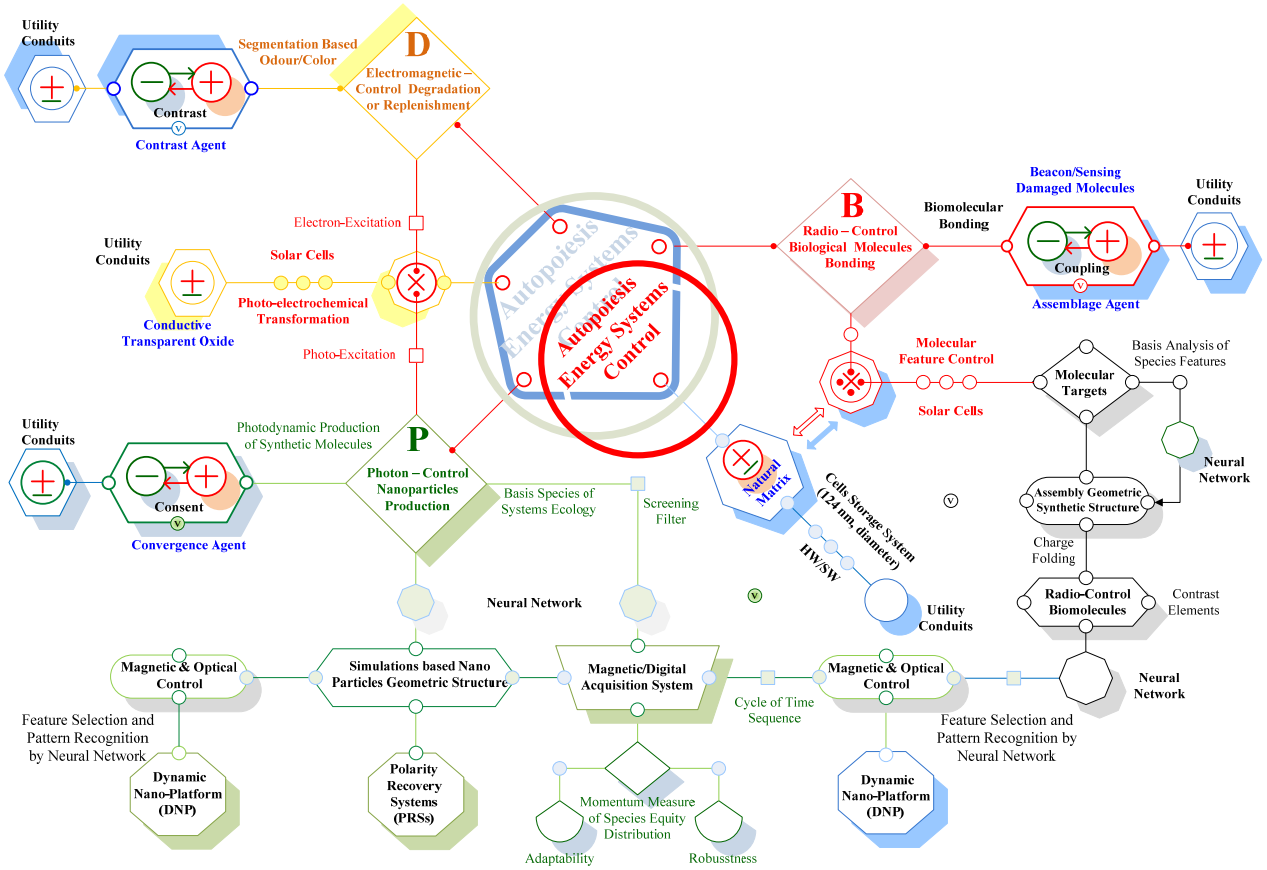

Fig. 5 The Electromagnetic, Optical and Radioactive Control Systems [173]

The model illustrates the processes through the interactions of its basis species (elements), with boundary and distinction emerge as a result of the same constitutive processes. The '*organization*' is an autonomous unity of a network model that has independent elements in a complete cycle, to participate recursively in the same network of productions of species. The elements are produced in cycle as biological systems. These miniature nanoparticles have unique advantages such as accessing to unprecedented and small areas, increased flexibility, functionality and robustness, and being low cost, adaptive and distributed. The structure is sustained in creative mechanisms or closed cycle of front–end process in the microscopic scale of a nanometer (10^{-9} meters) conditions [175], [176].

V. Conclusion

Nanotechnology offers tools to develop therapeutic and energy systems based on cost-effective and cost-efficient economies, thus seriously contributes to a sustainable

economic growth. Nanotechnology as a broad term is typically used to describe materials and phenomena at nanoscale, (i.e., on the scale of 1 billionth to several tens of billionths of a meter). However, it specifically implies not only the miniaturization but also the precise manipulation of atoms and molecules to design and control the properties of the nanomaterials/nanosystems. These properties are completely intra-disciplinary than those possessed by the raw materials, producing custom-made devices with capabilities not found in nature, or even to replicate some natural structures that have not been currently achieved through synthetic materials.

REFERENCES

[1] Wagner V, Dullaart A, Bock AK, Zweck A, (2006) "*The Emerging Nanomedicine Landscape*", Nat Biotechnol, Vol. 10: pp. 1211–1217, 2006.

[2] Abhilash M, (2010) "*Nanorobots*", International Journal of Pharma and Bio Sciences Vol. 1 (1): pp. 1–10, 2010.

[3] Barbosa G, Silva P A F, Luz G V S and Brasil L M, (2015) "*Nanotechnology Applied in Drug Delivery*", In World Congress on Medical Physics and Biomedical Engineering 51st Edition, Toronto, Canadá: Springer International Publishing Switzerland, Physics Letters, Vol. 89 (23): pp. 9–11, 2015.

[4] Vettiger P, Cross G, Despont M, Drechsler, Dürig U, Gotsmann B, Häberle W, Lantz M A, Rothuizen H E, Stutz R and Binnig G K, (2002), "*The Millipede Nanotechnology Entering Data Storage*", IEEE Transactions on Nanotechnology, Vol. 1 (1): pp. 39–55, 2002.

[5] Songhua Xiaoa, Daoyou Zhou, Ping Luan, Beibei Gu, Longbao Feng, Shengnuo Fan, Wang Liao, Wenli Fang, Lianhong Yang, Enxiang Tao, Rui Guo, Jun Liu, (2016) "*Graphene quantum dots conjugated neuroprotective peptide improve learning and memory capability*", Biomaterials, Vol. 106: pp. 98–110, November, 2016.

[6] Ji X, Pen F, Zhong Y, Su Y, He Y, (2014) "Fluorescent *quantum dots: synthesis, biomedical optical imaging, and biosafety assessment*", Colloids Surf B Biointerfaces, Vol. 124: pp. 132–139, 2014.

[7] Rocha T L, Mestre N C, Saboia-Morais S M T, Bebianno M J, (2017) "*Environmental behaviour and ecotoxicity of quantum dots at various trophic levels: a review*", Environ Int., Vol. 98: pp. 1–17, 2017.

[8] Caren, Neal and Aaron Panofski (2005) "TQCA: A Technique for Adding Temporality to Qualitative Comparative Analysis", Sociological Methods and Research, Vol. 34(2): pp. 147-172, 2005. https://doi.org/10.1177%2F0049124105277197

[9] Giaretta A, Balasubramaniam S, and Conti M, (2016), "*Security Vulnerabilities and Countermeasures for Target Localization in Bio-Nano Things Communication Networks*", in IEEE Transactions on Information Forensics and Security, Vol. 11 (4): pp. 665-676, April 2016.

[10] Christopher G. Hudson and Yvonne M. Vissing, (2013) "*Sustainability at the Edge of Chaos: Its Limits and Possibilities in Public Health*", BioMed Research International, Vol. 2013, Article ID 801614, 7 pages, 2013. https://doi.org/10.1155/2013/801614/

[11] Bock et al. (2010) "Permanent Genetic Resources added to Molecular Ecology Resources Database", Molecular Ecology Resources, Vol.10 (1):232-6, 2010 Jan. doi: 10.1111/j.1755-0998.2009.02796.x. PMID: 21565018.

[12] Dittrich-Schröder G, Hoareau T B, Hurley B P, Wingfield M J, Lawson S, Nahrung H F, and Slippers B, (2018) "Population Genetic Analyses of Complex Global Insect Invasions in Managed Landscapes: A Leptocybe Invasa (Hymenoptera) Case Study", Biological Invasions, Volume 20, Issue 9, pp. 2395–2420, September 2018. https://doi.org/10.1007/s10530-018-1709-0

[13] Maturana, H R, Varela, F J, (1973) "*Autopoiesis: the organization of the living*", In: Maturana H R and Varela F J, eds.: Autopoiesis and Cognition, Reidel, pp. 59-138, 1973.

[14] Jeffrey Braithwaite, Luke Testa, Gina Lamprell, Jessica Herkes, Kristiana Ludlow, Elise McPherson, Margie Campbell, and Joanna Holt, (2017) "*Built to last? The Sustainability of Health System Improvements, Interventions and Change Strategies: A Study Protocol for a Systematic Review*", BMJ open, Vol. 7, no. 11, 2017.

[15] Fernández Nelson, Maldonado C, and Gershenson C, (2014), "*Information Measures of Complexity, Emergence, Self-organization, Homeostasis, and Autopoiesis*", In Guided Self-Organization: Inception, pages 19–51. Springer, Berlin, Heidelberg, 2014.

[16] Vanderstraeten R, (2000) "*Autopoiesis and Socialization: on Luhmann's reconceptualization of communication and socialization*", British Journal of Sociology Vol. 51: pp. 581–598, 2000.

[17] Mingers J, (1989), "*An Introduction to Autopoiesis - Implications and Applications*", Systems Practice, Vol.2 (2): pp.159-180, 1989.

[18] Matthias Fischer, (2015) "*Fit for the future? A New Approach in the Debate about what Makes healthcare Systems Really Sustainable*", Sustainability (Switzerland), Vol.7 (1): pp.294–312, 2015.

[19] Roli A, Villani M, Filisetti A, and Serra R, (2018), "*Dynamical Criticality: Overview and Open Questions*", Journal of Systems Science and Complexity, Vol. 31 (3): pp.647–663, Iune 2018. https://doi.org/10.1007/s11424-017-6117-5

[20] West G B, and Brown J H, (2005) "*The Origin of Allometric Scaling Laws in Biology From Genomes To Ecosystems: Towards A Quantitative Unifying Theory of Biological Structure and Organization*", Journal of experimental biology, Vol. 208(9):1575-1592, 2005; https://doi.org/10.1242/jeb.01589 PMID: 15855389

[21] Castro-Nallar E, Pérez-Losada M, Burton GF, and Crandall KA, (2012) "*The Evolution of HIV: Inferences Using Phylogenetics*", Molecular Phylogenetics and Evolution, Vol.62 (2): pp.777-92, Feb. 2012. https://doi.org/10.1016/j.ympev.2011.11.019

[22] Akyildiz I F, Pierobon M, Balasubramaniam S, Koucheryavy Y, (2015) "*Internet of Bio-Nano Things*", IEEE Communications Magazine, Vol. 53 (3): pp. 32-40, March 2015.

[23] Berg S, Luther S, Lehnart S E, Hellenkamp K, Bauernschmitt R, Kurths J, Wessel N, and Parlitz U, (2010) "*Comparison of Features Characterizing Beat-to-Beat Time Series*", Proceedings of the International Biosignal Processing Conference, Berlin, Germany, Vol.49: pp. 1–4, 2010.

[24] Frank B, Pompe B, Schneider U, and Hoyer D, (2006) "*Permutation Entropy Improves Fetal Behavioural State Classification Based on Heart Rate Analysis from Biomagnetic Recordings in Near Term Fetuses*", Med. Biol. Eng. Comput., Vol.44: pp.179–187, 2006.

[25] Akselrod S, Gordon D, Ubel F A, Shannon D C, Barger A C, and Cohen R J, (1981) "*Power Spectrum Analysis of Heart Rate Fluctuation: A Quantitative Probe of Beat-To- Beat Cardiovascular Control*", Science, Vol.213: pp.220–222, 1981.

[26] Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, (1996) "*Heart Rate Variability*", European Heart Journal, Vol.17: pp.354–381, 1996.

[27] Wessel N, Voss A, Kurths J, Saparin P, Witt A, Kleiner H J, Dietz R, (1994) "*Renormalised Entropy: A New Method of Non-Linear Dynamics for The Analysis of Heart Rate Variability*", Computer. Cardiol. 21: pp. 137–140, 1994.

[28] Wessel N, Voss A, Malberg H, Ziehmann Ch, Voss H U, Schirdewan A, Meyerfeldt U, and Kurths J, (2000) "*Nonlinear Analysis of Complex Phenomena in Cardiological Data*", Herzschr. Elektrophys, Vol. 11 (3): pp.159–173, 2000.

[29] Wessel N, Malberg H, Bauernschmitt R, and Kurths J, (2007) "*Nonlinear Methods of Cardiovascular Physics and their Clinical Applicability*", Int. J. Bif. Chaos, Vol.17 (1): pp.3325–3371, 2007.

[30] Kurths J, Voss A, Saparin P, Witt A, Kleiner H J, and Wessel N, (1995) "*Quantitative Analysis of Heart Rate Variability*", Chaos, Vol.5 (1): pp.88–94, 1995.

[31] Wessel N, Ziehmann C, Kurths J, Meyerfeldt U, Schirdewan A, Voss A, (2000) "*Short-Term Forecasting of Life-Threatening Cardiac Arrhythmias Based on Symbolic Dynamics*", Phys. Rev. E., Vol.61 (1): pp.733–739, 2000.

[32] Cysarz D, Lange S, Matthiessen P F, van Leeuwen P, (2007) "*Regular Heartbeat Dynamics are Associated with Cardiac Health*", Am. J. Physiol. Regul. Integr. Comp. Physiol., Vol. 292: R368–R372, 2007.

[33] Porta A, et al., (2001) "*Entropy, Entropy Rate, And Pattern Classification as Tools to Typify Complexity in Short Heart Period Variability Series*", IEEE Transactions on Biomedical Engineering, Vol.48: pp.1282–1291, 2001.

[34] Porta A, et al., (2007) "*An Integrated Approach Based on Uniform Quantization for The Evaluation of Complexity of short-term Heart*

Period Variability: Application to 24 H Holter Recordings in Healthy and Heart Failure Humans", Chaos, Vol.17: pp.015117, 2007.

[35] Voss A, Kurths J, Kleiner H J, Witt A., Wessel N., Saparin P., Osterziel K J, Schurath R, and Dietz R, (1996) "*The Application of Methods of Non-Linear Dynamics for The Improved And Predictive Recognition of Patients Threatened by Sudden Cardiac Death*", Cardiovasc. Res., Vol.31: pp. 419–433, 1996.

[36] Moore M, and Nakano T, (2011) "*Addressing by Beacon Distances using Molecular Communication*", Nano Communication Network Journal (Elsevier), Vol. 2: pp. 161–173, 2011.

[37] Moore M, and Nakano T, (2013) "*Addressing by Concentrations of Receptor Saturation in Bacterial Communication*", In Proceedings of the 8th International Conference on Body Area Networks (BodyNets '13), ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), ICST, Brussels, Belgium, Belgium, pp. 472-475, 2013.

[38] Thomas S G, Csutak S, Jones R E, Bharatan S, Jasper C, Thomas R, Zirkle T, Campbell J C, (2002) "*CMOS-Compatible Photodetector Fabricated on Thick SO1 Having Deep Implanted Electrodes*", Electronics Lett 26th, Vol.38: pp.1202-1204, 2002;

[39] Hanada E, Antoku Y, Tani S, Kimura M, Hasegawa A, Urano S, Ohe K, Yamaki M, and Nose Y, (2000) "*Electromagnetic Interference on Medical Equipment by Low-Power Mobile Telecommunication Systems*", IEEE Transactions on Electromagnetic Compatibility, Vol. 42 (4): pp. 470-476, Nov. 2000.

[40] Sharma N N, and Mittal R K, (2008), "*Nanorobot Movement: Challenges and Biologically Inspired Solutions*", International Journal on Smart Sensing and Intelligent Systems, Vol.1 (1): pp.87–109, 2008.

[41] Malliani A, Pagani M, Lombardi F, Cerutti S, (1991) "*Cardiovascular Neural Regulation Explored In the Frequency Domain*", Circulation, Vol.84: pp.482–492, 1991.

[42] Xu Y, Murray J, and Munday J N, (2014) "*Photonics and Plasmonics for Enhanced Photovoltaic Performance*". In: Wu J, Wang MZ (eds) Quantum Dot Solar Cells, Springer New York, New York, pp.349–382, 2014.

[43] Gonzalez M J, Massari J R M, Duconge J, Riordan N H, Ichim T, Quintero-Del-Rio A I, and Ortiz N, (2012) "*The Bio-Energetic Theory of Carcinogenesis*", Med Hypotheses, Vol.79: pp.433–439, 2012.

[44] Cavalcanti A, Shirinzadeh B, Freitas Jr R A, and Hogg T, (2007) "*Nanorobot Architecture for Medical Target Identification*", Nanotechnology, Vol. 19 (1): pp. 015103, November, 2007. https://iopscience.iop.org/0957-4484/19/1/015103

[45] Earhart K C, Beadle C, Miller L K, Press M W, Gary G C, Ledbetter E K, and Wallace M R, (2001) "*Outbreak of influenza in highly vaccinated crewof US Navy ship*", Emerge. Infect. Dis., Vol. 7(3): pp. 463–465, 2001.

[46] Hillman M R, (2002) "*Overview: Cause and Prevention in Bio Warfare* and Bioterrorism", Vaccine, Vol. 20 (25-26): pp.3055– 3067, 2002.

[47] Frohlich H (1983) "*Evidence for Coherent Excitation in Biological Systems*", International Journal of Quantum Chemistry, Vol. 13: pp.1589–1595, 1983.

[48] Braff D, (1994) "*Fast Contact Force Computation for No Penetrating Rigid Bodies*", in Computer Graphics Proceedings, Annual Conf. Series. ACM SIGGRAPH, pp. 23-34, 1994.

[49] Dogan U, Kasap E, Cetin D, et al., (2016), "*Rapid Detection of Bacteria Based on Homogenous Immunoassay Using Chitosan Modified Quantum Dots*", Sens Actuators B Chem, Vol. 233: pp. 369–378, 2016.

[50] Lulec S Z, Sagiroglu C, Mostafazadeh A, Ermek E, Timurdogan E, Leblebici Y, and Urey H, (2012) "*Simultaneous Self-Sustained Actuation and Parallel Readout with MEMS Cantilever Sensor Array*", Micro Electro Mech. Syst. (MEMS), IEEE 25th Int. Conf., pp.644–647, 2012. https://dx.doi.org/10.1109/MEMSYS.2012.6170269.

[51] Hou H, Bai X, Xing C, Gu N, Zhang B, Tang J, (2013) "*Aptamer-Based Cantilever Array Sensors for Oxytetracycline Detection*", Anal. Chem. Vol.85: pp. 2010–2014, 2013. https://dx.doi.org/10.1021/ac3037574

[52] Cakmak O, Ermek E, Kilinc N, Yaralioglu G G, and Urey H, (2015) "*Precision Density and Viscosity Measurement using two Cantilevers with Different Widths*", Sens. Actuators A Phys. Vol.232: pp.141–147, 2015. https://dx.doi.org/10.1016/j.sna.2015.05.024

[53] Grass R N, (2015) "*Robust Chemical Preservation of Digital Information on DNA in Silica with Error-Correcting Codes*", Angewandte Chemie International Edition, Vol. 54 (8): pp. 2552-2555, 2015.

[54] Onur Cakmak, Caglar Elbuken, Erhan Ermek, Aref Mostafazadeh, Ibrahim Barisc, Erdem Alaca B, Ibrahim Halil Kavakli, and Hakan Ureyb, (2013) "*Microcantilever Based Disposable Viscosity Sensor for Serum and Blood Plasma Measurements*", Methods Vol.63(3): pp.225–232, October 2013. https://dx.doi.org/10.1016/j.ymeth.2013.07.009.

[55] Zhou W, and Wang L Z, (2011), "*Three-Dimensional Nano Architectures Designing Next Generation Devices*", Springer, New York, 2011.

[56] Parlitz U, Berg S, Luther S, Schirdewan A, Kurths J, and Wessel N, (2012) "*Classifying Cardiac Biosignals using Ordinal Pattern Statistics and Symbolic Dynamics*", Computers in Biology and Medicine, Vol. 42(3): pp. 319-327, 2012. https://doi.org/10.1016/j.compbiomed.2011.03.017

[57] Polesel-Maris J, Aeschimann L, Meister A, Ischer R, Bernard E, Akiyama T et al., (2007) "*Piezoresistive Cantilever Array for Life Sciences Applications*", J. Phys.Conf. Ser., Vol.6: pp.955–959, 2007. https://dx.doi.org/10.1088/1742-6596/61/1/189

[58] Gruber K., Horlacher T., Castelli R., Mader A., Seeberger P.H., Hermann B a, (2011) "*Cantilever Array Sensors Detect Specific Carbohydrate-Protein Interactions with Picomolar Sensitivity*", ACS Nano, Vol.5: pp.3670–3678, 2011. https://dx.doi.org/10.1021/nn103626q

[59] Ozturk A, Ocakli H I, Ozber N, Urey H, Kavakli I H, and Alaca B E, (2008) "*A Magnetically Actuated Resonant Mass Sensor with Integrated Optical Readout*", IEEE Photonics Technology Lett., Vol. 20: pp. 905-1907, 2008.

[60] Timurdogan E, Alaca B E, Kavakli I H, and Urey H, (2011) "*MEMS Biosensor for Detection of Hepatitis A and C Viruses in Serum*", Biosensors and Bioelectronics, Vol.28: pp.189-194, 2011.

[61] Lenaghan S C, Wang Y, Xi N, Fukuda T, Tarn T, Hamel W R, and Zhang M, (2013), "*Grand Challenges in Bioengineered Nanorobotics for Cancer Therapy*", IEEE Trans Biomed Eng., Vol. 60: pp. 667–673, 2013.

[62] Xu X, Kim K, and Fan D, (2015) "*Tunable Release of Multiplex Biochemicals by Plasmonically Active Rotary Nanomotors*", Angewandte Chemie (International ed. In English) 54 (8): pp. 2525–9, 2015.

[63] Weiss J R M, Menolfi C, Morf T, Schmatz M L., Jaeckel H. (2005) "*Effect of Body Contacts on High-Speed Circuits in 90 Nm CMOS SOI Technology*", IEEE ISSCS Int'l Symposium on Signals, Circuits and Systems, Vol. 2: pp. 537-540, 2005

[64] Goicoechea J, Zamarreño C R, Matias I R, and Arregui F J, (2007) "*Minimizing the Photo Bleaching of Self-Assembled Multilayers for Sensor Applications*", Sens. Actuator B-Chem., Vol. 126 (1): pp. 41–47, 2007.

[65] Neuss S, Bartel Y, Born C, Weil S, Koch J, Behrends C, Hoffmeister M, and Steinle A, (2018) "*Cellular Mechanisms Controlling Surfacing of AICL Glycoproteins, Cognate Ligands of the Activating NK Receptor NKp80*", J Immunol., Vol.201(4): pp.1275-1286, 2018 Aug 15. https://doi.org/10.4049/jimmunol.1800059

[66] Yuan F L, Li S H, Fan Z T, Meng X Y, Fan L Z, and Yang S H, (2016) "*Shining Carbon Dots: Synthesis and Biomedical and Optoelectronic Applications*", Nano Today, 11, 565–586, 2016.

[67] Shan X Y, Chai L J, Ma J J, Qian Z S, Chen J R, and Feng H, (2014) "*B-Doped Carbon Quantum Dots as a Sensitive Fluorescence Probe for Hydrogen Peroxide and Glucose Detection*", Analyst, Vol.139: pp.2322–2325, 2014.

[68] Lavrik N V, Sepaniak M J, and Datskos P G, "*Cantilever Transducers as a Platform for Chemical and Biology Sensors*," Review of Scientific Instruments, vol. 75, pp. 2229–2253, 2004.

[69] Liu, W J, Li C, Ren Y J, Sun X B, Pan W, Li Y H, Wang J P, and Wang W J, (2016) "*Carbon Dots: Surface Engineering and Applications*", J. Mater. Chem. B, Vol.4: pp.5772–5788, 2016.

[70] Wolfbeis O S, (2015) "*An Overview of Nanoparticles Commonly Used in Fluorescent Bioimaging*", Chem. Soc. Rev., Vol.44: pp.4743–4768, 2015.

[71] Swenberg J A, Lu K, Moeller B C, et al. (2011) "*Endogenous Versus Exogenous DNA Adducts: Their Role in Carcinogenesis, Epidemiology and Risk Assessment*", Toxicol Sci., Vol.120: pp. 130 – 145, 2011.

[72] Cadet J, Douki T, Ravanat J-L, (2008) "*Oxidatively Generated Damage to the Guanine Moiety of DNA: Mechanistic Aspects and Formation in*

Cells", Acc Chem Res, Vol.41: pp. 1075 – 1083, 2008.
[73] Dizdaroglu M, Jaruga P, (2012) "Mechanisms of free radical-induced damage to DNA", Free Radic Res, Vol. 46: pp. 382 – 419, 2012.
[74] O'Neill P, Wardman P, (2009) "*Radiation Chemistry Comes Before Radiation Biology*", Int J Radiat Biol., Vol. 85: pp. 9–25, 2009.
[75] Pouget J-P, Frelon S, Ravanat J-L, et al. (2002) "*Formation of Modified DNA Bases in Cells Exposed Either to Gamma Radiation or to High-LET Particles*", Radiation Research, Vol.157: pp.589–595, 2002.
[76] Von Sonntag C, (2006) "*Free-Radical-Induced DNA Damage and Its Repair*", Heidelberg: Springer; 2006
[77] Dixon K L, (2003) "*The Radiation Biology of Radioimmunotherapy*", *Nuclear Medicine Communications,* Vol.24 (9): pp. 951-57, 2003.
[78] Lieber M.R, (2010) "*The Mechanism of Double-Strand DNA Break Repair by the Nonhomologous DNA End-Joining Pathway*", Annu. Rev. Biochem., Vol.79: pp.181–211, 2010.
[79] Thompson LH, Schild D, (2001) "*Homologous Recombinational Repair of DNA Ensures Mammalian Chromosome Stability*", Mutat Res, Vol. 477: pp. 131–153, 2001.
[80] Willers H, Xia F, Powell S N, (2002) "*Recombinational DNA Repair in Cancer and Normal Cells: The Challenge of Functional Analysis*", J Biomed Biotechnol, Vol. 2: pp. 86– 93, 2002
[81] Powell S N, Kachnic L A (2003) "*Roles of BRCA1 and BRCA2 in Homologous Recombination, DNA Replication Fidelity and the Cellular Response to Ionizing Radiation*", Oncogene, Vol. 22: pp. 5784–5791, 2003.
[82] Jackson S P, (2002) "*Sensing and Repairing DNA Double-Strand Breaks*", Carcinogenesis Vol. 23: pp. 687–696, 2002.
[83] Khanna K K, Jackson S P, (2001) "*DNA Double-Strand Breaks: Signaling, Repair and the Cancer Connection*", Nat Genet Vol. 27: pp. 247–254, 2001.
[84] Botchway S W, Reynolds P, Parker A W, and O'Neill P, (2012) "*Laser-Induced Radiation Microbeam Technology and Simultaneous Real-Time Fluorescence Imaging in Live Cells*", Methods Enzymol., Vol.504: pp.3–28, 2012.
[85] Datta K, Jaruga P, Dizdaroglu M, Neumann R D, and Winters T A, (2006) "*Molecular Analysis of Base Damage Clustering Associated with a Site-Specific Radiation-Induced DNA Double-Strand Break*", Radiation Research., Vol.166: pp.767-781, 2006.
[86] Datta K, Neumann R D, Winters T A, (2005) "*Characterization of Complex Apurinic/Apyrimidinic-Site Clustering Associated with an Authentic Site-Specific Radiation-Induced DNA Double-Strand Break*", Proc National Academy Science USA, Vol.102: pp.10569-10574, 2005.
[87] Kamal Datta, Shubhadeep Purkayastha, Ronald D Neumann, Elzbieta Pastwa, and Thomas A Winters, (2011) "*Base Damage Immediately Upstream from Double-Strand Break Ends is a More Severe Impediment to Nonhomologous End Joining Than Blocked 30-Termini*", Radiation Research., Vol.175 (1): pp.97-112, 2011. https://doi.org/10.1667/RR2332.1
[88] Zharkov D O, (2008) "*Base Excision DNA Repair*", Cell Mol Life Sci., Vol.65: pp.1544-1565, 2008.
[89] Macrae C J, McCulloch R D, Ylanko J, Durocher D, and Koch C A, (2008) "*APLF (C2orf13) Facilitates Nonhomologous End-Joining and Undergoes ATM-Dependent Hyperphosphorylation Following Ionizing Radiation*", DNA Repair, Vol.7: pp.292–302, 2008.
[90] David-Cordonnier M-H, Laval J, O'Neill P, (2000) "*Clustered DNA Damage, Influence on Damage Excision by XRS5 Nuclear Extracts and Escherichia Coli Nth and Fpg Proteins*", J Biological Chemistry, Vol.275: pp.11865-11873, 2000.
[91] Lomax ME, Cunniffe S, O'Neill P, (2004) "*8-OxoG Retards the Activity of the Ligase III/XRCC1 Complex During the Repair of a Single Strand Break, When Present within a Clustered DNA Damage Site*", DNA Repair, Vol.3: pp.289-299, 2004.
[92] Eccles L J, Lomax M E, O'Neill P, (2010) "*Hierarchy of Lesion Processing Governs the Repair, Double-Strand Break Formation and Mutability of Three-Lesion Clustered DNA Damage*", Nucleic Acids Research, Vol.38: pp.1123-1134, 2010.
[93] Gilboa R, Zharkov D O, Golan G, Fernandes A S, Gerchman S E, Matz E, Kycia J H, Grollman A P, and Shoham G, (2002) "*Structure of Formamidopyrimidine-DNA Glycosylase Covalently Complexed to DNA*", J. Biol. Chem., Vol.277: pp.19811–19816, 2002.
[94] Fromme J C, and Verdine G L, (2003) "*Structure of a Trapped Endonuclease III-DNA Covalent Intermediate*", EMBO J., Vol.22: pp.3461–3471, 2003.
[95] Rogacheva M, Ishchenko A, Saparbaev M, Kuznetsova S, and Ogryzko V, (2006) "*High Resolution Characterization of Formamidopyrimidine-DNA Glycosylase Interaction with Its Substrate by Chemical Cross-Linking and Mass Spectrometry using Substrate Analogs*", J. Biological Chemistry, Vol.281: pp.32353–32365, 2006.
[96] Kano et al. (2007) "*Improvement of Cancer-Targeting Therapy, using Nanocarriers for Intractable Solid Tumors by Inhibition of TGF-Beta Signaling*", Proc. Natl. Acad. Sci. USA, Vol. 104 (9): pp. 3460–3465, 2007.
[97] De 97Ruysscher D, Faivre-Finn C, Moeller D, Nestle U, Hurkmans, C W, Le Pechoux C et al., (2017), "*European Organization for Research and Treatment of Cancer (EORTC) Recommendations for Planning and Delivery of High-Dose, High Precision Radiotherapy for Lung Cancer*", Radiotherapy Oncology, Vol. 124: pp. 1–10, 2017.
[98] Yoo S, and Dynan W S, (1999) "*Geometry of a Complex formed by Double Strand Break Repair Proteins at a Single DNA End: Recruitment of DNA-PKcs Induces Inward Translocation of Ku Protein*", Nucleic Acids Research, Vol.27: pp.4679–4686, 1999.
[99] Fengyi Du, Lirong Zhang, Li Zhang, Miaomiao Zhang, Aihua Gong, Youwen Tan, Jiawen Miao, Yuhua Gong, Mingzhong Sun, Huixiang Ju, Chaoyang Wu, and Shenqiang Zou, (2017) "*Engineered Gadolinium-Doped Carbon Dots for Magnetic Resonance Imaging-Guided Radiotherapy of Tumors*", Biomaterials, Vol. 121: pp. 109–120, 2017. https://doi.org/10.1016/j.biomaterials.2016.07.008
[100] Nestle U, Rischke H C, Eschmann S M, Holl G, Tosch M, Miederer M et al., (2015), "*Improved Inter-Observer Agreement of an Expert Review Panel in an Oncology Treatment Trial–Insights from a Structured Interventional Process*", European Journal of Cancer, Vol. 51: pp. 2525–2533, 2015.
[101] Konert T, Vogel W, MacManus M P, Nestle U, Belderbos J, Grégoire, V. et al., (2015), "*PET/CT Imaging for Target Volume Delineation in Curative Intent Radiotherapy of Non-Small Cell Lung Cancer: IAEA Consensus Report 2014*", Radiotherapy Oncology, Vol. 116: pp.27–34, 2015.
[102] Nestle et al. (2018), "*ESTRO ACROP Guidelines For Target Volume Definition in the Treatment of Locally Advanced Non-Small Cell Lung Cancer*", Radiotherapy and Oncology, Vol. 127 (1): pp. 1-5, April, 2018. https://doi.org/10.1016/j.radonc.2018.02.023
[103] Bhat A S, (2014) "*Nanorobots: The Future of Medicine*", International Journal of Engineering and Management Sciences, Vol. 5 (1): pp. 44–9, 2014.
[104] Mutoh K., Tsukahara S, Mitsuhashi J, Katayama K, and Sugimoto Y, (2006) "*Estrogen-Mediated Post Transcriptional Down-Regulation of P-Glycoprotein in MDR1-Transduced Human Breast Cancer Cells*", Cancer Science, Vol. 97 (11): pp. 1198–204, 2006.
[105] Lagzi, I., (2013), "*Chemical Robotics – Chemotactic Drug Carriers*", Open Medicine, Vol. 8 (4): pp. 377–82, 2013.
[106] Glatzer M, Elicin O, Ramella S, Nestle U, and Putora P M, (2016) "*Radio(chemo)therapy in Locally Advanced Nonsmall Cell Lung Cancer*", Eur Respir Rev., Vol. 25: pp.65–70, 2016.
[107] Borras J M, Barton M, Grau C, Corral J, Verhoeven R, Lemmens V, et al., (2015) "*The Impact of Cancer Incidence and Stage on Optimal Utilization of Radiotherapy: Methodology of A Population Based Analysis by the ESTRO-HERO Project*", Radiotherapy Oncology, Vol. 116: pp. 45–50, 2015.
[108] Borras J M, Lievens Y, Barton M, Corral J, Ferlay J, Bray F, et al., (2016) "*How Many New Cancer Patients in Europe will Require Radiotherapy by 2025? An ESTRO-HERO Analysis*", Radiotherapy Oncology, Vol. 119: pp. 5–11, 2016.
[109] Atun R, Jaffray D A, Barton M B, Bray F, Baumann M, Vikram B, et al., (2015) "*Expanding Global Access to Radiotherapy*", Lancet Oncol, Vol. 16: pp.1153–86, 2015.
[110] Gabriel O Sawakuchi, Uwe Titt, Dragan Mirkovic, George Ciangaru, X Ronald Zhu, Narayan Sahoo, Michael T Gillin and Radhe Mohan, (2010) "*Monte Carlo Investigation of The Low-Dose Envelope From Scanned Proton Pencil Beams*", Physics in Medicine & Biology, Volume 55, Number 3, pp. 711 – 722, 2010
[111] Daniel P. Hayes, (2008) "*Non-Problematic Risks from Low-Dose Radiation-Induced DNA Damage Clusters*", Dose Response, Vol. 6(1): pp.30–52, Jan 16, 2008. doi: 10.2203/dose-response.07-023.Hayes.
[112] Garty G, Schulte R, Shchemelinin S, Leloup C, Assaf G, Breskin A,

Chechik R, Bashkirov V, Milligan J, and Grosswendt B, (2010) "*A Nanodosimetric Model of Radiation-Induced Clustered DNA Damage Yields*", Physics in Medicine & Biology, Vol. 55 (3): pp. 329 – 562, January 2010.

[113] Nikjoo H1, O'Neill P, Wilson W E, Goodhead D T, (2001) "*Computational Approach For Determining The Spectrum of DNA Damage Induced by Ionizing Radiation*", Radiation Research, Vol.156 (5Pt2): pp.577-583, 2001.

[114] Venkhataraman R, Donald C D, Roy R, You H J, Doetsch P W and Kow Y W, (2001) "*Enzymatic Processing of DNA Containing Tandem Dihydrouracil by Endonucleases* III and VIII", Nucleic Acids Res. 29: 407–414.

[115] Weinfeld M, Rasouli-Nia A, Chaudhry M A, and Britten R A, (2001) "*Response of Base Excision Repair Enzymes to Complex DNA Lesions*", Radiat. Res., Vol.156: pp. 584–589, 2001.

[116] Laura J. Eccles, Martine E. Lomax and Peter O'Neill, (2010) "*Hierarchy of Lesion Processing Governs the Repair, Double-Strand Break Formation and Mutability of Three-Lesion Clustered DNA Damage*", Nucleic Acids Research, Vol. 38 (4): pp.1123–1134, 2010. https://doi.org/10.1093/nar/gkp1070.

[117] Freitas Jr. R A, (2005) "*Nanotechnology, Nanomedicine and Nanosurgery*", International Journal of Surgery, Vol. 3(12): pp. 1-4, December, 2005. http://www.nanomedicine.com/Papers/IntlJSurgDec05.pdf.

[118] Montoro Bustos A R, Garcia-Cortes M, González-Iglesias H, Ruiz Encinar J, Costa-Fernández J M, Coca-Prados M et al., (2015), "*Sensitive Targeted Multiple Protein Quantification Based on Elemental Detection of Quantum Dots*", Anal Chim Acta, Vol. 879: pp. 77–84, 2015.

[119] Martel S, Mathieu J B, Felfoul O, Macicior H, Beaudoin G, Soulez G, and Yahia L H, (2004) "*Adapting MRI Systems to Propel and Guide Microdevices in the Human Blood Circulatory System*", 26th Annual Int'l Conf. of the IEEE Engineering in Medicine and Biology Society, p. 1044-1047, September, 2004.

[120] Kumar M N V R, (2000) "*Nano and Microparticles as Controlled Drug Delivery Devices*", J Pharm Parmaceut Science, Vol. 3(2): pp. 234-258, 2000.

[121] Bogaerts W, Baets R, Dumon P, Wiaux V, Beckx S, Taillaert D, Luyssaert B., Campenhout J V, Bienstman P, and Thourhout D V, (2005*) "Nanophotonic Waveguides in Silicon-on-Insulator Fabricated with CMOS Technology*", J. of Light Wave Technology, Vol. 23 (1): pp. 401-412, Jan. 2005.

[122] Lander et al. (2001) "*Initial Sequencing and Analysis of the Human Genome*", Nature, Vol. 409 (6822): pp. 860–921, February, 2001.

[123] Hilborn J W, (1964) "*Self-Powered Neutron Detectors for Reactor Flux Monitoring*", Nucleonics, Vol. 22 (2): pp. 69-74, 1964.

[124] Liu W, Wyk J D V, Odendaal W G, (2004) "*Design and Evaluation of Integrated Electromagnetic Power Passives with Vertical Surface Interconnections*", 9th IEEE Applied Power Electronics Conf Exposition Vol. (2): pp. 958-963, 2004.

[125] Takeuchi S, Shimoyama I, (2002) "*Selective Drive of Electrostatic Actuators using Remote Inductive Powering Sensors and Actuators*", A. Phys., Vol. 95(2-3): pp. 269-273, 2002.

[126] Ghovanloo M, Najafi K, (2004) "*A Wide-Band Frequency-Shift Keying Wireless Link for Inductively Powered Biomedical Implants*", IEEE Trans. Circuits Syst. Vol. 51(12): pp. 2374-2383, 2004.

[127] Takeuchi S, Futai N, and Shimoyama I, (2001) "*Selective Drive of Electrostatic Actuators using Remote Inductive Powering*", Proc. IEEE Micro Electro Mechanical Systems (MEMS), 574-577, 2001.

[128] Sauer C, Stanacevic M, Cauwenberghs G, and Thakor N, (2005) "*Power Harvesting and Ttelemetry in CMOS for Implanted Devices*", IEEE Transactions on Circuits and Systems, Vol. 52 (12): pp. 2605-2613, Dec. 2005.

[129] Sankar Karan, Amrita Datta, and Dwijesh Dutta Majumder (2015) "*A Robust Design Criterion for Synthesis, Characterization and Quality Control of Nanoparticles - a Fuzzy Mathematical Approach*", International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 5(2): pp. 1–10, February, 2015.

[130] Eggers T, Marscher C, Marschner U, Clasbrummel B, Laur R, and Binder J, (2000) "*Advanced Hybrid Integrated Low-Power Telemetric Pressure Monitoring System for Biomedical Application*" Proc Int'l Conf Micro Electro Mech Sys, pp. 23-37, 2000.

[131] Ghovanloo M, Najafi K, (2004) "*Fully Integrated Wide-Band High-Current Rectifiers for Inductively Powered Devices*", IEEE J. Solid-State Circuits Vol. 39(9): pp.1976–1984, 2004.

[132] Ricciardi L, Pitz I, Sarawi SFA, Varadan V, and Abbott D, (2003) "*Investigation into the Future of RFID in Biomedical Applications*", Proc. of SPIE - Int'l Soc Optical Eng, Vol. 5119: pp. 199-209, 2003.

[133] Katz E, Riklin A, Shabtai VH, Willner I, and Bückmann AF, (1999) "*Glucose Oxidase Electrodes via Reconstitution of the Apo-Enzyme: Tailoring of Novel Glucose Biosensors*", Anal Chim Acta, Vol. 385: pp. 45-58, 1999.

[134] Sumino T, Tamura T, Koseki K et al., (1998) "*Preliminary Study of Calibration-free Continuous Glucose Monitoring with Microdialysis Technique*", Proceeding International Conference of the IEEE Engineering in Medicine and Biology Society, Vol. 20 (4): pp. 1775-1778, 1998.

[135] Cavalcanti A, Hogg T, Shirinzadeh B, and Liaw HC, (2006) "*Nanorobot Communication Techniques: A Comprehensive Tutorial*", IEEE ICARCV Int'l Conf. on Control, Automation, Robotics and Vision, Grand Hyatt, Singapore, December, 2006.

[136] Peng Y, Fanlu Z, Ziyuan L, Zhiqin Z, Alexander G, Lan F, Hoe T, Chennupati J, and Zhiming W, (2018) "*Giant Optical Pathlength Enhancement in Plasmonic Thin Film Solar Cells Using Core-Shell Nanoparticles*", J Phys D Appl Phys, Vol. 51: pp. 295106. https://doi.org/10.1088/1361-6463/aacb1089d.

[137] Schifferli K H, Schwartz J J, Santos A T, Zhang S, and Joseph Jacobson M, (2002) "*Remote Electronic Control of DNA Hybridization through Inductive Coupling to an Attached Metal Nanocrystal Antenna*", Nature, Vol. 415 (10): pp. 152-156, January, 2002.

[138] Bonnet G, Tyagi S, Libchaber A and Kramer F R, (1999) "*Thermodynamic Basis of the Enhanced Specificity of Structured DNA Probes*", Proc. Natl Acad. Sci. USA, Vol. 96: pp. 6171-6176 (1999).

[139] Froese T, and Stewart J, (2010) "*Life After Ashby: Ultrastability and the Autopoietic Foundations of Biological Autonomy*", Cybernetics and Human Knowing, Vol. 17 (4): pp. 7–50, 2010. URL http://tinyurl.com/cw6b57e.

[140] Zhang L, Gu F X, Chan J M, Wang A Z, Langer R S, and Farokhzad O C, (2008) "*Nanoparticles in Medicine: Therapeutic Applications and Developments*", Clinical Pharmacology & Therapeutics, Vol. 83 (5): pp. 761–769, 2008.

[141] Arvizo R R, Bhattacharyya S, Kudgus R A, Giri K, Bhattacharya R, and Mukherjee P, (2012) "*Intrinsic Therapeutic Applications of Noble Metal Nanoparticles: Past, Present and Future*", Chemical Society Reviews, Vol. 41 (7): pp. 2943–2970, 2012.

[142] Mewada A, Pandey S, Thakur M, Jadhav D, and Sharon M, (2014) "*Swarming Carbon Dots for Folic Acid Mediated Delivery of Doxorubicin and Biological Imaging*", J Material Chemistry B, Vol. 2: pp. 698–705, February 2014. https://doi.org/10.1039/c3tb21436b

[143] Couvreur P, and Vauthier C, (2006) "*Nanotechnology: Intelligent Design to Treat Complex Disease*", Pharmaceutical Research, Springer, Vol. 23 (7): pp.1417-50, July, 2006.

[144] Kong B, Zhu A, Ding C, Zhao X, Li B, and Tian Y, (2012) "*Carbon Dot-Based Inorganic-Organic Nanosystem for Two-Photon Imaging and Biosensing of pH Variation in Living Cells and Tissues*", Adv Mater, Vol. 24 (43): pp. 5844–5848, 2014.

[145] Huang J J, Zheng Z F, Rong M Z, Zhou X, Chen X D, and Zhang M Q, (2014) "*An Easy Approach of Preparing Strongly Luminescent Carbon Dots and Their Polymer Based Composites for Enhancing Solar Cell Efficiency*", Carbon, Vol. 70: pp.190–198, April, 2014.

[146] Cavalcanti A, Wood W W, Kretly L C, and Shirinzadeh B, (2006) "*Computational Nanomechatronics: A Pathway for Control and Manufacturing Nanorobots*", IEEE CIMCA Int'l Conf. on Computational Intelligence for Modeling, Control and Automation, IEEE Computer Society, Sydney, Australia, November, 2006.

[147] Cavalcanti A and Freitas Jr. R A, (2002) "*Autonomous Multi-Robot Sensor-Based Cooperation for Nano Medicine*," Int'l J. Nonlinear Science Numerical Simulation, Vol. 3 (4): pp.743-746, August 2002.

[148] Rivera A L, Estanol B, Senti′es-Madrid H, Fossion R, Toledo-Roy J C, Mendoza-Temis J et al., (2016), "*Heart Rate and Systolic Blood Pressure Variability in the Time Domain in Patients with Recent and Long-Standing Diabetes Mellitus*", PloS One, Vol. 11(2): e0148378, 2016.

[149] Maeda H, Matsumura Y, (1989) "*Tumoritropic and Lymphotropic*

Principles of Macromolecular Drugs", Crit Rev Ther Drug Carrier Syst, Vol. 6 (3): pp.193–210, 1989.

[150] Peng Yu, Yisen Yao, Jiang Wu, Xiaobin Niu, Andrey L Rogach, and Zhiming Wang, (2017) "*Effects of Plasmonic Metal Core -Dielectric Shell Nanoparticles on the Broadband Light Absorption Enhancement in Thin Film Solar Cells"*, Scientific Reports, Vol.7 (1): pp. 7696, (2017-08-09). Bibcode: 2017NatSR...7.7696Y. https://doi.org/10.1038/s41598-017-08077-9. ISSN 2045-2322. PMC 5550503. PMID 28794487.

[151] Jiang Wu, Peng Yu, Andrei S Susha, Kimberly A Sablon, Haiyuan Chen, Zhihua Zhou, Handong Li, Haining Ji, and Xiaobin Niu, (2015) "*Broadband Efficiency Enhancement in Quantum Dot Solar Cells Coupled with Multispiked Plasmonic Nanostars"*, Nano Energy, Vol. 13: pp. 827–835, (2015-04-01). https://doi.org/10.1016/j.nanoen.2015.02.012

[152] Millikan R A, (1916) "*A Direct Photoelectric Determination of Planck's h*", Phys. Rev., Vol.7 (3): pp. 355–88, March, 1916. Bibcode:1916PhRv....7..355M, doi:10.1103/PhysRev.7.355

[153] Lev Chuntonov, and Gilad Haran, (2011) "*Trimeric Plasmonic Molecules: The Role of Symmetry*", Nano Letters, Vol. 11 (6): pp. 2440–2445, 10 May 2011. Bibcode:2011NanoL...11.2440C. doi:10.1021/nl2008532. PMID 21553898.

[154] Li S H, Wang L Y, Chusuei C C, Suarez V M, Blackwelder P L, Micic M, Orbulescu J, and Leblanc R M, (2015) "*Nontoxic Carbon Dots Potently Inhibit Human Insulin Fibrillation*", Chem. Mater, Vol. 27(25): pp. 1764–177, February 9, 2015.

[155] Wang B B, Wang S J, Wang Y F, Lv Y, Wu H, Ma X J, and Tan M Q, (2016) "*Highly Fluorescent Carbon Dots for Visible Sensing of Doxorubicin Release Based on Efficient Nano Surface Energy Transfer*", Biotechnology Lett., Vol. 38 (1): pp.191–201, 2016.

[156] Fernandes A R, and Chari D M, (2016), "*Part II: Functional Delivery of a Neurotherapeutic Gene to Neural Stem Cells Using Minicircle DNA and Nanoparticles: Translational Advantages for Regenerative Neurology*", J Control Release, Vol. 238: pp.300–310, 2016.

[157] Christine E. Probst, Pavel Zrazhevskiy, Vaishali Bagalkot, and Xiaohu Gao, (2013) "*Quantum Dots as a Platform for Nanoparticle Drug Delivery Vehicle Design*", Advanced Drug Delivery Reviews, Volume 65, Issue 5, Pages 703-718, May 2013. https://doi.org/10.1016/j.addr.2012.09.036, PMID: 23000745

[158] Mei-Xia Zhao and Bing-Jie Zhu, (2016) "*The Research and Applications of Quantum Dots as Nano-Carriers for Targeted Drug Delivery and Cancer Therapy*", Nanoscale Research Letters, 11:20718 April, 2016. https://doi.org/10.1186/s11671-016-1394-9

[159] Hellman's A, (2003) "*German Team Creates New Type of Transistor-Like Device*", News Analysis, IEEE Spectrum Magazine, pp. 20-21, January 2003.

[160] Ghovanloo M, Najafi K, (2004) "*Awide-Band Frequency-Shift Keying Wireless Link for Inductively Powered Biomedical Implants*", IEEE Trans. Circuits Syst. Vol. 51(12): pp. 2374-2383, 2004.

[161] Takeuchi S, Futai N, and Shimoyama I, (2001) "*Selective Drive of Electrostatic Actuators using Remote Inductive Powering*", Proc. IEEE Micro Electro Mechanical Systems (MEMS), 574-577, 2001.

[162] Taberna P L, Mitra S, Piozot P, Simon P, and Tarascon J M, (2006) "*High Rate Capabilities Fe_3O_4-Based Cu Nano-Architectured Electrodes for Lithium-Ion Battery Applications*", Nat Mater., Vol. 5: pp.567–73, 2006.

[163] Rodriguez I, Ramiro-Manzano F, Atienzar P, Martinez J M, Meseguer F, Garcia H, et al., (2007) "*Solar Energy Harvesting in Photo electrochemical Solar Cells*" J Mater Chem, Vol. 17: pp. 3205–9, 2007.

[164] Arakawa H, and Sayama K Re, (2000) "*Oxide Semiconductor Materials for Solar Light Energy Utilization*", Chem Intermed, Vol. 26: pp.145–52, 2000.

[165] Corma A, Atienzar P, Garcia H, and Chane-Ching J Y, (2004) "*Hierarchically Mesostructured Doped CEO_2 with Potential for Solar-Cell Use*", Nat Mater., Vol. 3: pp. 394–7, 2004.

[166] Singh R S, Rangari V K, Sanagapalli S, Jayaraman V, Mahendra S, and Singh V P, (2004) "*Nano-Structured CdTe, CdS and TiO_2 for Thin Film Solar Cell Applications*", Sol Energy Sol Cells, Vol. 82: pp. 315–30, 2004.

[167] Singh VP, Singh RS, Thompson G W, Jayaraman V, Sanagapalli S, and Rangari V K, (2004) "Characteristics of Nanocrystalline CdS *Films Fabricated By Sonochemical, Microwave And Solution Growth Methods For Solar Cell Applications*", Sol Energy Mater Sol Cells Vol. 81: pp.293–303, 2004.

[168] Mathew X, Enriquez J P, Sebastian P J, McClure J C, and Singh V P, (2000) "*Charge Transport Mechanism in a Typical Au/CdTe Schottky Diode*", Sol Energy Mater Sol Cells, Vol. 63: pp. 355–65, 2000.

[169] Ignatiev A, Chen X, Wu N, Lu Z, Smith L, (2008) "*Nanostructured Thin Solid Oxide Fuel Cells With High Power Density*", Dalton Trans, Vol. 40: pp. 5501–6, 2008.

[170] Neale N R, and Frank A J, (2007) "*Size and Shape Control of Nanocrystallites in Mesoporous TiO2 Films*", J Mater Chem, Vol. 17: pp. 3216–21, 2007.

[171] Bruce P G, Scrosati B, Tarascon J M, (2008) "*Nanomaterials for Rechargeable Lithium Batteries*", Angew Chem Int Ed., Vol. 47: pp.2930–46, 2008.

[172] Agrawal R C, Pandey G P, (2008) "*Solid Polymer Electrolytes: Materials Designing and All-Solid-State Battery Applications: an Overview*", J Phys D Appl Phys, Vol. 41: pp. 223001–19, 2008.

[173] Juanjuan Wang, Shengli Jia, Yang Cao, Wenhao Wang, and Peng Yu, (2018) "*Design Principles for Nanoparticle Plasmon-Enhanced Organic Solar Cells*", Nanoscale Res Lett., Vol. 13: pp. 211, Published online 2018 Jul 16. doi: 10.1186/s11671-018-2620-4.

[174] Goosseff Kyrill A, (2010) "*Autopoeisis and Meaning: A Biological Approach to Bakhtin's Superaddressee*", Journal of Organizational Change Management, Vol. 23 (2): pp.145-151, 2010. https://doi.org/10.1108/09534811011031319

[175] Ramiro-Manzano F, Atienzar P, Rodriguez I, Meseguer F, Garcia H, and Corma A, (2007) "*Apollony Photonic Sponge based Photoelectrochemical Solar Cells*", Chem Commun, Vol. 3: pp. 242–4, 2007.

[176] Rodriguez I, Atienzar P, Ramiro-Manzano F, Meseguer F, Corma A, and Garcia H, (2005) "*Photonic Crystals for Applications in Photoelectrochemical Processes: Photoelectrochemical Solar Cells with Inverse Opal Topology*", Photonics Nanostruct, Vol. 3: pp.148–54, 2005.