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# **NTSE – Nano Technology Science Education**

**Concept paper for the realization of NTSE’s Virtual Lab**

## **Appendix A**

### **Curricula Matches**

**A.1 Curricula matches in Biology, Chemistry and Physics in Turkey**

**A.2 Curricula matches in Biology, Chemistry and Physics in Romania**

**A.3 Curricula matches in Biology, Chemistry and Physics in Bulgaria**

**A.5 Curricula matches in Biology, Chemistry and Physics in Italy**

## Appendix A.1 – Background in Biology for students in Turkey 9<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Common Properties of Living Things		
Fundamental components of Living Things	Inorganic Compounds	
	Organic Compounds: Carbohydrates Lipids Proteins Vitamins Enzymes ATP DNA RNA	* DNA Optical Transform Kit <a href="http://mrsec.wisc.edu/Edetc/supplies/DNA_OTK/index.html">http://mrsec.wisc.edu/Edetc/supplies/DNA_OTK/index.html</a>
The Cell	Parts of the Cell: Organelles Functions of parts of the cell Comparison of prokaryotic and eukaryotic cells	
Classification of Living Things and Diversification of Biological Species	Classification of Living Beings *Bacteria: Classification of Bacteria Reproduction of Bacteria *Archaea *Protozoa *Algae *Fungi *Plants *Animals	
Environment	Air Pollution Water Pollution Soil Pollution	

## 10<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
ATP		
Fermentation (Anaerobic respiration)	*Lactic Acid *Ethanol	
Aerobic Respiration		
Photosynthesis	*Light reactions *Calvin cycle ("dark reactions") *Energy relationships *How its details were discovered	Preparation of an Organic Light Emitting Diode <a href="http://mrsec.wisc.edu/Edetc/SlideShow/index.html">http://mrsec.wisc.edu/Edetc/SlideShow/index.html</a>
Cell Division	*Mitosis *Meiosis	
Reproduction	*Sexual Reproduction *Asexual Reproduction	
Food Chains	*Autotroph *Heterotrophic *Saprophyte	

Ecosystem	*Food Chains *Cycles *Population	
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### 11<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Plant Physiology and Morphology	*Parts of a plant *Plant Tissues *Plant Hormones *Plant Nutrition *Tropisms *Sexual Reproduction in Flowering Plants *Germination	
Genetics	* Mendel's Genetic *Blood Types *Pedigree *Multi-allele *Crossing over *Incomplete Dominance	
Synthesis of Nucleic Acid and Protein	*DNA *RNA *Protein Synthesis	DNA barcode slides <a href="http://mrsec.wisc.edu/Edetc/SlideShow/slides/contents/barcode.html">http://mrsec.wisc.edu/Edetc/SlideShow/slides/contents/barcode.html</a>
Biotechnology	*Cloning *Genetic Breeding *GMO	Quantum Dots: <a href="http://mrsec.wisc.edu/Edetc/background/quantum_dots/index.html">http://mrsec.wisc.edu/Edetc/background/quantum_dots/index.html</a>
Food Chains	*Autotroph *Heterotrophic *Saprophyte	
Ecosystem	*Food Chains *Cycles *Population	

### 12<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activities
Animal Tissues		
Nervous System		
Sense Organs		Nanowire sensor slides <a href="http://mrsec.wisc.edu/Edetc/SlideShow/index.html">http://mrsec.wisc.edu/Edetc/SlideShow/index.html</a>
Endocrine System		
Human Movement and Skeleton System		
Digestive System		
Circulatory System		
Respiratory System		
Excretory System		

## Appendix A.1 – Background in Chemistry for students in Turkey 9<sup>th</sup> degree

TOPIC	Content
Atom	Electron shell structure for chemical elements from 1, 2, 3, *4 periods.
Correlation between the structure of electronic shell and properties of elements	Connection between the electron shell structure, the placement in the Periodic Table and the properties of chemical elements. The variation of periodic properties of chemical elements from primary groups and 1, 2, 3,*4 periods. Ionic bond. Polar and nonpolar covalent bond. Coordinative bond. Hydrogen bond.
Compounds	Electronic Configuration of Atoms. Octet rule. Ionic Compounds. Covalent Compounds.
Mixtures	Homogeneous Mixtures. Heterogeneous Mixtures.
States of Matter	Properties of solid, liquid and gases. General Properties of Gases. Gas Pressure. Gas Laws. Ideal Gases.
Solutions	Dissolution. Factors involved in dissolution. Types of solutions. Solubility. Concentration types of solutions. Equilibrium in solutions. Equilibrium constant of solutions. Factors affecting solubility.
Acids and Bases	Autoionization of water. Definitions of Acids and Bases. Decomposition equilibriums of weak acids and bases. pH and pOH. Neutralization and titration. Hydrolysis. Buffer solutions.
Redox reactions	Oxidation-Reduction Reactions. Applications: Daniell Cell, Lead-Acid battery. The corrosion and anticorrosion protection.
Chemical Equilibrium	The qualitative and quantitative properties of equilibrium. Equilibrium constants ( $K_p$ , $K_c$ , $K_x$ ). Relations between the equilibrium constants. Factors affecting equilibrium constant.

### 10<sup>th</sup> degree

TOPIC	CONTENT
Introduction in organic chemistry	Introduction in Organic Chemistry. Molecular and structure formulas. Organic elements. Chemical bonds in organic compounds. Carbon chain types. Organic compounds classification: hydrocarbons and functional compounds.
Hydrocarbons + source of energy and raw organic matter	Alkanes (formula, structure, izomery, physical and chemical properties) . Alkenes (formula, structure, izomery, physical and chemical properties). Alkynes (formula, structure, izomery, physical and chemical properties). Arenes (formula, structure, izomery, physical and chemical properties, benzene, touene, naphtalene).
Hydrocarbon Derivates	Alcohols (methanol, ethanol, glycerine, acetic fermentation). Carboxilic acids (acetic acid, grease acids).
Organic compounds with biological activity	Greases. Proteins. Carbohidrates. Soaps and detergents. Drugs. Vitamins.
Fuels	Methane, oil fractions, coals. Petroleum: source of organic raw material. Petroleum processing.
Macromoleculare compounds	Natural and syntetic rubber. Plastic materials. Natural and syntetic fibres.
Dyes	Natural ans syntetic dyes. Dyes for fibres and food.

### 11<sup>th</sup> degree

TOPIC	CONTENT
Compounds with monovalent functional groups	Halogenated compounds. Hydroxilic compounds. Amines.
Compounds with di and trivalent functional groups	Carbonilic compounds. Carboxilic compounds and derivatives.
Compounds with mixed functional groups	Aminoacids. Hydroxiacids. Carbohydrates. Nucleic acids. AND. ARN.
Reactions of Organic Chemistry	Substitution. Adition. Elimination. Transpozition.
Organic compounds with biological activity	Introduction in biochemistry. General information.



## 12<sup>th</sup> degree

TOPIC	CONTENT
Chemical reactions in inorganic and organic chemistry	Redox reactions. Acid-base reactions. Precipitation reactions. Complexation reactions. Endothermic and exothermic reactions. Fast and slow reactions.
Chemical kinetics	Reaction speed. Reaction order. Calculating the speed of reactions. Reaction Mechanisms. Collision Theory. Activation Energy. Factors that affect Reaction Speed. Catalyzers. Inhibitors.
Chemical Reactions and Energy	Systems and Energy. 1st Law of Thermodynamics. Enthalphy. Laws of Thermochemistry (Lavoisier-Laplace, Hess). Heat Dissolution. Combustion heat. Neutralisation heat. Entrophy. Free Energy.
Electrochemistry	Redox reactions. Electrochemical Batteries. Faraday Laws. Electrolysis.

## Appendix A.1 – Background in Physics for students in Turkey 9<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
The nature of physics	<ul style="list-style-type: none"> <li>*Branches of physics</li> <li>*Base quantities - derived quantities</li> <li>*Conversion of unit</li> <li>*Scales</li> <li>*Scalar quantities – vector quantities</li> <li>*Calculations of volume</li> </ul>	Size and Scale <a href="http://mrsec.wisc.edu/Edetc/nanoscale/index.html">http://mrsec.wisc.edu/Edetc/nanoscale/index.html</a>
Work, Power and Energy		
Heat, Temperature and Phase Changes	<ul style="list-style-type: none"> <li>*Thermometer</li> <li>*Specific heat</li> </ul>	Preparation of a Cholesteryl Ester Liquid Crystal Thermometer <a href="http://mrsec.wisc.edu/Edetc/nanolab/LC_prep/index2.html">http://mrsec.wisc.edu/Edetc/nanolab/LC_prep/index2.html</a>
Properties of matter	<ul style="list-style-type: none"> <li>*Common characteristics of matter</li> <li>*Distinguishing features of matter</li> <li>*Density</li> <li>*Physical, chemical and nuclear change</li> </ul>	
Motion	<ul style="list-style-type: none"> <li>Position</li> <li>Velocity</li> <li>Acceleration</li> </ul>	
Force	<ul style="list-style-type: none"> <li>*The four fundamental forces</li> <li>*Gravitational force</li> <li>*Newton's laws</li> <li>*Force of friction</li> </ul>	
Electric current and the effects of electricity	<ul style="list-style-type: none"> <li>*Current intensity</li> <li>*Resistance</li> <li>*Ohm's Law</li> <li>*Series and Parallel Resistor</li> <li>*Serial and Parallel Battery</li> <li>*Magnets</li> <li>*The Earth's magnetic field</li> </ul>	Periodic Properties and Light Emitting Diodes <a href="http://mrsec.wisc.edu/Edetc/nanolab/LED/index.html">http://mrsec.wisc.edu/Edetc/nanolab/LED/index.html</a>
Waves	<ul style="list-style-type: none"> <li>*Wave frequency, period,</li> </ul>	

	wavelength, wave speed *Sound wave *Seismic waves *Electromagnetic wave, electromagnetic spectrum	
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### 10<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Properties of matter	*Stability *Adhesion, cohesion *Surface tension *Capillarity *Gases in the atmosphere *Plasma	Lotus Effect Activity: <a href="http://mrsec.wisc.edu/Edetc/EExpo/surfaces/index.html">http://mrsec.wisc.edu/Edetc/EExpo/surfaces/index.html</a>
Force and Vector	*Forces *Resultant vector	
Linear motion	*Speed *Velocity *Distance *Relative speed *Velocity-time graphs *Distance-time graphs *Acceleration-time graphs	
Motion on Earth	*Free fall *Motion in Two Dimensions *Uniform Circular Motion *Air resistance	
Newton's laws of motion	*First law *Second law *Third law *Friction force *Inertia	
Electrostatic	*Electric charge *Coulomb Law *Electric field and electric potential *Electric current and the effects of electricity	Preparation of a Fuel Cell <a href="http://mrsec.wisc.edu/Edetc/nanolab/fuelcell/index.html">http://mrsec.wisc.edu/Edetc/nanolab/fuelcell/index.html</a>
Modern Physics	*Principle of relativity *Michelson–Morley	



	experiment	
Waves	*Helical Springs *Waves on a spring *Waves on water	*NiTi Shape Memory Alloy Springs <a href="http://mrsec.wisc.edu/Edetc/nanolab/spring/indexX.html">http://mrsec.wisc.edu/Edetc/nanolab/spring/indexX.html</a>

### 11<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Pressure	*Pressure in solids *Pressure in liquids *Pressure in Gases	
Buoyancy	*Buoyancy of liquids *Buoyancy of Air	
Heat, temperature and thermal expansion	*Heat *Temperature *Internal Energy *Heat Exchange *Specific Heat *Thermal Expansion	
Work and energy	*Kinetic Energy *Potential Energy *Translational Kinetic Energy *Rotational Kinetic Energy *Energy changes on Friction Surfaces *Potential Energy of Flexibility *Conservation of Mechanical Energy	
Impulse and momentum	*Momentum *Impulse *Conservation of Momentum *Elastic Collision *Inelastic Collision	
Torque and Angular Momentum	*Torque and direction of rotation *Conservation of angular momentum *Kepler Laws	

Balance and center of mass	<ul style="list-style-type: none"> <li>*Balance</li> <li>*Mass and Center of Weight</li> <li>*Equal Arm Balance</li> <li>*Balance in Simple Machines</li> </ul>	
Magnetism	<ul style="list-style-type: none"> <li>*Magnetic Fields</li> <li>*Magnetic Fields around magnets</li> <li>*Magnetic fields on a wire</li> <li>*Electromagnetic Induction</li> </ul>	<ul style="list-style-type: none"> <li>*Giant Magneto Resistance  <a href="http://mrsec.wisc.edu/Edetc/cineplex/GMR/index.html">http://mrsec.wisc.edu/Edetc/cineplex/GMR/index.html</a></li> <li>*Ferrofluid Activity:  <a href="http://mrsec.wisc.edu/Edetc/EExpo/ferrofluid/index.html">http://mrsec.wisc.edu/Edetc/EExpo/ferrofluid/index.html</a></li> </ul>
Photoelectric and Compton effect	<ul style="list-style-type: none"> <li>*Quantum Physics</li> <li>*Black Body</li> <li>*Photon and its energy</li> <li>*Photoelectric</li> <li>*Compton Effect</li> </ul>	LED Color Stip Kit <a href="http://mrsec.wisc.edu/Edetc/SlideShow/index.html">http://mrsec.wisc.edu/Edetc/SlideShow/index.html</a>
Structure of Atom	<ul style="list-style-type: none"> <li>*Models of atom</li> <li>*Quantum Numbers</li> <li>*Stimulation of the atom</li> <li>*Lasers</li> </ul>	Solid-State Model Kit <a href="http://mrsec.wisc.edu/Edetc/SlideShow/index.html">http://mrsec.wisc.edu/Edetc/SlideShow/index.html</a>
Sound waves	<ul style="list-style-type: none"> <li>*Sound Propagation</li> <li>*Frequency of sound</li> <li>*Doppler Effect</li> <li>*Supersonic</li> <li>*Forced Vibration and resonance</li> <li>*Absorbtion and adsorbtion of sound</li> <li>*Diffraction of sound</li> <li>*Sound interference</li> </ul>	
Enlightenment	<ul style="list-style-type: none"> <li>*Light</li> <li>*Shadow</li> <li>*Photometers</li> <li>*Crookes Radiometer</li> </ul>	Preparation of an Organic Light Emitting Diode <a href="http://mrsec.wisc.edu/Edetc/SlideShow/index.html">http://mrsec.wisc.edu/Edetc/SlideShow/index.html</a>
Stars	<ul style="list-style-type: none"> <li>*Formation and structure of Stars</li> <li>*Electromagnetic Spectrum of stars</li> <li>*Classification of</li> </ul>	



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	stars according to the heat and spectrums *Supernova *Galaxies *Hubble Law	
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## Appendix A.2 – Background in Biology for students in Romania 9<sup>th</sup> degree

TOPIC	CONTENT
Common Properties of Living Things	World diversity. Introduction.
Classification of Living Things and Diversification of Biological Species	Classification of Living Beings *Bacteria: Classification of Bacteria Reproduction of Bacteria *Archaea *Protozoa *Algae *Fungi *Plants *Animals
The Cell	Parts of the Cell: Organelles Functions of parts of the cell Comparison of prokaryotic and eukaryotic cells Division of cell
Cell Division	Mitosis, Meiosis
Heredity and variability of living world	heredity, variability, mechanisms of heredity, genetic recombination, chromosomal determinism of sexes, environment influence on heredity, human genetics, genetic engineering

## 10<sup>th</sup> degree

TOPIC	Content
Vegetal and animal tissues (classification, structure, role)	Vegetal tissues (embryonic, final); Animal Tissues (epithelial, conjunctive, muscle, nervous)
Structure and functions of living organisms	<b>Nutrition</b> function (Nutrition - autotrophic and heterotrophic. Breathing - aerobic, anaerobic, plants, animals. Circulation - plants and animals. Excretion - plants and animals.) <b>Relationship</b> function (Sensitivity. Locomotion). <b>Reproduction</b> function (Plants and animals)
Ecological disequilibrium	Causes, effects and measures

## 11<sup>th</sup> degree

TOPIC	CONTENT
Human body composition	Topography of organs and organ systems
Basic functions of human body	Relationship functions (nervous system, analyzers, endocrine glands, skeleton, muscles). Nutrition function (digestion and absorption, circulation, breathing, excretion). Reproduction function (reproduction system, reproduction health, hygiene and pathology)

## 12<sup>th</sup> degree

TOPIC	BACKGROUND
Genetics	Molecular genetics. Human genetics.
Human ecology	Characteristics of anthropic ecosystems and method of investigation. Human impact on natural ecosystems (chemical pollution, habitat degradation, overexploitation of biological resources, urbanization and industrialization, environmental damage by pollution)

## Appendix A.2 – Background in Chemistry for students in Romania 9<sup>th</sup> degree

TOPIC	Content
Atom	Electron shell structure for chemical elements from 1, 2, 3, *4 periods.
Correlation between the structure of electronic shell and properties of elements	Connection between the electron shell structure, the placement in the Periodic Table and the properties of chemical elements. The variation of periodic properties of chemical elements from primary groups and 1, 2, 3,*4 periods. Ionic bond. Polar and nonpolar covalent bond. Coordinative bond. Hydrogen bond.
Compounds	Electronic Configuration of Atoms. Octet rule. Ionic Compounds. Covalent Compounds.
Mixtures	Homogeneous Mixtures. Heterogeneous Mixtures.
States of Matter	Properties of solid, liquid and gases. General Properties of Gases. Gas Pressure. Gas Laws. Ideal Gases.
Solutions	Dissolution. Factors involved in dissolution. Types of solutions. Solubility. Concentration types of solutions. Equilibrium in solutions. Equilibrium constant of solutions. Factors affecting solubility.
Acids and Bases	Autoionization of water. Definitions of Acids and Bases. Decomposition equilibriums of weak acids and bases. pH and pOH. Neutralization and titration. Hydrolysis. Buffer solutions.
Redox reactions	Oxidation-Reduction Reactions. Applications: Daniell Cell, Lead-Acid battery. The corrosion and anticorrosion protection.
Chemical Equilibrium	The qualitative and quantitative properties of equilibrium. Equilibrium constants ( $K_p$ , $K_c$ , $K_x$ ). Relations between the equilibrium constants. Factors affecting equilibrium constant.

## 10<sup>th</sup> degree

TOPIC	CONTENT
Introduction in organic chemistry	Introduction in Organic Chemistry. Molecular and structure formulas. Organic elements. Chemical bonds in organic compounds. Carbon chain types. Organic compounds classification: hydrocarbons and functional compounds.
Hydrocarbons + source of energy and raw organic matter	Alkanes (formula, structure, isomerism, physical and chemical properties). Alkenes (formula, structure, isomerism, physical and chemical properties). Alkynes (formula, structure, isomerism, physical and chemical properties). Arenes (formula, structure, isomerism, physical and chemical properties, benzene, toluene, naphthalene).
Hydrocarbon Derivates	Alcohols (methanol, ethanol, glycerine, acetic fermentation). Carboxylic acids (acetic acid, grease acids).
Organic compounds with biological activity	Greases. Proteins. Carbohydrates. Soaps and detergents. Drugs. Vitamins.
Fuels	Methane, oil fractions, coals. Petroleum: source of organic raw material. Petroleum processing.
Macromolecular compounds	Natural and synthetic rubber. Plastic materials. Natural and synthetic fibres.
Dyes	Natural and synthetic dyes. Dyes for fibres and food.

## 11<sup>th</sup> degree

TOPIC	CONTENT
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Compounds with monovalent functional groups	Halogenated compounds. Hydroxilic compounds. Amines.
Compounds with di and trivalent functional groups	Carbonilic compounds. Carboxilic compounds and derivatives.
Compounds with mixed functional groups	Aminoacids. Hydroxiacids. Carbohydrates. Nucleic acids. AND. ARN.
Reactions of Organic Chemistry	Substitution. Adition. Elimination. Transpozition.
Organic compounds with biological activity	Introduction in biochemistry. General information.

## 12<sup>th</sup> degree

TOPIC	CONTENT
Chemical reactions in inorganic and organic chemistry	Redox reactions. Acid-base reactions. Precipitation reactions. Complexation reactions. Endothermic and exothermic reactions. Fast and slow reactions.
Chemical kinetics	Reaction speed. Reaction order. Calculating the speed of reactions. Reaction Mechanisms. Collision Theory. Activation Energy. Factors that affect Reaction Speed. Catalyzers. Inhibitors.
Chemical Reactions and Energy	Systems and Energy. 1st Law of Thermodynamics. Enthalphy. Laws of Thermochemistry (Lavoisier-Laplace, Hess). Heat Dissolution. Combustion heat. Neutralisation heat. Entrophy. Free Energy.
Electrochemistry	Redox reactions. Electrochemical Batteries. Faraday Laws. Electrolysis.

## Appendix A.2 – Background in Physics for students in Romania 9<sup>th</sup> degree

TOPIC	CONTENT
Optics	Reflection and refraction. Thin lenses. Systems of lenses. Human eye. Optical instruments.
Principles and Laws of Classical Mechanics	Motion and rest. Classical Mechanics Principles (1-3). Hooke Law. Elastic limit. Law of sliding friction. Universal attraction law.
Variation Theorems and Conservation Laws in Mechanics	Mechanical work. Power. Theorem of kinetic energy variation of the material point. Gravitational and *elastic potential energy. Law of conservation of mechanical energy. *Impulse variation theorem.
Elements of Statics	Translation balance. Rotation balance.

## 10<sup>th</sup> degree

TOPIC	CONTENT
Thermodynamics	Elements of thermodynamics. Calorimetry. 1st Law of Thermodynamics. 1st Law of thermodynamics applications to ideal gases transformations. Change of the aggregation state. Thermal engines.*2nd Law of Thermodynamics.
Production and use of direct current (DC)	Electric current. Ohm's Law. Kirchhoff's Laws. Series and Parallel Resistor Combinations. Serial and Parallel Battery. Energy and electric power. Applications.
Production and use of alternating current (AC)	Alternating current. Elements of circuits. Energy and power in alternating current. Rectifier. Electric engines. Home appliance.

## 11<sup>th</sup> degree

TOPIC	CONTENT
Oscillations and Mechanic Waves.	Oscillations in nature and technique. Oscillations characteristics. Mechanic oscillator. Coupled mechanical oscillators. Mechanical waves. Seismic waves. Reflection, refraction, interference of mechanical waves. Stationary waves. Acoustics. Ultrasounds and infrasounds. Applications in medicine, industry and military techniques.
Oscillations and Electromagnetic Waves.	RLC in alternating current. Electromagnetic oscillations in RLC circuit. Electromagnetic field. Electromagnetic waves. Classification of electromagnetic waves. Applications.
Optical Waves	Light dispersion. Interference. Young's Device. Localized interference. Applications. *Light diffraction. Applications. *Light polarization. Applications.
*Elements of Chaos Theory	*Determinism and predictability. Conditions. Models. *Determinism and unpredictability. Chaotic behaviour. Conditions. *Description of chaotic behaviour. Phases space. Strange and classical attractors. *Elements of fractal geometry.

## 12<sup>th</sup> degree

TOPIC	CONTENT
Special Theory of Relativity	Introduction. Classical relativity. Michelson's Experiment. STR Postulates. Lorentz's transformations. Consequences.



	Elements of relativistic kinematics. Bases of relativistic dynamics. Composition of velocities. Relativistic mechanics. Mass - Energy relation.
Elements of Quantum Physics	External photoelectric effect. Laws of external photoelectric effect. Planck's Hypothesis. Einstein's Hypothesis. Einstein's Equation. De Broglie's Hypothesis. Electron diffraction. Applications. Wave-particle dualism. *Compton Effect.
Atomic Physics	Spectra. Rutherford experiment. The Planetary Model of Atom. Franck-Hertz Experiment. Bohr Model. X-Rays.
Semiconductors. Applications in Electronics.	Electrical conduction in metals and semiconductors. Intrinsic and extrinsic semiconductors. Semiconductor diode. AC Recovery.
Nuclear Physics	General properties of nucleus. Core energy. Nucleus stability. Radioactivity. Radioactive Dezintegration Laws. Interaction between nuclear radiation and substance. Nuclear radiation detection. Dosimetry. Nuclear fission. Nuclear reactors. Nuclear fusion. *Particle accelerators. *Elementary particles.



## Appendix A.3 – Background in Biology for students in Bulgaria and nanorelated topics

### 8<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Toxicology		Negative impact of nanoparticles on human health used in Pharmaceutical, Food and Cosmetic industry
Digestive system	organic and inorganic foods compounds, Agrocultures	Nano food definition

### 9<sup>th</sup> degree

Topic	Background	Mathcing nano activities
Chemical compounds in the cell		Cancer and medicines nano transportation
Environmental protection	Pedosphere protection	Nano fertilizers (nanonutrient transporters, nanopesticides transporters, nano plant growth regulators transporters, nano herbicides transporters)
Viruses and diseases	Detection of viruces	Nano assistant

### 10<sup>th</sup> degree

Topic	Background	Matching nano activities
Genetics	inheritance, Discrete inheritance and Mendel's laws, Molecular basis for inheritance (DNA and chromosomes, Reproduction, Recombination and linkage)	Nano tools for DNA transport, Nano harmful effects on DNA
Natural mechanisms		Natural nanomechanisms /new one

## Appendix A.3 – Background in Chemistry for students in Bulgaria and nanorelated topics

### 6<sup>th</sup> degree

Topic	Background	matching nano tech activity
The Growth and Development of Plants	Plant Development	Nano transporters, mediators in Nature
The Substances - Composition and Structure	Substances in Nature and Practice	Nano self-assembly; nanofabrication
	Hydrogen production and storage	Hydrogen storage
	Conductors	Nano electric conductors
	Physical Phenomena (review)	nanometrics

### 7<sup>th</sup> degree

Topic	Background	Matching Nano tech activity
Substances and materials	Types of Substances, Simple Substances	Description of nanoparticles / their production from various substances
Organic Chemistry	Petrol Products	Lubricants
	Fuels	Nano futer for Fuels
	Fibres	Nano particles in fibres
Cathalysis	Bio-cathalyzers	Enzyms nano transporters
Processes	Polymers	Nano control of polymerization

### 9<sup>th</sup> degree

Topic	Background	Matching Nanotech activity
Elements from 4th A group	Carbon	Fullerene, Carbon Nanotubes and structures
Aromatic Compounds	Petrol and Natural Gas	Nanotube based storage
	Petrol and Natural Gas	Hydrogen as Fuel, Hydrogen Storage
Chemical Bonds		
	Structure of Substances	Van der Waals interactions etc
	Bonds	The nature of bonds In nanostructures

### 10<sup>th</sup> degree

Topic	Background	Matching Nano activities
Oxidation Reduction Processes	Burning	Fuel Cells



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Cathalysis	Cathalysis - chemical processes	Nanostructures improving the cathalysis
	Noble Metals	Monolayers
Dyes		Nano-security/nanoparticles in security systems

### **11<sup>th</sup> degree**

Topic	Background	Matching nanotech activities
Fats	Soaps and synthetic detergents	Nano Applications, surfactants etc
Solutions	Colloid Solutions	Sol/Gel Applications
Energy production and carriers	Organic Photovoltaic Elements	Nanoparticles in photovoltaic elements

## Appendix A.3 – Background in Physics for students in Bulgaria and nanorelated topics

### 7<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Electrical Current	*Electrical Charges *Movement of Charges * Voltage *Ohm's Law and Conductivity *Resistors	
Electrical Cuircuits	* Sources of Voltage * Resistors in Series and in Parallel	
Electrical Energy	* Electrical Energy in a Current *Electrical Power *Energy Pduction and Economy, Ecological Aspects	
Magnetic Action of the Electric Current	*Electrically produced Magnetic Field *Electric Motor, Stator, Rotor *Magnetic Levitation and Use in Transport *Linear Electric Engine	
Propagation of Light	Sources of Light, LEDs etc, Transparency, Shadowing, The Speed of Light, Reflection and Refraction, Total Internal Refraction and Light Guides	
Light and Colours	Perception of Light, Mixing Colours	The Colours of the Substances when Viewed , Holographics and Fringes etc.
Mirrors and Lenses		
Optical Devices	The Eye, Photocameras and CCD , Optical Sensors, (Electromagnetic Frequency Spectrum)	
Sound	*Audible Sound, Ultrasound, Infrasound *Sound Propagation *Speed of Sound *Sounds in Music Noise, Sound reduction etc. Speakers and Microphones Applications of Ultrasound etc	
Atoms and Atomic Nuclei	*Atomic Structure *Radioactivity *Use of Nuclear Energy *Nuclear Fusion *Purification Methods For Mixtures , Ecological Aspects	
The Solar System and the World of the Stars	From Atoms to Space	

### 8<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Mechanical Motion	Uniform Motion, Acceleration etc	
Principles of Mechanics	Newton's Second Law	
Mechanical Work	Transformation of Mechanical Energy	MEMS, NEMS etc



and Energy		
Mechanical Equilibrium and Simple Mechanisms		Nano Levers etc
Mechanics of Liquids and Gases	Hydrostatic Pressure etc	Pressure sensors etc
Heat and Motion	Thermal Conductivity and Insulation	Thermal conductivity Nanostructured Thermal Insulators
Energy Conservation for Thermal Processes	Heat Transfer etc	
Ideal Gas		
Phase Transitions in Substances		
Thermal Machines	Ecological Aspects	Thermal Conservation with Good insulators etc, Effectiveness

### 9<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Electrostatics / Electrostatic Interaction	*Electrostatic Potential      *Charged particles in Electrostatic Potential	Electrostatic charges on nanosurfaces
Homogeneous Electrostatic Field	Electrical Double Layers, Electrical Capacity, Capacitors	electrical double nanolayers
Conductors and Dielectrics	Electrical Field in Dielectrics	Conductivity of carbon structures and electronics, supercapacitors + electrochemical sources, (piezo effects etc)
Electrical Current / Direct Electrical Current, Electric Circuits	Electrical Current in Conductors, Moving Charges, Electrical Measurements	Conductivity of nanostructures, carbon structures, surface electromigration, Biomolecular electronics
Electrical Current in Various Media	Electrical Current in Metals, Electrolytes, Semiconductors, Electrical Power etc Semiconductor Devices (diodes, transistors, LEDs)	Nanoelectronics, nanotransistors, Liquid Crystals, LEDs etc
Magnetic Interactions	Magnetic field, magnetism	magnetic nanostructures, carbon tubes with metals, magnetic nanoparticles for therapeutic use, magnetosomes
Magnetic Materials	Magnetic properties of the materials	Magnetic Fluids and Liquids, ferrofluids, superparamagnetics etc
Electromagnetic Induction and Alternate Currents	Electromagnetic induction, AC Voltages and Currents	Biological motors, molecular rotors/stators etc
Electromagnetic Interactions	*Magnetic Field      *Charged Particles in Magnetic Field      *Magnetic Field of Electrical Currents      *Magnetic Properties of the Substances and their Origins	Magnetic Nanostructures, ferromagnetic nanoparticles, colossal magnetoresistance etc
Mechanical Oscillations and Waves / Harmonic Vibration	Definitions of wave characteristics	Examples from nanoworld
Mechanical Waves	Interference and Reflection, Types of Mechanical waves	Illustrations from nanoworld, surface electron waves, X-ray diffraction etc
Sound	Ultrasound and Infrasound	Ultrasound pressing of nanoparticles
Electromagnetic Waves	The Spectrum of Electromagnetic Waves	Ultraviolet and X-ray Lithography, quantum dots, nanophotonics, LEDs, lasers as light sources, applications etc

### 10<sup>th</sup> degree

TOPIC	BACKGROUND	Matching Nanotech Activity
Propagation of Light, Reflection and Refraction	Light reflection and refraction, optical surfaces etc	Optical tweezers and optical traps, optical waveguides, photonic crystal fibers, light propagation across surfaces



Light - Wave Phenomena	Photons and Quantization of Light, Photoeffect	Lithography at nanoscale, Photonic crystals, photonic integrated circuits etc
Infrared, Ultraviolet and X-ray Emissions		Ultraviolet and X-ray Lithography, quantum dots, nanophotonics, LEDs, etc
Quantization of Light and Wave properties of the Particles		photonic crystals, laser diodes, etc
Atoms and Atomic Transitions	Atomic Structure	self-assembly, atomic force microscopy etc

**11<sup>th</sup>, 12<sup>th</sup> degree- only in 12<sup>th</sup> grade some additional contents is offered in the form of optional chapters with modern physics topics**

## Appendix A.5 – Background in Biology for student of Classic Lyceum In Italy 11<sup>th</sup> degree

Subject	Topic	Matching Nanotech Activities
Botany and zoology	Descriptive and comparative analysis of both plants and animals emphasizing the main taxonomic differences (e.g.: monocotyledons and dicotyledons, invertebrate and vertebrate, etc.) and classifying the living beings according with their progressive complexity. First outlines of physiological mechanics in order to let the students understand an evolutonal conception of life	Preparation of an Organic Light Emitting Diode <a href="http://mrsec.wisc.edu/Edetc/SlideShow/index.html">http://mrsec.wisc.edu/Edetc/SlideShow/index.html</a> Nanowire sensor slides <a href="http://mrsec.wisc.edu/Edetc/SlideShow/index.html">http://mrsec.wisc.edu/Edetc/SlideShow/index.html</a>

## 12<sup>th</sup> degree

Subject	Topic	Matching Nanotech Activities
Genetics	Deeper analysis of living being considering the process of development of the cell and its progressive differentiations in tissues and organs. Vegetal, animal (and human) anatomy and physiology . During the 12th degree the study of biology, physiology and genetics is stricly related to the study of general and organic chemistry	DNA Optical Transform Kit <a href="http://mrsec.wisc.edu/Edetc/supplies/DNA_OTK/index.html">http://mrsec.wisc.edu/Edetc/supplies/DNA_OTK/index.html</a> DNA barcode slides <a href="http://mrsec.wisc.edu/Edetc/SlideShow/slides/contents/barcode.html">http://mrsec.wisc.edu/Edetc/SlideShow/slides/contents/barcode.html</a> Quantum Dots: <a href="http://mrsec.wisc.edu/Edetc/background/quantum_dots/index.html">http://mrsec.wisc.edu/Edetc/background/quantum_dots/index.html</a>
Vegetal, animal and human phydiology		
Hygiene	Outlines of hygiene	



## Appendix A.5 – Background in Chemistry for student of Classic Lyceum In Italy and nanorelated topics 12<sup>th</sup> degree

Subject	Topic	Matching Nanotech Activities
General chemistry	Matter structure: atoms and molecules; atomic and molecular weight. Modern theories related to the structure of the atoms. Basic phenomena in chemistry. Symbols, formulas and equations in chemistry. Valence. Chemical nomenclature. Periodic Table Ions and electrolytes: theories in electrolytic dissociation. Acids, bases and salts.	X-Ray Diffraction and Scanning Probe Microscopy <a href="http://mrsec.wisc.edu/Edetc/modules/HighSchool/xray/index.html">http://mrsec.wisc.edu/Edetc/modules/HighSchool/xray/index.html</a> Solid-State Model Kit <a href="http://mrsec.wisc.edu/Edetc/supplies/SSMK/index.html">http://mrsec.wisc.edu/Edetc/supplies/SSMK/index.html</a> Amorphous Metal Activity <a href="http://mrsec.wisc.edu/Edetc/EExpo/amorphous/index.html">http://mrsec.wisc.edu/Edetc/EExpo/amorphous/index.html</a> Citrate Synthesis of Gold Nanoparticles: <a href="http://mrsec.wisc.edu/Edetc/nanolab/gold/index.html">http://mrsec.wisc.edu/Edetc/nanolab/gold/index.html</a>
Mineralogy	Minerals and rocks. Crystal and their composition. Axis and planes of symmetry ; crystallographic axis and their parameters. Crystallographic systems and habits. Physical properties of minerals	some of the above listed activities can be related also to mineralogy
Organic chemistry	Outlines of carbon compounds. Structure formulas. Cyclic and acyclic compounds. Isomers and polymers. Outlines on hydrocarbons (saturate and not) and aromatic hydrocarbons. Mineral oils and their by-product. Alcools, aldehyde , organic acids, phenols, ethers, salts, greases. Outlines on amines, alkaloids and proteinic substance	some of the above listed activities can be related also to organic chemistry

## Appendix A.5 – Background in Physics for student of Classic Lyceum In Italy and nanorelated topics 12<sup>th</sup> degree

Subject	Topic	Matching Nanotech Activities
Basic skills	Branches of physics Base quantities - derived quantities Conversion of unit Scales Scalar quantities – vector quantities Calculations of volume	Size and Scale <a href="http://mrsec.wisc.edu/Edetc/nanoscale/index.html">http://mrsec.wisc.edu/Edetc/nanoscale/index.html</a>
Kynematics	motion; speed and acceleration as scalars and as vectors. Rectilinear motion.	
Mechanics and dynamics	Forces and their static measure. Equilibrium among forces on a solid body. F orces centre in a solid body. Simple machines. Inertia principle. Relationship among force and acceleration. Mass and weight; dynamical measure of forces. Action and reaction principle: centripetal force and centrifugal reaction. Falling bodies free and on inclined plane. Projectiles motion. Pendulum. Work, power and their units. Energy, conservation of energy principle. Friction.	
Dynamics of fluids	Pressure in fluids. Pascal's and Archimedes principles. Atmospheric pressure. Law of Boyle. Outlines of dynamics of fluids.	