Glossary

January 4, 2010

1 Definitions.

AMP see adenosine monophosphate

adenine a compound that is one of the four constituent bases of nucleic acids. A purine derivative, it is paired with thymine in double-stranded DNA.

Alternative name: 6-aminopurine; chem. formula: $C_5H_5N_5$.

adenosine monophosphate a compound consisting of an adenosine molecule bonded to one acidic phosphate group, present in most DNA and RNA. It often exists in a cyclic form with the phosphate bonded to the nucleoside at two points.

adenosine triphosphate (ATP) a compound consisting of an adenosine molecule bonded to three phosphate groups, present in all living tissue. The breakage of one phosphate linkage (to form adenosine diphosphate, ADP) provides energy for physiological processes such as muscular contraction.

adipocyte a cell specialized for the storage of fat, found in connective tissue.

amphiphile describes a chemical compound possessing both hydrophilic (water-loving) and lipophilic (Fat-liking) properties. Such a compound is called amphiphilic or amphipathic.

anaphase the stage of meiotic or mitotic cell division in which the chromosomes move away from one another to opposite poles of the spindle.

association the linking of molecules through hydrogen bonding or other interaction short of full bond formation.

atomic mass unit the unified atomic mass unit or atomic mass unit (u), or dalton (Da) or, sometimes, universal mass unit (u), is a unit of mass used to express atomic and molecular masses. It is the approximate mass of a hydrogen atom, a proton, or a neutron.

The precise definition is that the atomic mass unit (u) is one twelfth of the mass of an isolated atom of carbon-12 (12C) at rest and in its ground state

ATP (adenosine triphosphate) the universal phosphate donor of the cell

autophosphorylation occurs when a kinase phosphorylates itself

bifurcation analysis

bifurcation diagrams In mathematics, particularly in dynamical systems, a bifurcation diagram shows the possible long-term values (equilibria/fixed points or periodic orbits) of a system as a function of a bifurcation parameter in the system. It is usual to represent stable solutions with a solid line and unstable solutions with a dotted line.

bifurcation theory Bifurcation theory is the mathematical study of changes in the qualitative or topological structure of a given family. Examples of such families are the integral curves of a family of vector fields or, the solutions of a family of differential equations. Most commonly applied to the mathematical study of dynamical systems, a bifurcation occurs when a small smooth change made to the parameter values (the bifurcation parameters) of a system causes a sudden 'qualitative' or topological change in its behaviour. Bifurcations occur in both continuous systems (described by ODEs, DDEs or PDEs), and discrete systems (described by maps).

biochemical kinetics the study of biochemical reaction rates

biosynthesis 1. the production of complex molecules within living organisms or cells.

2. an enzyme-catalyzed process in cells of living organisms by which substrates are converted to more complex products. The biosynthesis process often consists of several enzymatic steps in which the product of one step is used as substrate in the following step.

C-terminus of a protein or polypeptide the end of the amino acid chain terminated by a free carboxyl group (-COOH).

Also known as the carboxyl-terminus, carboxy-terminus, C-terminal end, or COOH-terminus.

calmodulin a protein that binds calcium and is involved in regulating a variety of activities in cells.

carboxyl of or denoting the acid radical -COOH, present in most organic acids

Cell cycle The cell cycle, or cell-division cycle, is the series of events that take place in a cell leading to its division and duplication (replication).

centromere the point on a chromosome by which it is attached to a spindle fiber during cell division.

checkpoint Cell cycle checkpoints are control mechanisms that ensure the fidelity of cell division in eukaryotic cells. These checkpoints verify whether the processes at each phase of the cell cycle have been accurately completed before progression into the next phase.

chromatid each of the two threadlike strands into which a chromosome divides longitudinally during cell division. Each contains a double helix of DNA.

chromatin the material of which the chromosomes of organisms other than bacteria (i.e., eukaryotes) are composed. It consists of protein, RNA, and DNA.

chromosome a threadlike structure of nucleic acids and protein found in the nucleus of most living cells, carrying genetic information in the form of genes.

Each chromosome consists of a DNA double helix bearing a linear sequence of genes, coiled and recoiled around aggregated proteins (histones). Their number varies from species to species: humans have 22 pairs plus the two sex chromosomes (two X chromosomes in females, one X and one Y in males). During cell division, each DNA strand is duplicated, and the chromosomes condense to become visible as distinct pairs of chromatids joined at the centromere. Bacteria and viruses lack a nucleus and have a single chromosome without histones.

codon a sequence of three nucleotides which together form a unit of genetic code in a DNA or RNA molecule.

complementary DNA (cDNA) synthetic DNA in which the sequence of bases is complementary to that of a given example of DNA.

congression a process that governs movement of partner/sister chromosomes to the spindle equator and ensures equapartition of chromosomes. Failure in chromosome congression due to malorientation or misattachment will lead to either the activation of spindle checkpoint that blocks anaphase chromosome segregation or a disastrous chromosome distribution into the daughter cells.

constitutive happening without stimulation, as part of normal functioning of a biological unit; a constitutive protein is one that is constantly active and a gene product is constitutive if it is made all the time.

covalent bond : a form of chemical bonding that is characterized by the sharing of pairs of electrons between atoms, or between atoms and other covalent bonds. In short, attraction-to-repulsion stability that forms between atoms when they share electrons is known as covalent bonding. Another, weaker form of bond is an *ionic bond*.

covalent modification Enzymes can be regulated by transfer of a molecule or atom from a donor to an amino acid side chain that serves as the acceptor of the transferred molecule. Another way of regulating an enzyme is by altering the amino acid sequence itself by proteolytic cleavage.

Cyclin any of a number of proteins associated with the cycle of cell division that are thought to initiate certain processes of mitosis.

Cyclin-dependent kinase (cdk) Cyclin-dependent kinases (CDK) belong to a group of protein kinases originally discovered as being involved in the regulation of the cell cycle. CDKs are also involved in the regulation of transcription and mRNA processing. CDKs phosphorylate proteins on serine and threonine amino acid residues: they are serine/threonine kinases. A cyclin-dependent kinase is activated by association with a cyclin, forming a cyclin-dependent kinase complex.

cyclin-dependent kinase inhibitor (CKI)

cysteine (abbreviated as Cys or C) is an α-amino acid with the chemical formula $HO_2CCH(NH_2)CH_2SH$. It is a non-essential amino acid, which means that it is biosynthesized in humans. Its codons are UGU and UGC. The side chain on cysteine is thiol, which is nonpolar and thus cysteine is usually classified as a hydrophobic amino acid. The thiol side chain often participates in enzymatic reactions, serving as a nucleophile. The thiol is susceptible to oxidization to give the disulfide derivative cystine, which serves an important structural role in many proteins. Cysteine is named after cystine.

cystine a compound that is an oxidized dimer of cysteine and is the form in which cysteine often occurs in organic tissue.
Chem. formula: $C_6H_{12}N_2O_4S_2$.

cytoplasm The cytoplasm is the part of a cell that is enclosed within the cell membrane. In eukaryotic cells, the contents of the cell nucleus are not part of the cytoplasm and are instead called the nucleoplasm. Also in eukaryotic cells, the cytoplasm contains organelles, such as mitochondria, which are filled with liquid that is kept separate from the rest of the cytoplasm by biological membranes. The cytoplasm is the site where most cellular activities occur, such as many metabolic pathways like glycolysis, and processes such as cell division. The inner, granular mass is called the endoplasm and the outer, clear and glassy layer is called the cell cortex or the ectoplasm.

cytosine a compound found in living tissue as a constituent base of nucleic acids. It is paired with guanine in double-stranded DNA.

A pyrimidine derivative; chem. formula: $C_4H_5N_3O$.

cytosol the aqueous component of the cytoplasm of a cell, within which various organelles and particles are suspended.

dalton the common biochemical term for the atomic mass unit

dimer A dimer is a chemical or biological entity consisting of two structurally similar subunits called monomers, which are joined by bonds, which can be strong or weak. The term homodimer is used when the two molecules are identical (e.g. A-A) and heterodimer when they are not (e.g. A-B).

dissociation the splitting of a molecule into smaller molecules, atoms, or ions, esp. by a reversible process.

disulfide a sulfide containing two atoms of sulfur in its molecule or empirical formula.

- an organic compound containing the group -S-S- bonded to other groups.

divalent having a valence of two.

DNA a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses. The main role of DNA molecules is the long-term storage of information. DNA is often compared to a set of blueprints or a recipe, or a code, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules. The DNA segments that carry this genetic information are called genes, but other DNA sequences have structural purposes, or are involved in regulating the use of this genetic information.

Down-regulate Downregulation is the process by which a cell decreases the quantity of a cellular component, such as RNA or protein, in response to an external variable.

ectodomain portion of a cell surface (membrane) protein that protrudes from the plasma domain into the extracellular space (the space outside a cell). Ectodomains are usually the part of a protein that initiate contact with surface which leads to signal transduction. In SARS-CoV the ectodomain of the spike protein is responsible for attachment to and entry into cells during infection.

endocytosis process by which patches of plasma membrane and associated proteins are internalized into the cell cytoplasm, forming cytoplasmic vesicles.

endothelial cells 1. Mesenchymal cells that form the walls of capillaries or lymph ducts by assuming a tubelike shape.

2. Mesenchymal cells lining the luminal walls of larger blood vessels or lymph ducts.

epithelial cells A layer of cells that forms the lining of a cavity or duct, including the specialized epithelium that forms the skin.

erythroleukemia a leukemia of the red blood cell precursors

eukaryotic A eukaryote is an organism whose cells contain complex structures enclosed within membranes. The defining membrane-bound structure that sets eukaryotic cells apart from prokaryotic cells is the nucleus, or nuclear envelope, within which the genetic material is carried. The presence of a

nucleus gives eukaryotes their name, which comes from the Greek word eu, "good', "noble' and "true" and karyon, "nut" and "kernel".

exocytosis process by which cells secrete products by storing them in cytoplasmic membrane vesicles that are caused to fuse with the plasma membrane, allowing the products carried in these vesicles to be released into the extracellular space.

fibroblast mesenchymal cell type that is common in connective tissue and in the stromal compartment of epithelial tissues and is characterized by its secretion of collagen.

fibronectin Fibronectin is a high-molecular weight (440kDa) extracellular matrix glycoprotein that binds to membrane-spanning receptor proteins called integrins. In addition to integrins, fibronectin also binds extracellular matrix components such as collagen, fibrin and heparan sulfate proteoglycans (e.g. syndecans).

G-protein linked receptor kinase

G1 The G1 phase is a period in the cell cycle during interphase, after cytokinesis and before the S phase. For many cells, this phase is the major period of cell growth during its lifespan.

G2 G2 phase is the third, final, and usually the shortest subphase during interphase within the cell cycle in which the cell undergoes a period of rapid growth to prepare for mitosis. It follows successful completion of DNA synthesis and chromosomal replication during the S phase, and occurs during a period of often four to five hours (for human cells).

GRK see G-protein linked receptor kinase.

gap junction

gene a distinct sequence of nucleotides forming part of a chromosome, the order of which determines the order of monomers in a polypeptide or nucleic acid molecule which a cell (or virus) may synthesize.

gene expression Gene expression is the process by which information from a gene is used in the synthesis of a functional gene product. These products are often proteins, but in non-protein coding genes such as rRNA genes or tRNA genes, the product is a functional RNA. Alternately, the process by which possession of a gene leads to the appearance in the phenotype of the corresponding character.

Genome the entirety of an organism's hereditary information. It is encoded either in DNA or, for many types of virus, in RNA.

growth factor a protein that is able to stimulate the growth and/or proliferation of a cell by binding to a specific cell surface receptor displayed by that cell.

guanine a compound that occurs in guano and fish scales, and is one of the four constituent bases of nucleic acids. A purine derivative, it is paired with cytosine in double-stranded DNA.

Alternative name: 6-oxy-2-aminopurine; chem. formula: $C_5H_5N_5O$.

heterodimer Molecular complex composed of two distinct types of subunit.

histone any of a group of proteins found in chromatin

homodimer Molecular complex composed of two identical subunits.

hydrolysis the chemical breakdown of a compound due to reaction with water.

hydrolyze break down (a compound) by chemical reaction with water.

immediate early genes : an ensemble of more than 100 genes expressed in the first half hour after introduction of growth factors.

immunoreceptor tyrosine-based activation motif (ITAM) a sequence common to signaling MIRRs (but not ligand-binding MIRRs), in which the earliest cellular response (tyrosine phosphorylation) to MIRR-mediated signal transduction appears.

inhibitory phosphorylation

inositol a simple carbohydrate that occurs in animal and plant tissue and is a vitamin of the B group

interdivision time

kinase an enzyme that catalyzes the transfer of a phosphate group from ATP to a specified molecule, converting the ATP to ADP:
R^U + ATP $\rightarrow$ R^P + ADP.

kinetics

1. the branch of chemistry or biochemistry concerned with measuring and studying the rates of reactions.
   (a) Enzyme kinetics is the study of biochemical reaction rates catalysed by an enzyme.
   (b) In biochemistry, receptor-ligand kinetics is a branch of chemical kinetics in which the kinetic species are defined by different non-covalent bindings and/or conformations of the molecules involved, which are denoted as receptor(s) and ligand(s).
2. the rate of a chemical or biochemical reaction.

lecithin a substance widely distributed in animal tissues, egg yolk, and some higher plants, consisting of phospholipids linked to choline. Also called phosphatidylcholine.

ligand a molecule that binds specifically to a receptor and activates its signaling powers.

lipid : Lipids are fatty acids and their derivatives, and substances related biosynthetically or functionally to these compounds. This is actually a term that is used in a variety of ways; see http://www.lipidlibrary.co.uk/Lipids/whatlip/index.htm

M phase Mitosis and cytokinesis together define the mitotic (M) phase of the cell cycle - the division of the mother cell into two daughter cells, genetically identical to each other and to their parent cell. This accounts for approximately 10% of the cell cycle.

mass-balance equation

mass doubling time

membrane an enclosing or separating amphipathic layer that acts as a barrier within or around a cell. It is almost invariably a lipid bilayer, composed of a double layer of lipid molecules (usually phospholipids) and proteins that may constitute close to 50% of membrane content.

mesenchyme connective tissue

metabolic machinery endoplasmic reticulum , Golgi complex , ribosomes , mitochondria

metaphase plate Metaphase, from the ancient Greek word "meta" for between) and "phase" for stage, is a stage of mitosis in the eukaryotic cell cycle in which condensed and highly coiled chromosomes, carrying genetic information, align in the middle of the cell before being separated into each of the two daughter cells. Metaphase accounts for approximately 4% of the cell cycle's duration.

Preceded by events in prometaphase and followed by anaphase, microtubules formed in prophase have already found and attached themselves to kinetochores in metaphase. The centromeres of the chromosomes convene themselves on the metaphase plate (or equatorial plate), an imaginary line that is equidistant from the two centrosome poles. This even alignment is due to the counterbalance of the pulling powers generated by the opposing kinetochores, analogous to a tug of war between equally strong people.

metazoan Animals are a major group of mostly multicellular, eukaryotic organisms of the kingdom Animalia or Metazoa.

microtubule a microscopic tubular structure present in numbers in the cytoplasm of cells, sometimes aggregating to form more complex structures.

MIRR multi-chain immune recognition receptor

mitogen an agent that provokes cell proliferation.

mitosis Mitosis is the process by which a eukaryotic cell separates the chromosomes in its cell nucleus into two identical sets in two nuclei. It is generally followed immediately by cytokinesis, which divides the nuclei,

cytoplasm, organelles and cell membrane into two cells containing roughly equal shares of these cellular components.

molecular species a particular kind of molecule

motif a distinctive sequence on a protein or DNA, having a three-dimensional structure that allows binding interactions to occur.

motility movement

multi-chain immune recognition receptor (MIRR) A class of receptors, which includes FcϵR1, the B cell Ag receptor, and TCR.

N-terminus The N-terminus (also known as the amino-terminus, NH2-terminus, N-terminal end or amine-terminus) refers to the start of a protein or polypeptide terminated by an amino acid with a free amine group (-NH2).

neoplasm : a new and abnormal growth of tissue in some part of the body, esp. as a characteristic of cancer.

nucleophile

nucleoside a compound (e.g., adenosine or cytidine) commonly found in DNA or RNA, consisting of a purine or pyrimidine base linked to a sugar.

nucleotide a compound consisting of a nucleoside linked to a phosphate group. Nucleotides form the basic structural unit of nucleic acids such as DNA.

oncogene :

1. a cancer-inducing gene.
2. a gene that can transform cells.

Examples: src and ras.

oncoprotein : A protein specified by an oncogene.
Examples: Src and Ras.

phenotype the set of observable characteristics of an individual resulting from the interaction of its genotype with the environment.

phosphatase an enzyme that catalyzes the hydrolysis of organic phosphates in a specified (acid or alkaline) environment.

phosphatidylcholine a substance widely distributed in animal tissues, egg yolk, and some higher plants, consisting of phospholipids linked to choline. Also called lecithin.

phosphoform

phospholipase an enzyme that hydrolyzes lecithin or a similar phospholipid.

phosphoprotein a protein carrying phosphate groups covalently attached to one or more of the amino acid side chains.

phosphorylate Phosphorylation is the addition of a phosphate (PO4) group to a protein or other organic molecule. Phosphorylation turns many protein enzymes on and off, causing or preventing the mechanisms of diseases such as cancer and diabetes.

phosphotyrosine phosphorylated tyrosine

plasma membrane : lipid bilayer membrane that surrounds a eukaryotic cell and separates the aqueous environment of the cytoplasm from that in the extracellular space.
Phosphatidylcholine (once given the trivial name 'lecithin') is usually the most abundant phospholipid in animal and plants, often amounting to almost 50% of the total, and as such it is obviously the key building block of membrane bilayers. In particular, it makes up a very high proportion of the outer leaflet of the plasma membrane.
Phosphatidylserine may comprise 10 to 20 mol% of the total phospholipid in the plasma membrane and endoplasmic reticulum of the cell. It is located entirely on the inner monolayer surface of the plasma membrane and other cellular membranes and is an essential cofactor for the activation of protein kinase C.
See http://www.lipidlibrary.co.uk/Lipids/whatlip/index.htm

pleiotropic a single gene that influences multiple phenotypic traits. The term pleiotropy comes from the Greek $\pi\lambda\epsilon\iota\omega\nu$ (pleion), meaning "more", and $\tau\rho\epsilon\pi\epsilon\iota\nu$ (trepein), meaning "to turn, to convert". A common mistake is to use "pleiotrophic" instead of "pleiotropic"

polypeptide Peptides (from the Greek $\pi\epsilon\pi\tau\iota\delta\iota\alpha$, "small digestibles") are short polymers formed from the linking, in a defined order, of α-amino acids. The link between one amino acid residue and the next is called an amide bond or a peptide bond.
Proteins are polypeptide molecules (or consist of multiple polypeptide sub-units). The distinction is that peptides are short and polypeptides/proteins are long.

post-translational modification Posttranslational modification (PTM) is the chemical modification of a protein after its translation. It is one of the later steps in protein biosynthesis for many proteins.

protein kinase C (PKC)

protein tyrosine kinase (PTK)

proteome the entire complement of proteins, including the modifications made to a particular set of proteins, produced by an organism or system.

Analogous to "genome".

proteomics the large-scale study of proteins, particularly their structures and functions.

protist Protists are a diverse group of eukaryotic microorganisms. Historically, protists were treated as the kingdom Protista but this group is no longer recognized in modern taxonomy. Instead, it is "better regarded as a loose grouping of 30 or 40 disparate phyla with diverse combinations of trophic modes, mechanisms of motility, cell coverings and life cycles.

PTK : see protein tyrosine kinase

PTM : see post-translational modification

purine a colorless crystalline compound with basic properties, forming uric acid on oxidation.

A bicyclic compound; chem. formula: $C_5H_4N_4$.

Purine base: a substituted derivative of this, esp. the bases adenine and guanine present in DNA and RNA.

pyrimidine a colorless crystalline compound with basic properties.

A heteroaromatic compound; chem. formula: $C_4H_4N_2$.

Pyrimidine base: a substituted derivative of this, esp. the bases thymine and cytosine present in DNA.

reaction rate laws

receptor a protein found on the plasma membrane or within a cell that is capable of specifically binding a signaling molecule (its ligand). Most types of receptors emit signals, such as those inducing cell proliferation, in response to such binding.

Replicate a process by which genetic material, a cell, or an organism reproduces or makes an exact copy or copies

Replication-division cycle The cell cycle, or cell-division cycle, is the series of events that take place in a cell leading to its division and duplication (replication).

ribosome molecular machines that make proteins out of amino acids. One of the central tenets of biology is that DNA makes RNA, which then makes protein. The DNA sequence in genes is copied into a messenger RNA (mRNA). Ribosomes then read the information in this RNA and use it to produce proteins. Ribosomes do this by binding to a messenger RNA and using it as a template for the correct sequence of amino acids in a particular protein. The amino acids are attached to transfer RNA (tRNA) molecules, which enter one part of the ribosome and bind to the messenger RNA sequence. The attached amino acids are then joined together by another part of the ribosome. The ribosome moves along the mRNA, "reading' its sequence and producing a chain of amino acids.

S phase The S phase, short for synthesis phase, is a period in the cell cycle during interphase, between G1 phase and the G2 phase. Following G1, the cell enters the S stage, when DNA synthesis or replication occurs.

At the beginning of the S stage, each chromosome is composed of one coiled DNA double helix molecule, which is called a chromatid. The enzyme DNA helicase splits the DNA double helix down the hydrogen bonds (the middle bonds). DNA polymerase follows, attaching a complementary base pair to the DNA strand, making two new semi-conservative strands.

At the end of this stage, each chromosome has two identical DNA double helix molecules, and therefore is composed of two sister chromatids (joined at the centromere). During S phase, the centrosome is also duplicated.

serum : the fluid left behind when blood clots. Serum includes all proteins not used in blood clotting and all the electrolytes, antibodies, antigens, hormones, and any exogenous substances (e.g., drugs and microorganisms). In particular, serum includes the growth factors that persuade cells to multiply.

signal transduction the process of getting a signal from the exterior of a cell to its interior, through the mediation of protein-protein interactions of the signaling molecules.

spindle a slender mass of microtubules formed when a cell divides. At metaphase, the chromosomes become attached to it by their centromeres before being pulled toward its ends.

stiff equations a stiff equation is a differential equation for which certain numerical methods for solving the equation are numerically unstable, unless the step size is taken to be extremely small. It has proven difficult to formulate a precise definition of stiffness, but the main idea is that the equation includes some terms that can lead to rapid variation in the solution.

stoichiometric inhibitor

stoichiometry the calculation of quantitative (measurable) relationships of the reactants and products in a balanced chemical reaction (chemicals). It can be used to calculate quantities such as the amount of products that can be produced with the given reactants and percent yield.

stroma the mesenchymal components of epithelial and hematopoietic tissues and tumors, which may include fibroblasts, adipocytes, endothelial cells, and various immunocytes as well as associated extracellular matrix.

substrate the substance on which an enzyme acts.

temporal dynamics

temporal gap the interval between two biological events.

trimer a polymer comprising three monomer units.

tetramer a polymer comprising four monomer units.

thiol In organic chemistry, a thiol is a compound that contains the functional group composed of a sulfur-hydrogen bond (-SH). Being the sulfur analogue of an alcohol group (-OH), this functional group is referred to either as a thiol group or a sulfhydryl group. More traditionally, thiols are often referred to as mercaptans.

thymine a compound that is one of the four constituent bases of nucleic acids. A pyrimidine derivative, it is paired with adenine in double-stranded DNA.

Alternative name; 5-methyluracil; chem. formula: $C_5H_6N_2O_2$.

transcription the process by which genetic information represented by a sequence of DNA nucleotides is copied into newly synthesized molecules of RNA, with the DNA serving as a template.

transduction :

1. process whereby a signaling element, such as a protein, receives a signal and, in response, emits another signal.
2. process by which a gene is introduced into a cel, usually by a vector such as a viral vector.

transformation :

1. process of converting a normal cell into a cell having some or many of the attributes of a cancer cell
2. process by which a gene is introduced into a cell, usually by a vector such as a viral vector

translation : the production of proteins by decoding mRNA produced in transcription.

transmembrane domain the domain of a protein that is threaded through a membrane and therefore exists in the hydrophobic environment of a lipid bilayer.

transphosphorylation The exchange of phosphate groups between organic phosphates, without their going through the stage of inorganic phosphate.

tyrosine a hydrophilic amino acid that is a constituent of most proteins and is important in the synthesis of some hormones.

Abbreviated as **Tyr** or **Y**.

Chem. formula: $C_6H_4(OH)CH_2CH(NH_2)COOH$.

ubiquitin : Ubiquitin is a small, highly-conserved regulatory protein that is ubiquitously expressed in eukaryotes. Ubiquitination (or ubiquitylation) refers to the post-translational modification of a protein by the covalent attachment (via an isopeptide bond) of one or more ubiquitin monomers. The most prominent function of ubiquitin is labeling proteins for proteasomal degradation.

vector :

1. agent, often a virus, that is able to carry a gene from one cell to another.
2. an infected organism that serves to transmit and distribute an infectious agent to other organisms.

VSMC vascular smooth muscle cell

2 The Actors.

2.1 Genes.

fos		c-Fos is a proto-oncogene belonging to the immediate early gene family of transcription factors.
junB		
egr-1		early growth response protein 1
ras		family of genes encoding small GTPases that are involved in cellular signal transduction.
src	sarc	short for sarcoma functioning as a kinase, can phosphorylate more than 50 distinct substrates phosphorylates certain tyrosine residues transforms cells through its ability to act as a tyrosine kinase (TK) phosphorylate substrate proteins within transformed cells

2.2 Proteins

2.2.1 Ligands.

LPA thrombin ET	
TGF-α	
EGF	Epidermal Growth Factor mitogenic effects on epithelial cells mitogenic signaling is initiated by binding to EGF-R
epiregulin	
β-cellulin	
HB-EGF	
amphiregulin	
NRG-1	
NRG-2	
NRG-3	
NRG-4	
cytokines	
PDGF	Platelet-Derived Growth Factor
NGF	
M-SCF	
VEGF	
Eph	

2.2.2 Receptors.

EGF-R		EGF receptor The EGF-R family of receptors consists of four distinct proteins, ErbB1 (EGF-R), ErbB2 (HER2, Neu), ErbB3 (HER3), and ErbB4 (HER4). They often bind ligands as heterodimeric receptors, for example, ErbB1+ErbB3, ErbB1+ErbB2 or ErbB2+ErbB4. They are similar to a protein expressed by the oncogene ErbB. 621 amino acids in N-terminal ectodomain 23 hydrophobic amino acids in transmembrane domain 542 amino acids at C-terminus end or cytoplasmic tail Most function as a tyrosine kinase receptors ie. they signal intracellular proteins to start cell proliferation by phosphorylating tyrosine domains expressed on surface of epithelial cells, not expressed on surface of other mesenchymal cells
IGF-1 NGF receptor	insulin receptor neuron growth factor	 affects neurons
PDGF receptor	platelet-derived growth factor	endothelial, VSMCs, fibroblasts, other mesenchymal cells glial cells expressed on the surfaces of mesenchymal cells not expressed on the surfaces of epithelial cells
M-SCF receptor		
VEGF receptor Eph receptor		

2.2.3 Growth Factors

PDGF	PDGF-R	endothelial, VSMCs, fibroblasts, other mesenchymal cells, glial cells
EGF	EGF-R	many types of epithelial cells, some mesenchymal cells
NGF	Trk	neurons
FGF	FGF-R	endothelial, fibroblasts, other mesenchymal cells, VSMCs, neuroectodermal cells prototypes are acidic FGF (aFGF) and basic FGF (bFGF), but there are other known ligands in this family. There are four well-characterized FGF-Rs.
HGF/SF	Met	various epithelial cells
VEGF	VEGF-R	endothelial cells in capillaries, lymph ducts
IGF	IGF-R1	wide variety of cell types
GDNF	Ret	neuroectodermal cells
SCF	Kit	hematopoietic, mesenchymal cells

2.2.4 Oncoproteins.

Src
Abl
Fes
Raf
Mos

2.3 Amino Acids

tyrosine
threonine
serine

2.4 Kinases

Syk
Lyn