Champion Cheatsheets

Division B/C

Georgia Tech Event Workshop Series
2024-25

Science Olympiad at Georgia Tech®

01 CHEATSHEET RULES

02 GENERAL TIPS

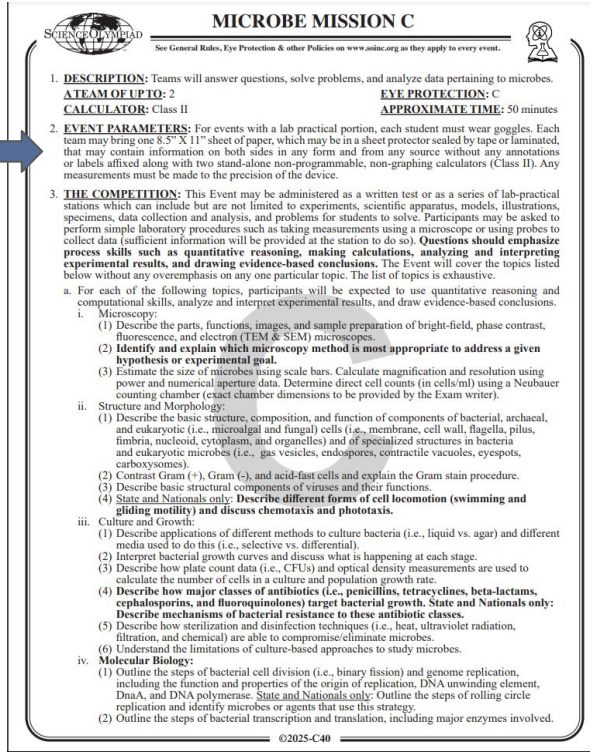
03 CHEATSHEET CONTENT

04 EXAMPLES

05 TIPS FROM A VETERAN

Cheatsheet Rules

- Check your event rules sheet for cheatsheet rules under “Event Parameters”!
- Typical Cheatsheet Rules:
  - 8.5” x 11” (Letter size)
  - Usually 1 sheet per team
  - Front & Back
  - Cannot affix additional labels to the cheatsheet to increase surface area
  - May be laminated / sealed in protector



MICROBE MISSION C

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Teams will answer questions, solve problems, and analyze data pertaining to microbes.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** C
   CALCULATOR: Class II **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:** For events with a lab practical portion, each student must wear goggles. Each team may bring one 8.5" X 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with two stand-alone non-programmable, non-graphing calculators (Class II). Any measurements must be made to the precision of the device.
3. **THE COMPETITION:** This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Participants may be asked to perform simple laboratory procedures such as taking measurements using a microscope or using probes to collect data (sufficient information will be provided at the station to do so). **Questions should emphasize process skills such as quantitative reasoning, making calculations, analyzing and interpreting experimental results, and drawing evidence-based conclusions.** The Event will cover the topics listed below without any overemphasis on any one particular topic. The list of topics is exhaustive.
   a. For each of the following topics, participants will be expected to use quantitative reasoning and computational skills, analyze and interpret experimental results, and draw evidence-based conclusions.
      i. Microscopy:
         (1) Describe the parts, functions, images, and sample preparation of bright-field, phase contrast, fluorescence, and electron (TEM & SEM) microscopes.
         (2) **Identify and explain which microscopy method is most appropriate to address a given hypothesis or experimental goal.**
         (3) Estimate the size of microbes using scale bars. Calculate magnification and resolution using power and numerical aperture data. Determine direct cell counts (in cells/ml) using a Neubauer counting chamber (exact chamber dimensions to be provided by the Exam writer).
      ii. Structure and Morphology:
         (1) Describe the basic structure, composition, and function of components of bacterial, archaeal, and eukaryotic (i.e., microalgal and fungal) cells (i.e., membrane, cell wall, flagella, pilus, fimbria, nucleoid, cytoplasm, and organelles) and of specialized structures in bacteria and eukaryotic microbes (i.e., gas vesicles, endospores, contractile vacuoles, eyespots, carboxysomes).
         (2) Contrast Gram (+), Gram (-), and acid-fast cells and explain the Gram stain procedure.
         (3) Describe basic structural components of viruses and their functions.
         (4) State and Nationals only: **Describe different forms of cell locomotion (swimming and gliding motility) and discuss chemotaxis and phototaxis.**
      iii. Culture and Growth:
         (1) Describe applications of different methods to culture bacteria (i.e., liquid vs. agar) and different media used to do this (i.e., selective vs. differential).
         (2) Interpret bacterial growth curves and discuss what is happening at each stage.
         (3) Describe how plate count data (i.e., CFUs) and optical density measurements are used to calculate the number of cells in a culture and population growth rate.
         (4) **Describe how major classes of antibiotics (i.e., penicillins, tetracyclines, beta-lactams, cephalosporins, and fluoroquinolones) target bacterial growth. State and Nationals only: Describe mechanisms of bacterial resistance to these antibiotic classes.**
         (5) Describe how sterilization and disinfection techniques (i.e., heat, ultraviolet radiation, filtration, and chemical) are able to compromise/eliminate microbes.
         (6) Understand the limitations of culture-based approaches to study microbes.
      iv. **Molecular Biology:**
         (1) Outline the steps of bacterial cell division (i.e., binary fission) and genome replication, including the function and properties of the origin of replication, DNA unwinding element, DnaA, and DNA polymerase. State and Nationals only: Outline the steps of rolling circle replication and identify microbes or agents that use this strategy.
         (2) Outline the steps of bacterial transcription and translation, including major enzymes involved.

Binder Rules

- Check your event rules sheet for binder rules under “Event Parameters”!
  - Binders may be one per team or one per participant
  - Some events have binder size limits of 2”, some events have no limit
  - Some events do not let you remove pages from binder during the event
- Material should be secured onto the binder using sheet protectors or through hole-punch
- Sheet protectors, laminations, tabs, and labels are typically allowed

General Tips

General Tips - Formating Cheatsheets

- Include as much information as possible, but keep it readable
  - Decrease font size, decrease margins
  - Utilize highlighting and bolding
  - Eliminate articles (the, a, etc.)
  - Abbreviate common words (ex: because → bc)
  - Abbreviate content words if you know them (ex: hydrochloric acid → HCl)
- For events with labeling (ex: A&P), include diagrams
  - May be helpful to draw your own diagrams! Decreasing size of diagrams make words hard to read due to lower image resolution
  - Print in color, if available

General Tips - Formating Cheatsheets

- Organize content by topic
  - Try to group similar information together or sequentially so that it is easier to find during your event
- Don't write every single piece of information – you will run out of space
  - Exclude simple content that you can easily study
- Know what kind of information you need
  - Graphs, images, vocabulary, labeled diagrams, equations/formulas
- Hand-write / label additional information into margins after printing
- Print multiple copies just in case!
- Bringing sheet protector can help prevent soggy/wrinkled cheatsheets

General Tips - Google Docs

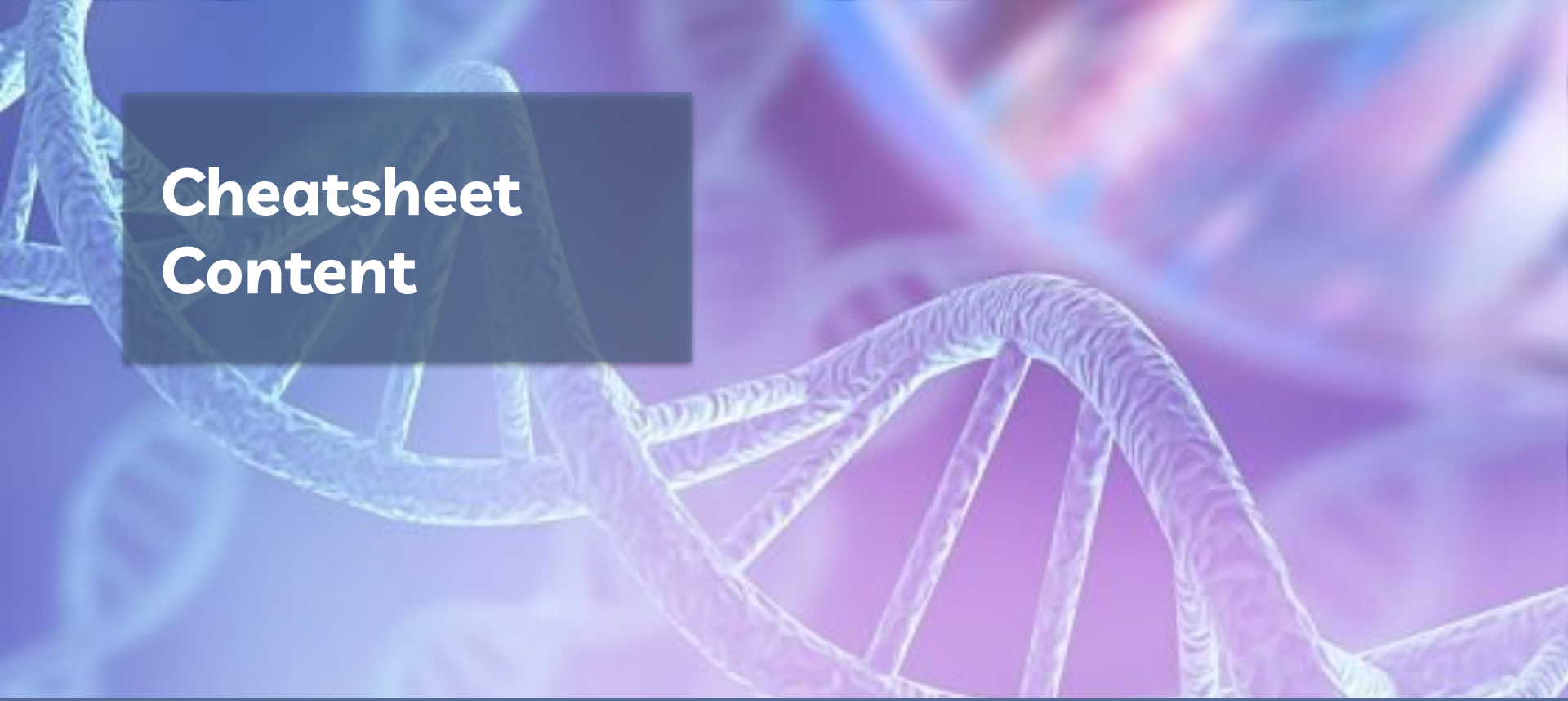
- Google docs is commonly used to create cheatsheets (easy to collaborate!)
- Other: microsoft word, canva, OneNote, etc.

Google Docs - Changing Formatting

- Adjusting Margins: files → page setup → margins
- Adjusting Orientation: files → page setup → orientation
- Making Columns: format → columns
- Adjusting Image Margins: select image → wrap text → adjust margins
- Play around to figure out what works best for your team

General Tips - Formating Binders

- Binders are much larger than a single cheatsheet
  - You can include much more detailed, thorough information
  - Organization is crucial
- Create a table of contents for your binder, use page numbers
- Use tabs to easily find sections
- Highlight main points, definitions
- Compile your resources in google drive and print ahead of time
  - Hole-punching and organizing takes time

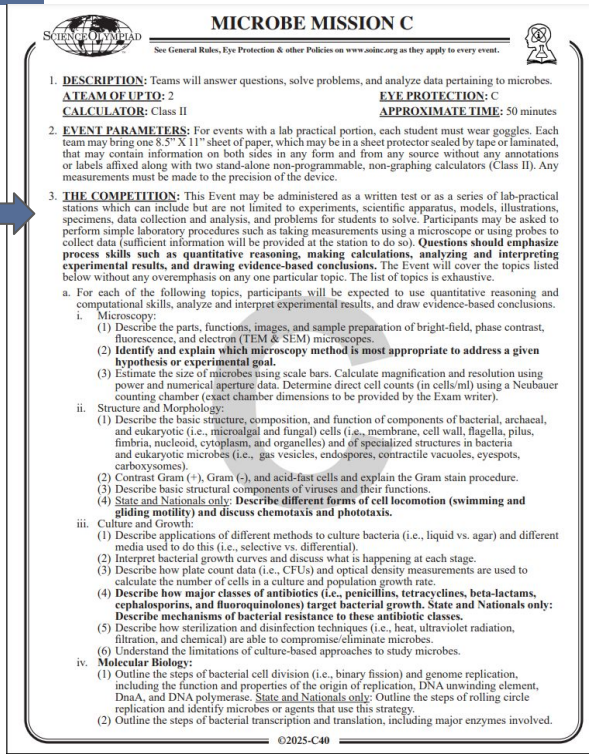


Cheatsheet Content

Content

- Event topics can be found on your Event Rules sheet under
  "The Competition"

- Read the topics that are included in your level of tournament
  - There may be more topics included in a state competition than regional
- Check for additional resources you can bring
  - Field guides, national lists



MICROBE MISSION C

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Teams will answer questions, solve problems, and analyze data pertaining to microbes.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** C
   CALCULATOR: Class II **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:** For events with a lab practical portion, each student must wear goggles. Each team may bring one 8.5" X 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with two stand-alone non-programmable, non-graphing calculators (Class II). Any measurements must be made to the precision of the device.
3. **THE COMPETITION:** This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Participants may be asked to perform simple laboratory procedures such as taking measurements using a microscope or using probes to collect data (sufficient information will be provided at the station to do so). **Questions should emphasize process skills such as quantitative reasoning, making calculations, analyzing and interpreting experimental results, and drawing evidence-based conclusions.** The Event will cover the topics listed below without any overemphasis on any one particular topic. The list of topics is exhaustive.
   a. For each of the following topics, participants will be expected to use quantitative reasoning and computational skills, analyze and interpret experimental results, and draw evidence-based conclusions.
      i. Microscopy:
         (1) Describe the parts, functions, images, and sample preparation of bright-field, phase contrast, fluorescence, and electron (TEM & SEM) microscopes.
         (2) **Identify and explain which microscopy method is most appropriate to address a given hypothesis or experimental goal.**
         (3) Estimate the size of microbes using scale bars. Calculate magnification and resolution using power and numerical aperture data. Determine direct cell counts (in cells/ml) using a Neubauer counting chamber (exact chamber dimensions to be provided by the Exam writer).
      ii. Structure and Morphology:
         (1) Describe the basic structure, composition, and function of components of bacterial, archaeal, and eukaryotic (i.e., microalgal and fungal) cells (i.e., membrane, cell wall, flagella, pilus, fimbria, nucleoid, cytoplasm, and organelles) and of specialized structures in bacteria and eukaryotic microbes (i.e., gas vesicles, endospores, contractile vacuoles, eyespots, carboxysomes).
         (2) Contrast Gram (+), Gram (-), and acid-fast cells and explain the Gram stain procedure.
         (3) Describe basic structural components of viruses and their functions.
         (4) State and Nationals only: **Describe different forms of cell locomotion (swimming and gliding motility) and discuss chemotaxis and phototaxis.**
      iii. Culture and Growth:
         (1) Describe applications of different methods to culture bacteria (i.e., liquid vs. agar) and different media used to do this (i.e., selective vs. differential).
         (2) Interpret bacterial growth curves and discuss what is happening at each stage.
         (3) Describe how plate count data (i.e., CFUs) and optical density measurements are used to calculate the number of cells in a culture and population growth rate.
         (4) **Describe how major classes of antibiotics (i.e., penicillins, tetracyclines, beta-lactams, cephalosporins, and fluoroquinolones) target bacterial growth. State and Nationals only: Describe mechanisms of bacterial resistance to these antibiotic classes.**
         (5) Describe how sterilization and disinfection techniques (i.e., heat, ultraviolet radiation, filtration, and chemical) are able to compromise/eliminate microbes.
         (6) Understand the limitations of culture-based approaches to study microbes.
      iv. **Molecular Biology:**
         (1) Outline the steps of bacterial cell division (i.e., binary fission) and genome replication, including the function and properties of the origin of replication, DNA unwinding element, DnaA, and DNA polymerase. State and Nationals only: Outline the steps of rolling circle replication and identify microbes or agents that use this strategy.
         (2) Outline the steps of bacterial transcription and translation, including major enzymes involved.

Content

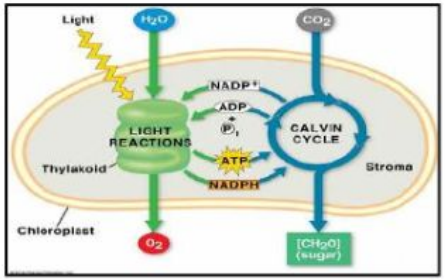
- For both binder and cheatsheet events, it is best if you have a general understanding of content
  - Your resource should serve as a supplemental
- Read your topics to see what type of information would be useful in your resource, for example:
  - A&P - labeled diagrams
  - Fossils - lists, pictures, details, dichotomous key
  - Chemistry - formulas, rules

Content

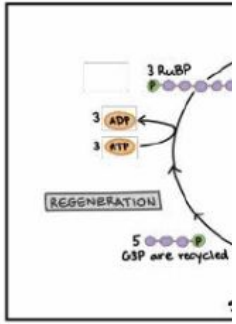
- Where to gather content?
  - Studying general content knowledge: Khan academy, youtube, simple google searches
  - Detailed content: textbooks, manuals, nationally published resources
- Ask your coach and teammates
  - There may be resources previous students at your school may have used
- Science Olympiad website: event-specific links to resources, practice exams

Examples

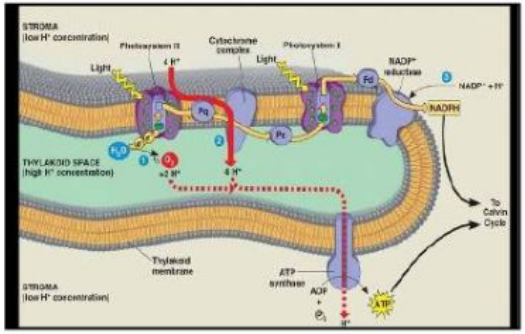
Examples



Photosynthesis: The goal of the **light-dependent reactions** of photosynthesis is to collect energy from the sun and break down water molecules to produce ATP and NADPH. These two energy-storing molecules are then used in the light-independent reactions. Within chloroplasts, chlorophyll is the pigment that absorbs sunlight. It is stored in the thylakoid membranes in protein complexes called photosystem I and photosystem II. The series of light-dependent reactions begins when sunlight hits a molecule of chlorophyll, located in photosystem II. This excites an electron, which leaves the chlorophyll molecule and travels along the thylakoid membrane via a series of carrier proteins (known as the electron transport chain).Then, something amazing happens—photosystem II splits a water molecule to restore this lost



electron and fill the "energy vacuum" that been created. This is a process humans haven't been able to replicate exactly in a Each water molecule breaks down into one oxygen (O) atom. The oxygen is —oxygen atoms from disassembled water form oxygen gas (O_2).The hydrogen ions in the lumen of the thylakoid. They pass ATP synthase, and their movement to add a third phosphate to ADP form ATP (adenosine triphosphate). This powers many cellular processes. In fact, photosynthesis is broken down to produce cellular respiration. Meanwhile, the photosystem II arrives at photosystem I, chlorophyll. Energy from the sun excites enough energy to pass across the create the energy-carrying molecule



has

lab!

two hydrogen (H) atoms and released as a waste product molecules join up in pairs to build up in high concentration through an enzyme called provides the energy needed (adenosine diphosphate) to energy-storing molecule the glucose made during more ATP later, during electron released from which also contains the electron again, giving it membrane and into the stroma, where it joins NADPH. ATP and NADPH move from the thylak

store is used to power the light-independent reactions. The ultimate goal of the **light-independent reactions** (or Calvin cycle) is to assemble a molecule of glucose. This is the part plant gets from the air. Essentially, the plant needs the carbon from the CO_2 to create the building blocks for glucose. An enzyme in the stroma called ruBisCo combines a five-carb biphosphate) with a molecule of carbon dioxide. This creates a six-carbon molecule that is broken down into two three-carbon molecules (3-phosphoglycerate). This part of the lig carbon fixation. Then, the energy carriers from the light-dependent reactions make their contribution. ATP and NADPH give each 3-phosphoglycerate a hydrogen atom, creating tw (glyceraldehyde-3-phosphate). Ultimately, these two molecules of G3P are used to build one molecule of glucose. This part of the light-independent reactions is typically referred because electrons are added. It is important to note that the Calvin cycle typically uses six molecules of carbon dioxide at a time. This means that twelve molecules of G3P are gen to produce a molecule of glucose—the rest are recycled back into RubP so that the cycle can keep running.

Great use of diagrams highlighting, bolding

Word organization could be improved, better sectioned for easier reading

Examples

(I apologize for image resolution)

Color coding topics like this can be an easy way to locate information. Writing in columns can be easier to read.

Examples (My Personal Cheatsheet!)

Complex Carbohydrates (CHO)
Starch - plant energy storage, easily digested. Tested for with iodine. Hydrophilic
Glycogen - animal short term energy storage
Cellulose - fiber; wall of plants, algae
Chitin - wall of fungi, exoskeleton of arthropods
Glucose detected by Benedict's test.
3 **Main Lipid Types (CHO)**
Triglyceride - glycerol + 3 fatty acids, long term energy storage, main fat in animals
Phospholipid - cell membrane
Steroid - lipid w/ ring structure core of 17 C
Tested for with Sudan III test.
Proteins (CHONS)
1 - polypeptide chain w/ covalent peptide bonds
2 - H bonds b/w carbonyl & amino groups that make up the backbone.
a-helix - most common, -NH group & -CO interact
B-pleated sheet - stretched, then intermol H bond
3 - H-bonds, electrostatic forces, disulphide linkages, and Vander Waals; give 2 shape:
Fibrous - long narrow, structural role
Globular - compact round, functional role
4 - tertiary structure interact and arrange
Tested for with Biuret stain.
Nucleic Acid (CHONPS)

DNA rep: initiation, elongation, termination
Post-Translational Modifications
Phosphorylation - protein; critical for cell process
Glycosylation - protein; cell surface receptors
Ubiquitination - protein; marks for degradation
Proteolytic cleavage - may activate/inhibit/destroy

Photorespiration: occurs when rubisco acts on oxygen rather than carbon dioxide
C3:
* rice, wheat, soybeans, all trees (cool, wet)
* In mesophyll: CO2 fixation by rubisco → 3 carbon compound
C4:
* tropical grass, sugarcane, corn (hot, sunny)
*Kranz anatomy
* light dependent reaction and Calvin cycle is separate
- LD reaction: mesophyll
- Calvin cycle: bundle sheath (BS)
* In mesophyll: CO2 → oxaloacetate by PEP carboxylase … oxaloacetate → malate (final product)

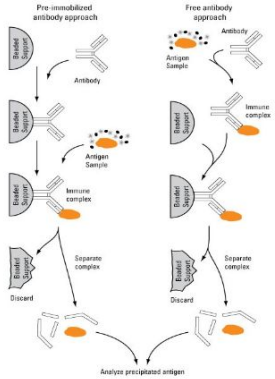
* transmembrane proteins: span the entire membrane
* peripheral protein: loosely bound to surface of membrane or to part of integral protein. Not embedded in lipid bilayer.
* glycolipid: cellular recognition
* glycoprotein: receptors for chemical signals
* aquaporin: type of channel protein that specifically facilitates diffusion of water
* tonicity: ability of surrounding solution to cause a cell to gain or lose water
* sodium-potassium pump: 3 Na+ out, 2 K+ in. Maintains negative charge inside cells.
* most permeable to K+ ions.

Necrosis: accidental cell death
Apoptosis: programmed cell death.
- Intrinsic: non-receptor-mediated
- extrinsic: receptor-mediated
Controlled by p53 gene, which codes for cytochrome c to be released by mitochondria. Caspases dismantle cell structures.
Inactivation of FAK ---> detachment of apoptotic cell.
Tumor necrosis factor is an extracellular messenger of apoptosis.
BCI-2 regulates the intrinsic pathway of apoptosis.
Steps:
1. cell shrinks and blebs
2. cell components broken down by proteins
3. enzymes break down nucleus and cell emits signals to attract macrophages
4. Cell breaks into smaller pieces
5. Macrophage find & engulf apoptotic cell fragments
* Caspases: proteases & nucleases (chop things up)
Cancer
Transformation: process by which cell acquires ability to divide indefinitely
HeLa cells: "immortal"
Benign tumor: cells remain at original tumor site
Malignant: cells can invade and survive on other sites
Metastasis: spread of cancer cells from origin to another location
Angiogenesis: growth of new blood vessel
Telomere: 5'-TTAGGG-3'
Telomerase: extends telomeres, usually active in germ cells, but also active in cancer cells. Cancer immortality
When cancer cells are grown in culture they do not form monolayers.
Tumor suppressor gene p53 regulates G1 to S trans.

G-protein linked: (aka heptahelical receptor)
* when ligand binds, activates a G-protein, which then interacts with nearby membrane protein
* all have seven transmembrane domains, but each receptor has specific extracellular domain and G-protein binding site
* G proteins have three subunits: a, B, y. In resting state, aBy is bound together with GDP attached to a.
* when GPCR is activated, it exchanges GTP for GDP in the protein. The subunit w/ GTP dissociates from B-y dimer.
* a-GTP can bind with effector enzymes
* B-y dimer can activate ion channels and kinases

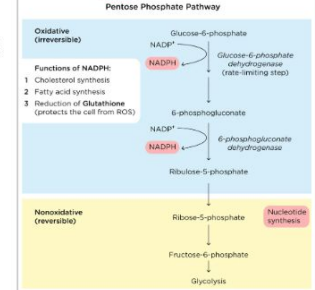
Lipid Raft
* segments of plasma membrane that contain high concentrations of cholesterol, glycosphingolipids, saturated phospholipids
* causes tight packing, insoluble w/ nonionic detergent
Vesicles: Fusion
* RabGTPase: family of proteins that regulate vesicle transport and docking
- RabGDP is the inactive form. GEF proteins make RabGDP → RabGTP, which is then active.
- some Rabs bind to vesicle membrane and some bind to target membrane
- after binding to membrane, they recruit Rab effector proteins, which assist in vesicle transport and docking
-- motor adaptors: form link between vesicles and motor proteins
-- tethering factors: assist in docking
* fusion of membranes is highly unfavorable and only happen when membranes are brought together few nanometers close
*SNAREs: proteins that help do this. This also allows for specificity
* once vesicle docked, v-SNARE (anchored to vesicular membrane) coil with t-SNARE (anchored to target membrane)
* this coiling tightens gap between vesicle and target membranes, causing membranes to form a hemifuse (highly unstable), then flatten out.
* RabGTP is made inactive by GAPs protein
* ATPase called NSF and other cofactors use ATP hydrolysis to release the binded v-SNARE from t-SNARE
Vesicles: Formation
- GEF proteins activate GTPase, which binds to

Km is the concentration of substrate which permits the enzyme to achieve half Vmax.
Velocity of rxn = (Vmax•[S])/(Km + [S])
Western Blot
1 gel electrophoresis to separate proteins
2 membrane transfer of separated proteins
3 immunodetection of target protein w/ antibody
ELISA
1 Coating - antigen is absorbed onto well in ELISA plate in coating buffer
2 Blocking - buffer containing unrelated protein is used to block free sites in the wells
3 Detection - enzyme conjugated detection antibody binds antigen
4 Readout - substrate is catalyzed by enzyme to generate colored readout
Immunoprecipitation
* to precipitate protein out of a solution using antibody

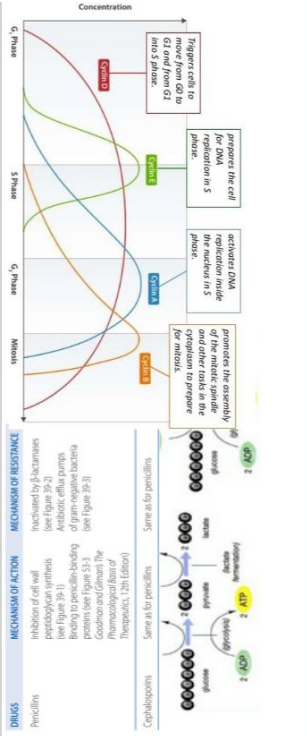


IP vs Co-IP
* IP - specific target/antigen is purified
* Co-IP - target antigen w/ binding partners purified

-MPF is activated at the end of the G2 phase by an enzyme phosphatase. It is made from three parts such as a kinase, a cyclin, and a phosphate group. It can be inactivated by destroying a protein called cyclin. The function is to promote spindle assembly, chromatin condensation and the breakdown of the nuclear envelope. Starts metaphase.
Photosynthesis:
LDR: H2O + ADP + NADP+ -> O2 + ATP + NADPH
Independent: 2 NADPH + 3 ATP + CO2 -> G3P + 2 NADP+ + H2O.
Cellular respiration:
Glycolysis: Glucose + 2 ATP + 2 NAD+ -> 2 Pyruvate + 4 ATP + 2 NADH
Fermentation: 2 ethanol or lactic acid produced. If ethanol, 2 CO2 also produced.
Oxidation of Pyruvate: Pyruvate + NAD+ + Acetyl group + Coenzyme A -> Acetyl CoA + NADH + CO2.
Krebs Cycle: Acetyl CoA + 3NAD+ + FAD -> 3NADH + FADH2 + ATP
Oxydation Phosphorylation: NADH + FADH2 + O2 -> H2O + NAD+ + FAD+ + 32 ATP.



Hill eq - rate law to model biological interactions that demonstrate sigmoidal response



Examples

Ultimately, these are just examples and tips on how you can structure your cheatsheet or binder.

Work with your partner, your team, and coach to build your resource that works best for you.

Tips from a Veteran

Tips from a Veteran

- Split up event topics with your partner
  - Focusing more deeply on smaller number of topics can be helpful
- Try to study and understand the general information within a topic, putting more complex, detailed, difficult to memorize parts of information on the cheatsheet
- Know your cheatsheet!
  - It is inefficient to continuously search for where you wrote information

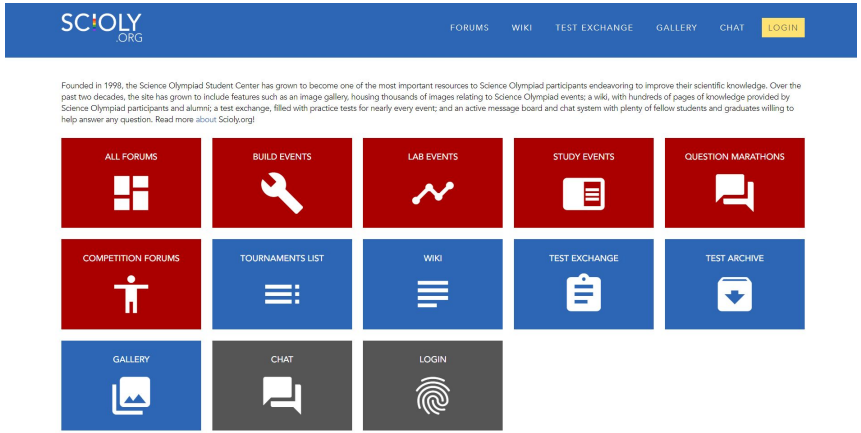
Tips from a Veteran

- Check your printed cheatsheet
  - Make sure things did not get cut off (personal experience 🥲) and images are visible
  - Things may look fine on computer and get distorted when printing
- Collaborate and work together with your team and coach

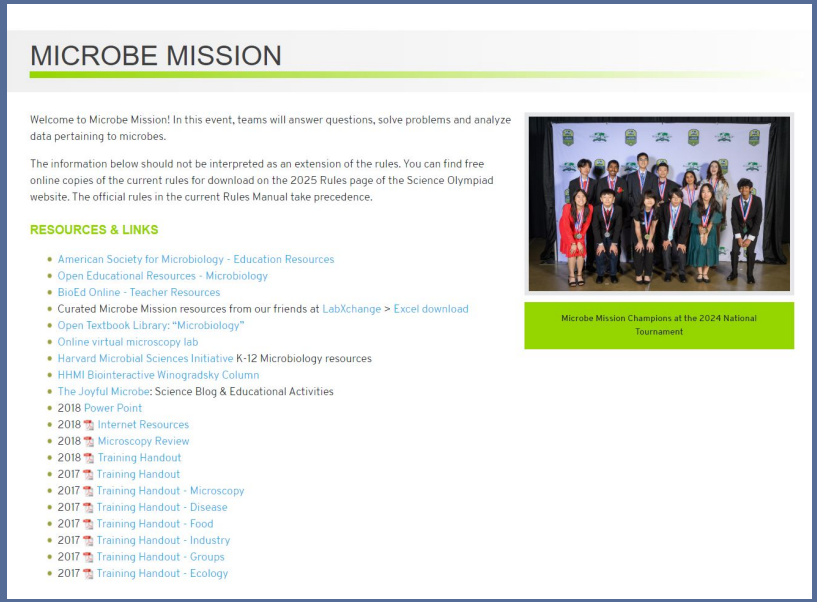
- **Learn and have fun!**

Resources to Check Out

Scioly.org



Soinc.org



THANKS!