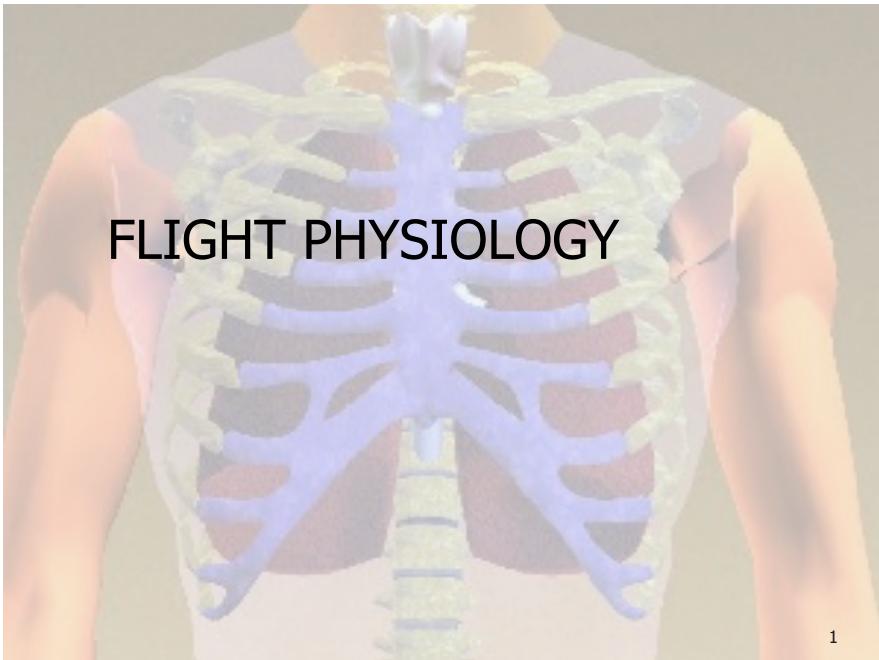


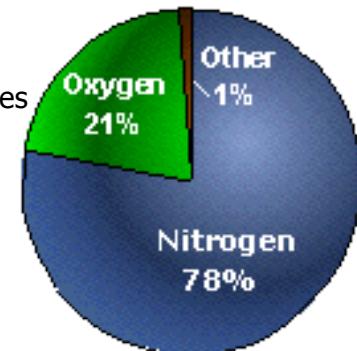
FLIGHT PHYSIOLOGY



1

Atmospheric Considerations

- Composition
 - 78% nitrogen, 21% oxygen at all altitudes
- Pressure is due to the weight of the gases
 - Decreases with altitude, predictably
- Gases are subject to physical laws
 - Gases in our bodies will change with the environment



2

Gas laws

- Boyle's Law - volume is inversely proportional to pressure
 - Gases expand when pressure is decreased
 - Ascending in a pool, bubbles get bigger
 - Gas expansion and contraction problems
 - middle ear, sinuses, stomach & intestines



3

Gas laws

- Dalton's Law
 - Total barometric pressure = sum of partial pressures (pressure of each gas present)
 - Partial pressure = (Total pressure)(% of gas)
 - Without adequate partial pressure of oxygen, you cannot absorb oxygen in your lungs
- Remember: As you ascend, the percentage of oxygen remains constant, but partial pressures decrease.



4

Gas laws

- Henry's Law
 - The amount of dissolved gas in a liquid will decrease if the pressure around the liquid decreases.
- When pressure is released, gas comes out of solution in the form of bubbles
- These bubbles in the body cause evolved gas problems (decompression sickness)



5

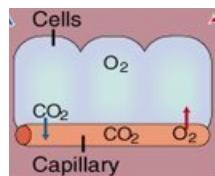
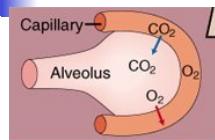
Physiological Zones

- Physiological Zone - SL to 10,000'
 - We can adapt in this zone
- Physiological Deficient Zone - 10,000' to 50,000'
 - Majority of commercial flying
 - Hypoxia due to altitude, as well as trapped and evolved gas problems, are concerns



6

Respiration



- Definition – An exchange of gases in the body
 - Absorbing oxygen, eliminating carbon dioxide
- Gas exchange is a function of the partial pressures of the gases
 - Adequate percentage of oxygen and pressure required

7

Hypoxia



8

Definition

- Lack of sufficient oxygen in the body to the point where function is impaired.
 - Is due to a number of causes
 - Can occur at any altitude
- Clearly is a pilot's most important physiological concern.



9



10

Causes of Hypoxia

- An inadequate oxygen partial pressure
 - Inadequate oxygen system or supply
 - Exposure to high altitude
- Poor circulation
 - G Forces or diseases of the blood vessels
- Blood donation or Anemia
- Toxic exposures
 - Cyanide in burning aircraft



11

Four types of Hypoxia



- Hypoxic
- Hypemic
- Stagnant
- Histotoxic



12

Hypoxic Hypoxia



- Partial pressure of oxygen is insufficient
 - You cannot absorb adequate oxygen
- Correction: breathe a greater percentage of oxygen or oxygen under pressure
 - Oxygen systems vary in what they deliver
 - Descend to higher barometric pressures

13

Hypemic Hypoxia

- The oxygen-carrying capacity of the blood is reduced
 - Carbon Monoxide interferes with oxygen binding to the blood
 - Smoking, engine exhaust
 - Sulfa drugs can have an effect also
 - Blood donation also limits capability



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Blood Donation

- Symptoms of hypoxia at lower altitudes
- Most airlines:
 - No flight for 72 hours after donation of whole blood
 - No flight for 12 hours after donation of plasma



15

Stagnant Hypoxia

- Oxygen deficiency due to impaired circulation
 - G forces from maneuvers
 - Disease of the blood vessels



16

Histotoxic Hypoxia

- Tissue cells are poisoned and unable to use oxygen

- Alcohol
- Cyanide



17

Effective Performance Time (EPT)

- Definition –
 - Amount of time from loss of adequate oxygen in which an individual can perform effectively
 - Varies with altitude
 - This is not a guarantee!



19

Symptoms of Hypoxia

- Symptoms vary between individuals
- Each symptom will ultimately lead to unconsciousness if untreated.



- Headache
- Decreased Reaction Time
- Impaired Judgment
- Euphoria
- Visual Impairment
- Drowsiness
- Lightheaded or Dizzy Sensation
- Tingling in Fingers and Toes
- Numbness
- Blue Fingernails and Lips (Cyanosis)
- Limp Muscles



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Chart of EPT

Altitude

EPT

45,000 feet MSL	9 to 15 seconds
40,000 feet MSL	15 to 20 seconds
35,000 feet MSL	30 to 60 seconds
30,000 feet MSL	1 to 2 minutes
28,000 feet MSL	2 1/2 to 3 minutes
25,000 feet MSL	3 to 5 minutes
22,000 feet MSL	5 to 10 minutes
20,000 feet MSL	30 minutes or more



20

Factors that influence EPT

- **Altitude** - the higher, the shorter the time
- **Rate of ascent** - increase rate, decrease EPT
- **Physical activity** - exercise decreases EPT



21

Corrective Actions for Hypoxia

- Immediately use supplemental oxygen
 - System on, Mask on, breathe normally
- Check operation of oxygen equipment
 - Don't wait for problems
- Make emergency descent if oxygen is not available



22

Oxygen Use -Recommended

- Use above 10,000' in the day
- Use above 5,000' at night



23

Federal Aviation Regulations

Part 91.211 – Supplemental Oxygen

Flight crew must use O₂ for flight's duration. O₂ must be provided to each occupant.

15,000 feet MSL

Flight crew must use O₂ for flight's duration.

14,000 feet MSL

Flight crew must use O₂ after 30 minutes.

12,500 feet MSL



24

Hypoxia Vs. Hyperventilation



25

Hyperventilation

- Respiration that is too rapid and/or deep for current physical activity
 - results in a abnormal loss of carbon dioxide (CO_2) from the blood.



26

Carbon Dioxide Management

- Carbon Dioxide levels stimulate respiratory center of the brain, influencing how we breathe.
- Normal Breathing Rate is 12-16 breaths per minute
- Controlled breathing will keep our Carbon Dioxide levels stable.



27

Heavy exertion

- Increase in physical activity causes more carbon dioxide to be produced, and we respond by breathing deeper and faster.
- Breathing returns to normal when excess is eliminated.



28

Hyperventilation

- An abnormal increasing in breathing rate and depth, leading to symptoms.
- Causes
 - Emotional tension or stress
 - Fear or anxiety
 - Pain
 - Pressure breathing equipment



29

Hyperventilation - Symptoms

- Dizziness
- Hot & / or cold sensations
- Tingling of hand, legs, or feet
- Muscle spasms
- Nausea
- Sleepiness
- Unconsciousness
- Hyperventilation symptoms are very similar to that of Hypoxia



30

Corrective Actions

- Correct for any potential of Hypoxia
- Check oxygen equipment for proper function
- Breathe normally
 - If problem was hypoxia, symptoms disappear rapidly
- Hyperventilation symptoms are very similar to hypoxia symptoms
- If symptoms remain:
 - breath slower
 - breath into a bag
 - talk aloud



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Trapped Gas



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Trapped Gas

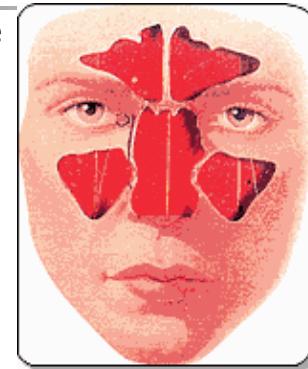
- Ear - eardrum flexes causing pain
 - Head colds & infections can block Eustachian tube (more common on descent)
- Remedy
 - swallow, yawn, tense throat, Valsalva, nasal inhalant
 - Ascend until pain resolves, then use a slower descent



33

Trapped Gas - Sinus

- Pressure occurs the same way as in the ears
 - Pain is felt on sides of nose, upper jaw, above eyes
 - Occurs more commonly on descent
- Remedy
 - Valsalva maneuver
 - Nasal sprays can be used only to help with descent...DO NOT USE PRIOR TO FLIGHT!



34

Trapped Gas - Toothache

- Problem
 - abscesses
 - imperfect fillings
 - inadequately filled root canals
- Remedy
 - descent
 - visit to dentist



35

Trapped Gas - Gastrointestinal

- Problem
 - Abdominal Pain
 - Difficulty breathing
 - Lowers blood pressure, leading to shock
 - Severe pain above 25,000'
- Remedy
 - belching, passing flatus, descending



36

Fitness for Flight

- IMSAFE Checklist
 - I: Illness
 - M: Medications
 - S: Stress
 - A: Alcohol
 - F: Fatigue
 - E: Emotions/Eating



37

Illness

- Any illness may degrade performance
- Produces fever and distracting symptoms
- If you have questions about your illness and flying...Consult an Aviation Medical Examiner



38

Medication

- Medication taking for an illness degrades pilot performance
 - Both prescription and over the counter
- Questions?? Consult AME!



39

Over-the-Counter Drugs

- Aspirin, Ibuprofen (Motrin®, Nuprin®), and Tylenol
 - toxic effects are rare
 - safe to take it and fly
 - Side effects
 - Upset Stomach



40

Over-the-Counter Drugs

- Antihistamines
 - Drowsiness
 - Inattention, confusion
 - Depression
 - Dizziness, Vertigo
 - Impaired depth perception
- Generally not approved, talk with your AME



41

Over-the-Counter Drugs

- Nasal decongestants
 - Proper use in-flight can relieve sinus pain or blockage
 - Short-term effects
 - Improper use causes sinus and ear blocks
 - Prior to flight
 - Repeated or frequent use
- Motion sickness medications
 - wait 8-12 hours after taking
 - Drowsiness
- Anti-diarrhea medications
 - wait 12 hours after use
 - could cause drowsiness, visual disturbances, accidents
 - Gas expansion problems are also more likely



42

Prescription Drugs

- What is being treated may cause you to be grounded
 - Ear infections
 - Sore throats
- AME is authority on prescription drugs and flying
- Amphetamines (NoDoz, etc)
 - Do Not Fly
 - Nervousness
 - Impaired Judgment
 - Euphoria



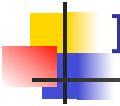
43

Prescription Drugs

- Tranquilizers
 - Do Not Fly
 - Poor Judgment
 - Alertness
 - Efficiency
 - Overall Performance
- Sedatives
 - Can help a person get to sleep
 - Wait 12 – 24 hours after taking to fly
- Antibiotics
 - Pilot is usually too sick to fly anyway
 - Ask Doctor



44

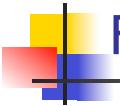


Illegal Drugs

- Very Damaging
- Potential Certificate Action



45



Fatigue

- One of the most treacherous hazards of flying
- Both acute (short-term) and chronic (long-term)
- Be aware of your sleeping habits!



47



Alcohol

- FAR's
 - 8 hours bottle to throttle (12 UND)
 - .04% blood alcohol content -1/2 of automobile standard
 - No effect of alcohol prior to the flight....
 - A hangover is an effect seen with <0.04% alcohol
- Two ounces of alcohol absorbed into bloodstream in 10 minutes
 - takes 6 hours to metabolize out of system⁴⁶



46



Stress

- Body's reaction to physical and psychological demands
- Excessive stress reduces the body's efficiency
 - results in degraded performance



48

Stress Of Life

- CHANGES
- FINANCIAL
- FAMILY
- INTERPERSONAL
- PERSONAL

STRESS IS CUMULATIVE!!!!!!



49

Mental/Emotional Stress

- Related to
 - job disappointments
 - family problems
 - financial difficulties
 - School!



50

Mental/Emotional Stress

- Pilot does not think clearly
- Senses dulled
- Risks are taken
- Self destructive behavior
- PIC is responsible for ensuring proper mental state



51

Reactions to Stress

- Heart rate quickens
- Blood is diverted to organs
- Sweating
- Paleness
- Motion sickness
- Stress, in moderation, can improve:
 - Thinking speed
 - Reaction time
 - Situational awareness
 - Motivation



52

Emotion/Eating

- Emotions
 - Could lead to taking risks
 - Could be self-destructive
- Eating
 - Are you nourished



53



I llness - Do I have any symptoms?
M edication - Have I been taking prescription or over-the-counter drugs?
S tress - Am I under psychological pressure from the job? Worried about financial matters, health problems, or family discord?
A lcohol - Have I been drinking within 8 hours? Within 24 hours?
F atigue - Am I tired and not adequately rested?
E ating - Am I adequately nourished?

54

Aeronautical Decision Making

- Decision making under pressure
 - Time Pressure
 - Other than time pressure
- Knowledge
- Skills Required
- Understanding
- Self Awareness



55

Personal Minimums

PILOT		EXTERNAL PRESSURES	
Experience/Recency			
Takeoff/landings.....	<input type="text"/> In the last _____ days	Allowance for delays.....	<input type="text"/> minute
Hours in make/model.....	<input type="text"/> In the last _____ days	Notification of person(s) you are meeting	
Instrument approaches..... (simulated or actual)	<input type="text"/> In the last _____ days	Passengers briefed on diversion or cancellation plans and alternatives	
Instrument flight hours..... (simulated or actual)	<input type="text"/> In the last _____ days	Modification or cancellation of car rental, restaurant, or hotel reservations	
Terrain and airspace.....	<input type="text"/> familiar	Arrangement of alternative transportation (Airline, car, etc.)	
Physical Condition			
Sleep.....	<input type="text"/> In the last 24 hours	Credit card and telephone numbers available for alternate plans	
Food and water.....	<input type="text"/> In the last _____ hours	Appropriate clothing or personal needs (eye wear, medication...) in the event of an unexpected stay	
Alcohol.....	<input type="text"/> None in the last _____ hours		
Drugs or medication.....	<input type="text"/> None in the last _____ hours		
Stressful events.....	<input type="text"/> None in the last _____ days		
Illnesses.....	<input type="text"/> None in the last _____ days		

56

Fitness for Flight

- AIM section 8
- Requirements for Medical Certificates
 - Found in FAR 67
- 1st Class
- 2nd Class
- 3rd Class



57

Fitness for Flight

- Mental Fitness
 - Obvious mental problems (Psychosis)
 - Personal problems can interfere with normal thought processes
 - Stress, even positive stress, can be debilitating



58

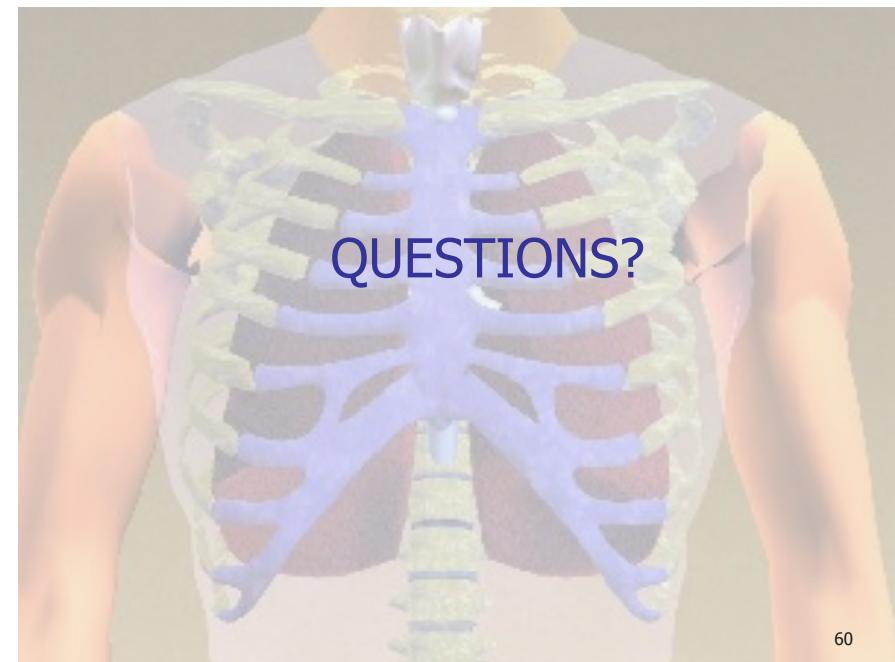
Drug Misuse

- If involved with drugs to ANY extent, get help BEFORE getting caught
- There is no such thing as a “little cocaine use”
- Anti-Drug Program
 - Random sampling
 - Post-Accident Testing



59

QUESTIONS?



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