

# Neurobiology of drug addiction



Brain Tales

[www.neuro.agh.edu.pl](http://www.neuro.agh.edu.pl)

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# Drug addiction

„Complex illness, characterized by intense and uncontrollable drug craving, along with compulsive drug seeking and use that persist even in the face of devastating consequences”

„Addiction is a brain disease that affects multiple brain circuits, including those involved in reward and motivation, learning and memory and inhibitory control over behavior”





# Drug addiction



- disrupt many aspects of an individual's life,
- treatment programs typically incorporate many components,
- must help the individual stop using drugs,
- maintain a drug-free lifestyle,
- achieve productive functioning in the family, at work, and in society,
- most patients require long-term or repeated episodes of care to achieve the ultimate goal of sustained abstinence and recovery of their lives.

# Addiction definition

The National Institute of Drug Abuse (NIDA) defines addiction as *a chronic, relapsing brain disease that is characterized by compulsive drug seeking and use, despite harmful consequences*



# Addiction is preventable and treatable

When a disease is chronic, that means it's long-lasting.

It can't be cured, but it can be managed with treatment.

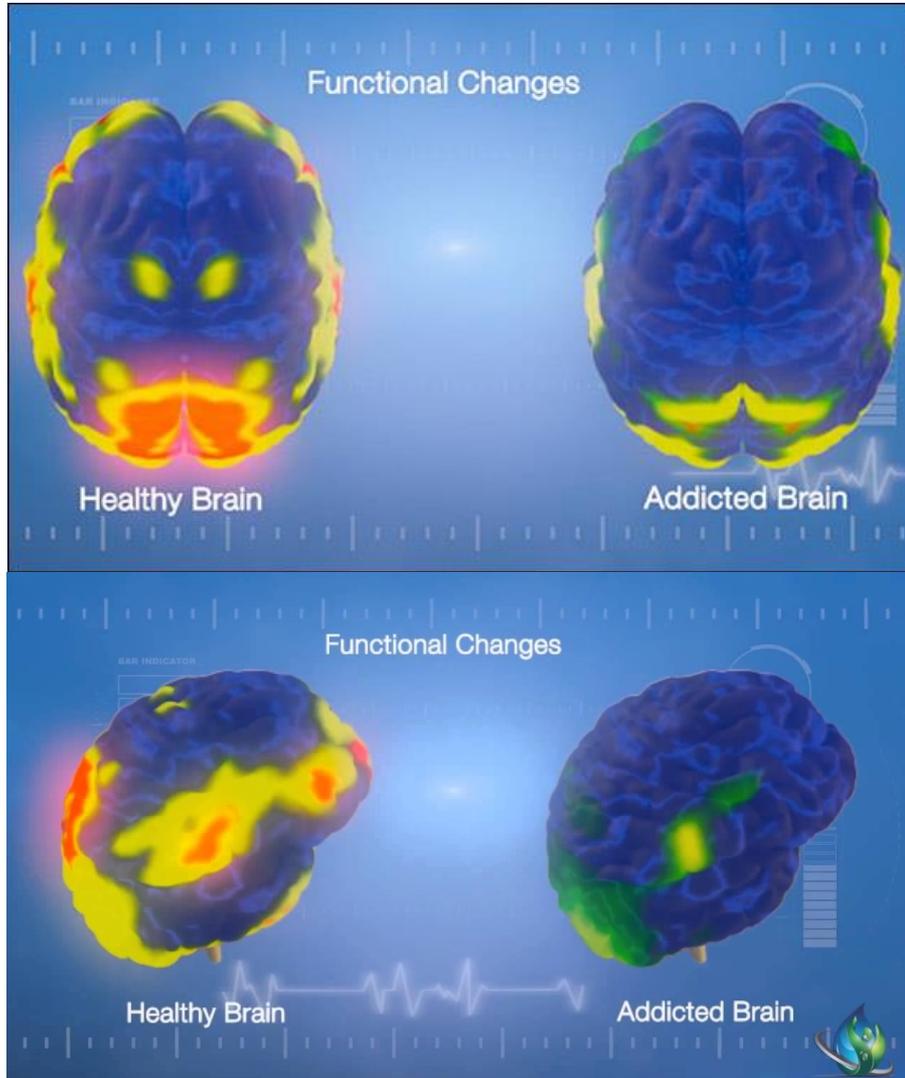
Other examples of chronic diseases include asthma, diabetes, and heart disease



200 Million People Worldwide Use Illegal Drugs



# Addiction development



The initial decision to take drugs is voluntary for most people, but repeated drug use can lead to brain changes that challenge an addicted person's self-control and interfere with their ability to resist intense urges to take drugs.

# WHAT IS ADDICTION?

Addiction is when one obsessively thinks about and compulsively uses drugs or alcohol, despite negative consequences.

**It is generally characterized by:**

- Tolerance
- Withdrawal
- Physical Cravings
- Emotional Obsession

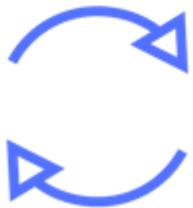




**TOLERANCE**



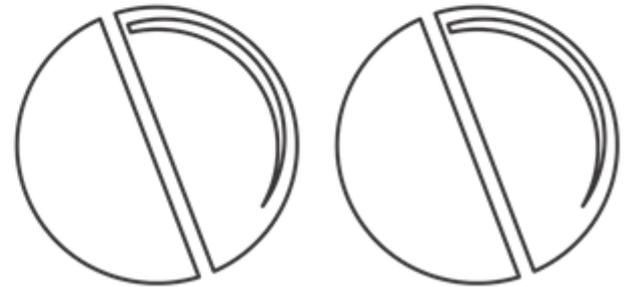
**REPEAT  
CYCLE**



**TOLERANCE**



**⊕ DOSE INCREASE**



# WITHDRAWAL SYMPTOMS



HEADACHE



NAUSEA



ANXIETY



SWEATING



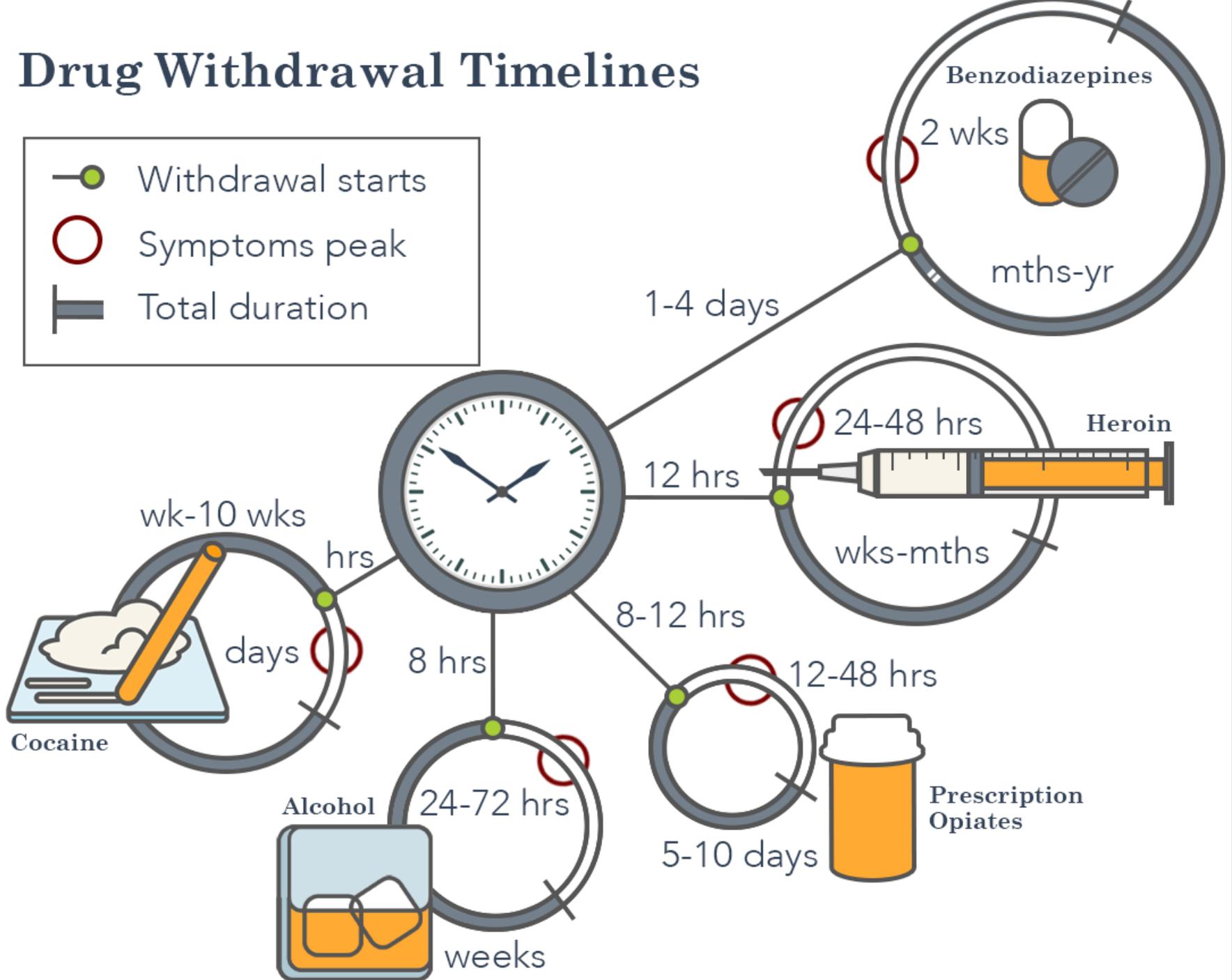
INSOMNIA



DECREASED  
APPETITE

# Drug Withdrawal Timelines

—●— Withdrawal starts  
○ Symptoms peak  
▬ Total duration



# THE PEAK OF THE CYCLE

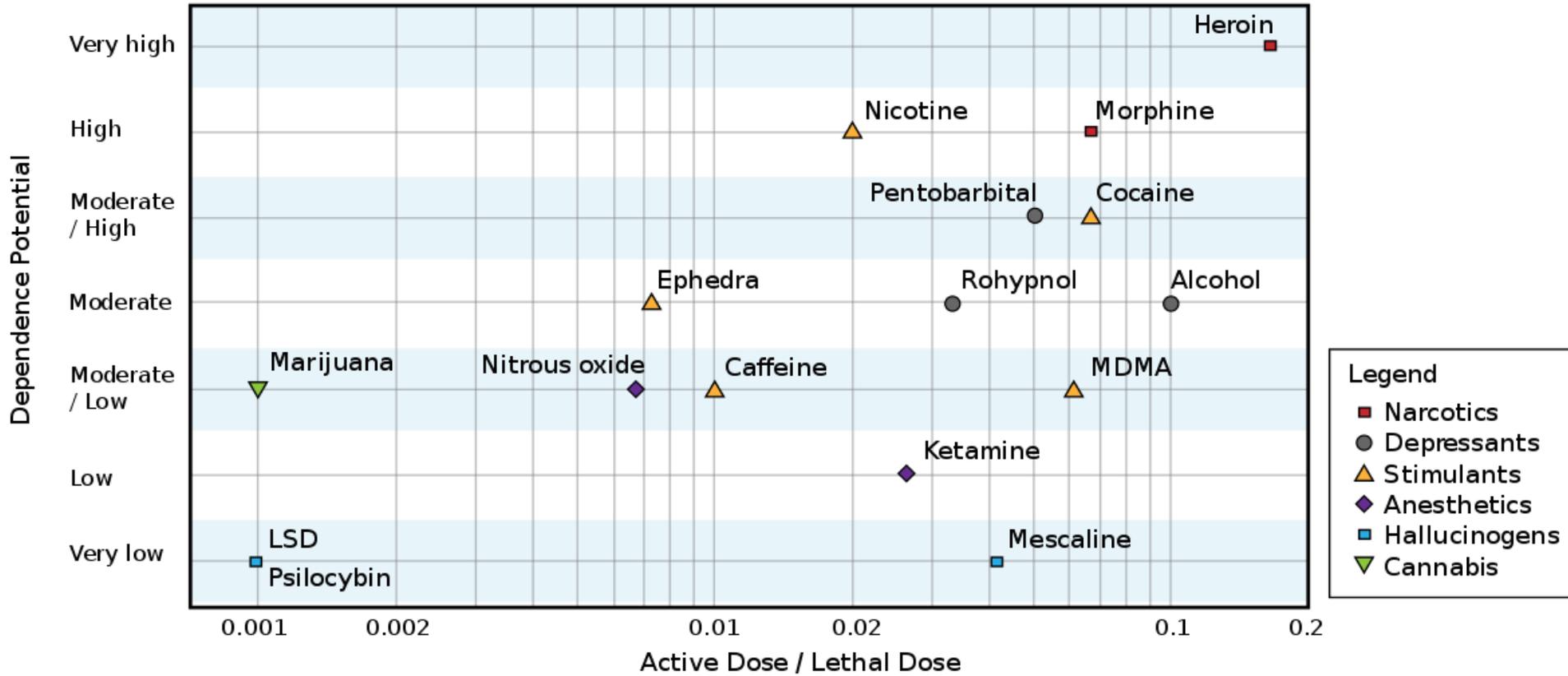


According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) people must show at least two of the following symptoms to be deemed an addict:

- An inability to stop using a drug
- Using drugs despite negative effects on their personal relationships
- Using drugs despite negative effects on their physical health
- Withdrawing from social life to use drugs
- Experiencing strong cravings for the drug
- Building a tolerance for the drug



# Craving



# Substances abuse

- Anabolic Steroids
- Cigarettes and Other Tobacco Products
- Cocaine
- Fentanyl
- Hallucinogens
- Heroin
- Inhalants
- Kratom
- Marijuana
- Marijuana as Medicine
- MDMA (Ecstasy/Molly)
- Methamphetamine
- Over-the-Counter Medicines
- Prescription CNS Depressants
- Prescription Opioids
- Prescription Stimulants
- Synthetic Cannabinoids (K2/Spice)
- Synthetic Cathinones ("Bath Salts")
- Vaping Devices (Electronic Cigarettes)



# Drugs abuse

Most drugs affect the brain's "reward circuit," causing euphoria with the chemical messenger dopamine.

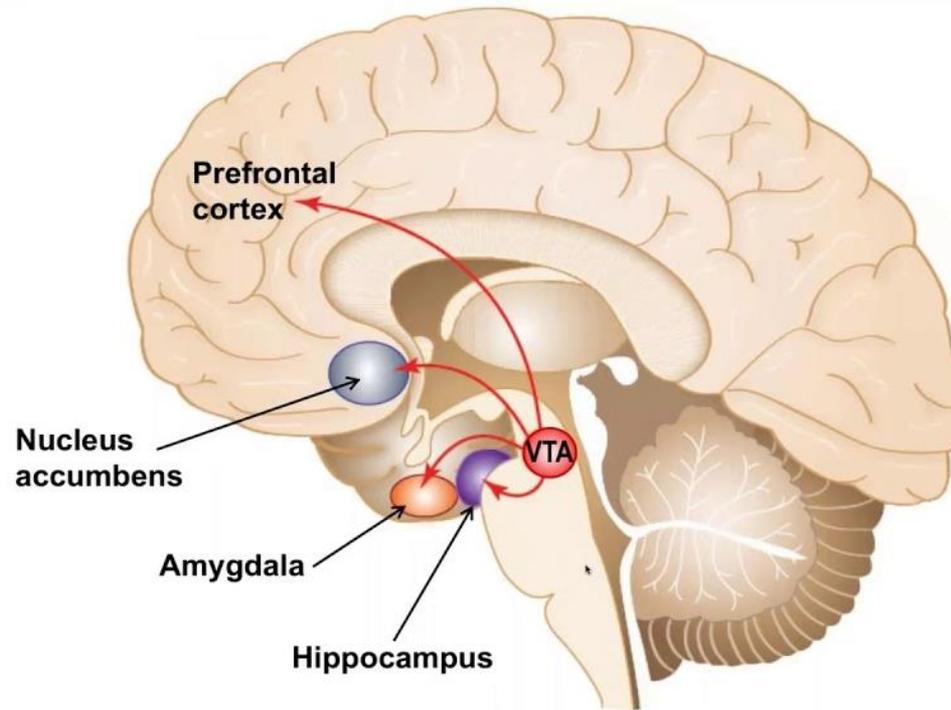
As a person continues to use drugs, the brain adapts by reducing the ability of cells in the reward circuit to respond to dopamine.

These brain adaptations often lead to the person becoming less and less able to derive pleasure from other things they once enjoyed, like food, sex, or social activities.



# Why addiction occurs?

Reward circuit: mediates responses to natural rewards (food, sex, social interactions, etc.)

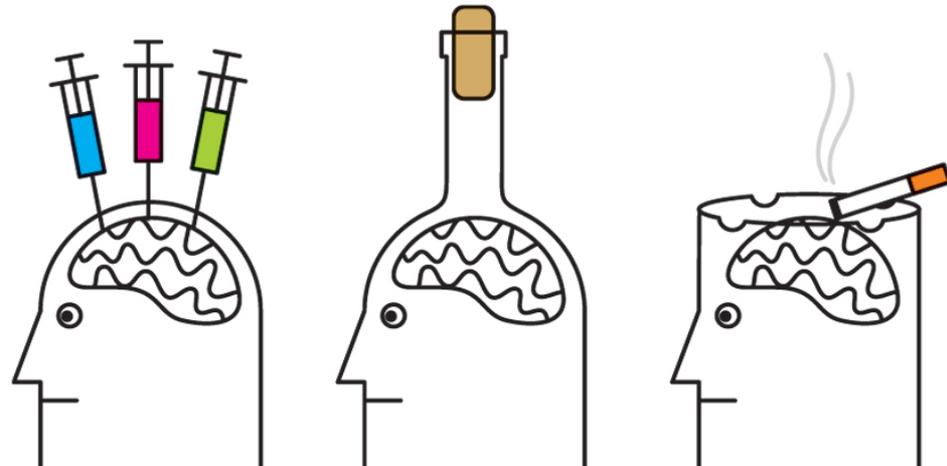


<https://www.youtube.com/watch?v=DMcmrP-BWGk>

# Addiction effects

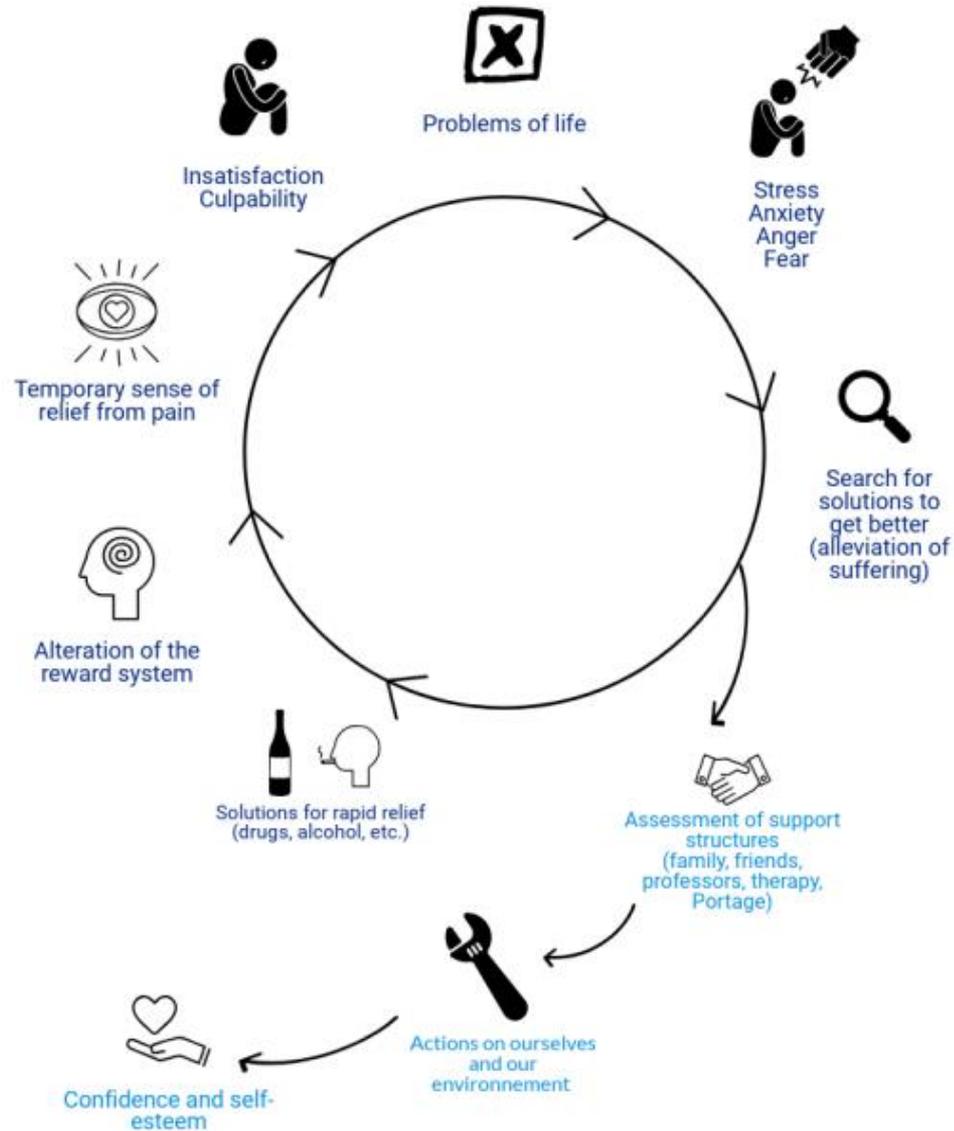
Long-term use also causes changes in other brain chemical systems and circuits as well, affecting functions that include:

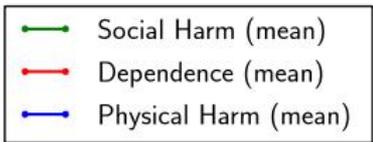
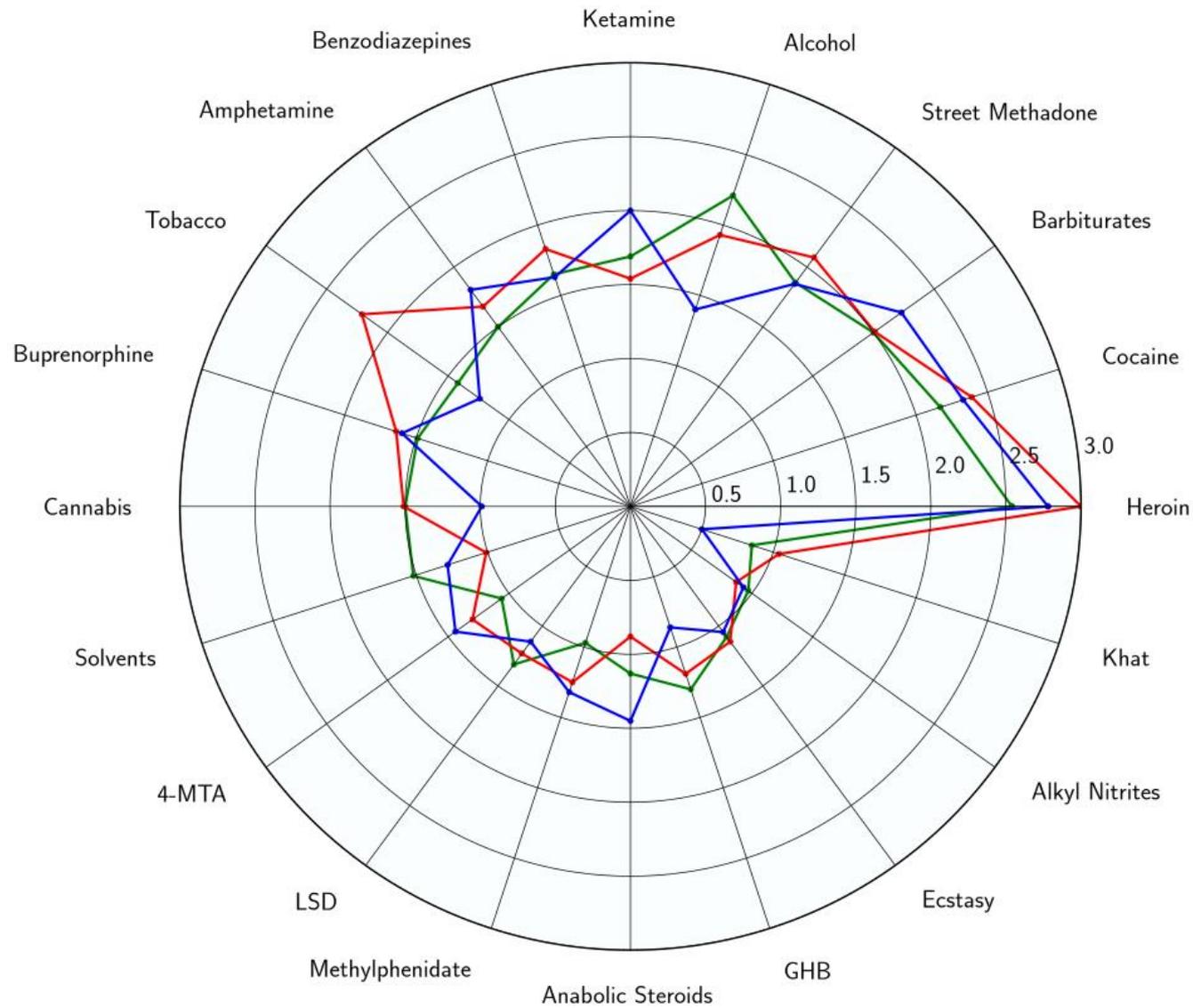
- learning
- judgment
- decision-making
- stress
- memory
- behavior



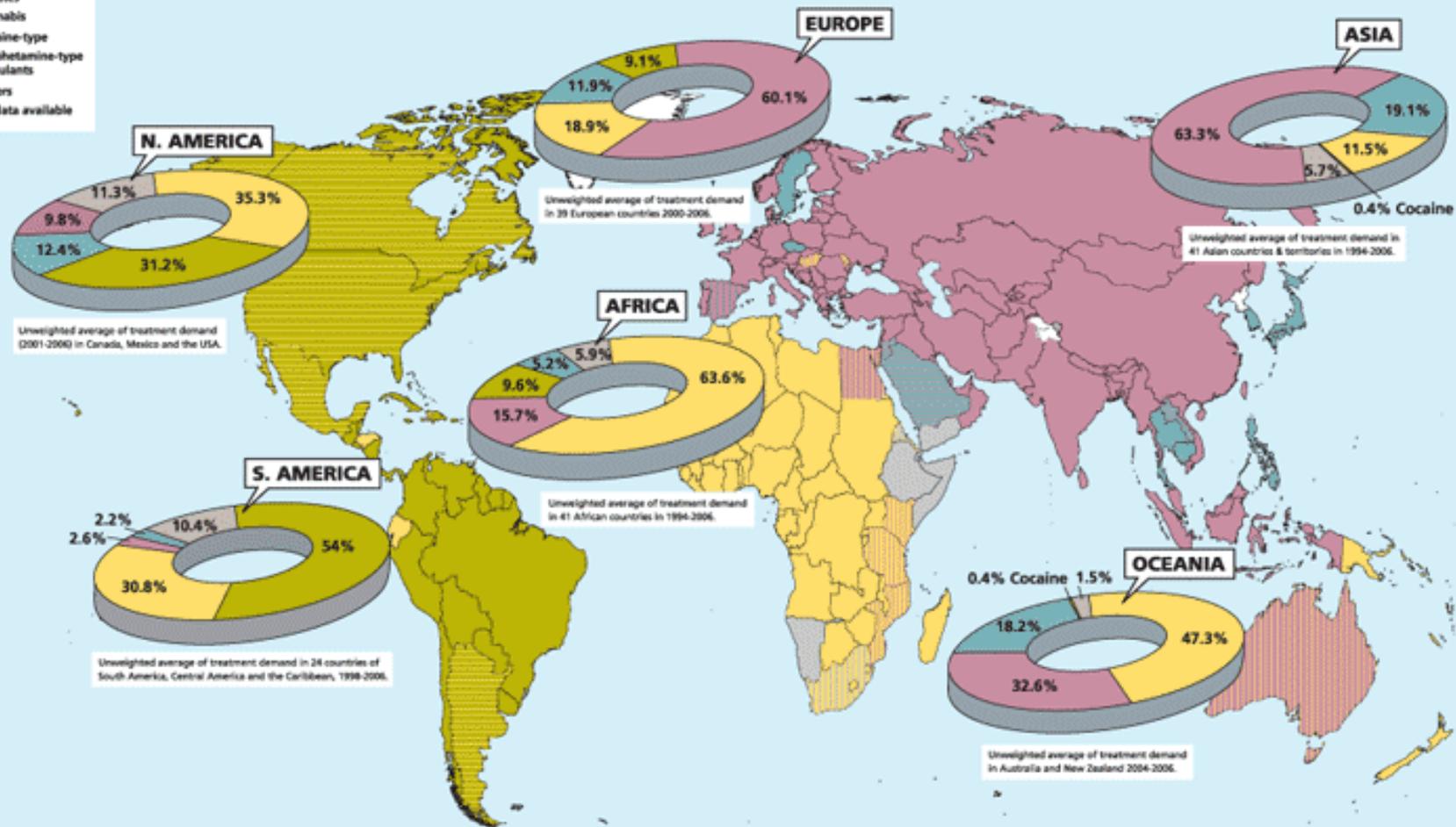
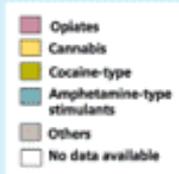
# The Addiction

## CYCLE





# MAIN PROBLEM DRUGS\*



# BREAKING THE CYCLE OF ADDICTION

**PRE-CONTEMPLATION** – The addict has given no thought to quitting

**CONTEMPLATION** – Quitting begins to enter the mind

**PREPARATION** – Prepares mentally to quit

**ACTION** – Treatment is sought

**MAINTENANCE** – Following a recovery program, the addict is now living a substance-free lifestyle

# ADDICTION TREATMENT OPTIONS



## **INPATIENT REHAB**

A residential program that lasts about 30 days



## **DETOXIFICATION**

Cleanses the body of all substances



## **PROFESSIONAL COUNSELING**

Patients work through the issues that led to their addictions



## **DUAL DIAGNOSIS TREATMENT**

Mental health conditions are treated along with addiction

# Untreated addiction\*



23.2 million persons (9.4 percent of the U.S. population) aged 12 or older needed treatment for an illicit drug or alcohol use problem

2.4 million (10.4 percent of those who needed treatment) received treatment at a specialty facility (i.e., hospital, drug or alcohol rehabilitation or mental health center)

\* NIDA statistics

# Drug free



The Red Ribbon was used as an awareness symbol made by after DEA Agent Enrique Camarena was kidnapped, tortured, and murdered while working undercover in Guadalajara, Mexico.

Citizens in his home town of Calexico, California donned the ribbons to emphasize the need for increased prevention efforts.





# Medical Consequences of Drug Abuse

Drug addiction is a brain disease.

Once addiction develops, these brain changes interfere with an individual's ability to make voluntary decisions, leading to compulsive drug craving, seeking and use.

- HIV, Hepatitis and Other Infectious Diseases (needle sharing, unsafe sex; [Heroin](#), [Cocaine](#), [Steroids](#), [Methamphetamine](#))
- Cardiovascular Effects (abnormal heart rate, heart attacks, collapsed veins and bacterial infections; [Cocaine](#), [Heroin](#), [Inhalants](#), [Ketamine](#), [LSD](#), [Marijuana](#), [MDMA](#), [Methamphetamine](#), [Nicotine](#), [PCP](#), [Prescription Stimulants](#), [Steroids](#))
- Respiratory Effects (bronchitis, emphysema, lung cancer, asthma symptoms; [Cocaine](#), [GHB and Ketamine](#), [Heroin](#), [Inhalants](#), [Marijuana](#), [Nicotine](#), [PCP](#), [Prescription Opiates](#))



# Medical Consequences of Drug Abuse

- Gastrointestinal Effects (inflammation of the stomach, chronic constipation, bloating, liver damage, ulcers; Cocaine, GHB, Heroin, LSD, MDMA, Nicotine, Prescription Opiates)
- Musculoskeletal Effects (Steroid use - artificially high sex hormone levels, short stature, muscle cramping and weakness; Inhalants, MDMA, PCP, Steroids)
- Kidney Damage (directly or indirectly from dangerous increases in body temperature and muscle breakdown; Heroin, Inhalants, MDMA, PCP)
- Liver Damage (heroin, inhalants and steroids)



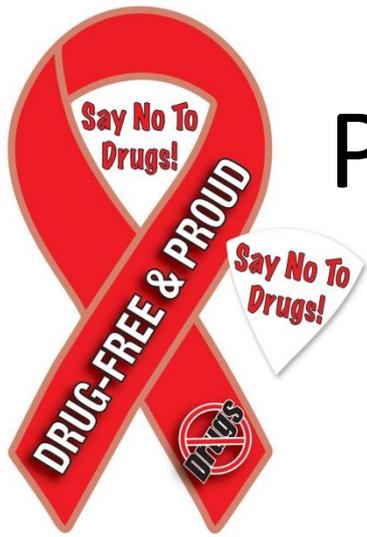
# Medical Consequences of Drug Abuse

- Neurological Effects (seizures, stroke, and widespread brain damage, problems with memory, attention and decision-making; Cocaine, GHB and Rohypnol, Inhalants, Marijuana, MDMA, Methamphetamine, Nicotine, Prescription Stimulants)
- Mental Health Effects (paranoia, depression, aggression, and hallucinations; Cocaine, Inhalants, Ketamine, Marijuana, MDMA, Methamphetamine, Prescription Stimulants)



# Medical Consequences of Drug Abuse

- Cancer (mouth, neck, stomach, and lung; [Nicotine, Steroids](#))
- Prenatal Effects (premature birth, miscarriage, low birth weight, and a variety of behavioral and cognitive problems)
- Hormonal Effects (infertility and testicle shrinkage in men as well as masculinization in women; [steroids](#))
- Other Health Effects (increases in body temperature, restlessness, mood swings, fatigue, changes in appetite, muscle and bone pain, insomnia, cold flashes, diarrhea, and vomiting)
- Mortality (one in four deaths is attributable to alcohol, tobacco, and illicit drug use)



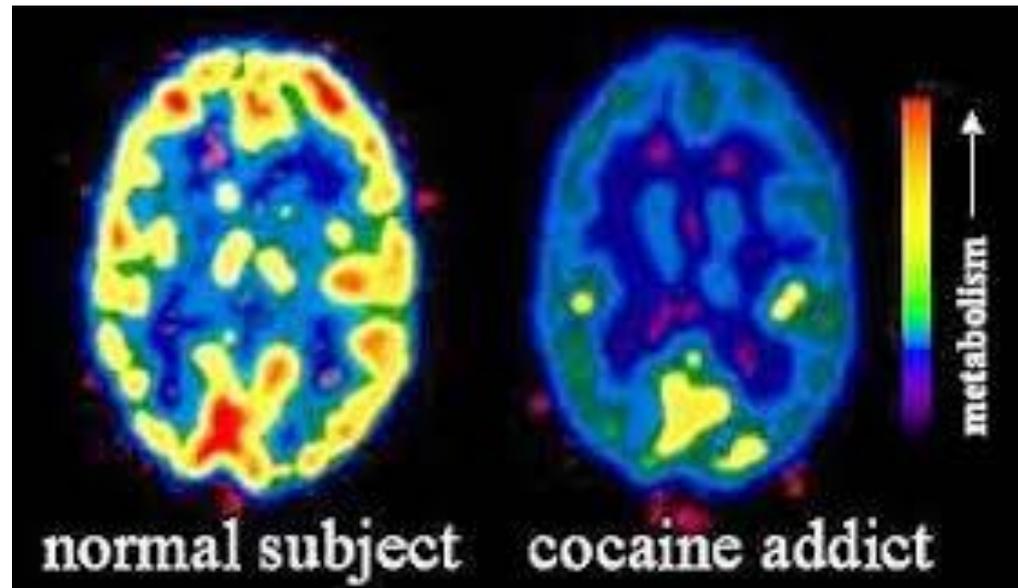
# Principles of Effective Treatment

Since the mid-1970s shows that treatment can help patients addicted to drugs stop using, avoid relapse, and successfully recover their lives.

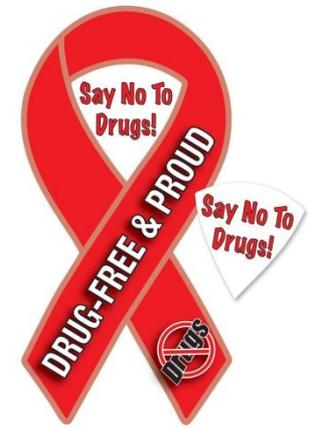
Key principles of an effective treatment programs:

- Addiction is a complex but treatable disease that affects brain function and behavior.

# Addiction is a complex but treatable disease that affects brain function and behavior



Drugs of abuse alter the brain's structure and function, resulting in changes that persist long after drug use has ceased. This may explain why drug abusers are at risk for relapse even after long periods of abstinence and despite the potentially devastating consequences.



# Principles of Effective Treatment

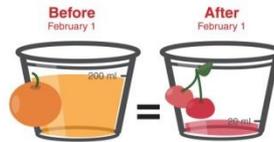
Key principles of an effective treatment programs:

- Addiction is a complex but treatable disease that affects brain function and behavior.
- Medications are an important element of treatment for many patients, especially when combined with counseling and other behavioral therapies.

# Medications are an important element of treatment



**CAUTION**  
New Methadone  
**10x stronger**

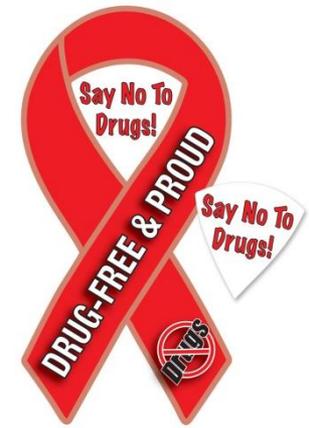


Cherry methadone = same dose in less juice

**Think before you drink**



For example, methadone, buprenorphine (clonidine), and naltrexone (including a new long-acting formulation) are effective in helping individuals addicted to heroin or other opioids stabilize their lives and reduce their illicit drug use. Acamprosate, disulfiram, and naltrexone are medications approved for treating alcohol dependence. For persons addicted to nicotine, a nicotine replacement product (available as patches, gum, lozenges, or nasal spray) or an oral medication (such as bupropion or varenicline) can be an effective component of treatment when part of a comprehensive behavioral treatment program.



# Principles of Effective Treatment

Key principles of an effective treatment programs:

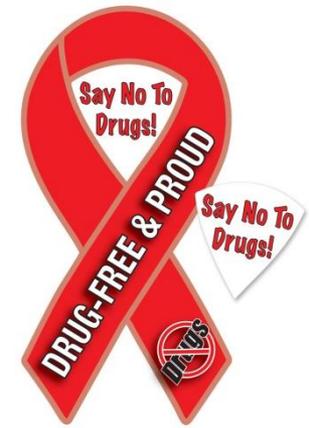
- Addiction is a complex but treatable disease that affects brain function and behavior.
- Medications are an important element of treatment for many patients, especially when combined with counseling and other behavioral therapies.
- No single treatment is appropriate for everyone.

# No single treatment is appropriate for everyone



Treatment varies depending on the type of drug and the characteristics of the patients.

Matching treatment settings, interventions, and services to an individual's particular problems and needs is critical to patient ultimate success in returning to productive functioning in the family, workplace, and society.



# Principles of Effective Treatment

Key principles of an effective treatment programs:

- Addiction is a complex but treatable disease that affects brain function and behavior.
- Medications are an important element of treatment for many patients, especially when combined with counseling and other behavioral therapies.
- No single treatment is appropriate for everyone.
- Treatment needs to be readily available.

# Treatment needs to be readily available



## THE Keeley Cure

**Inebriety-A Disease**

Inebriety, morphine, and other drug habits are dependent upon a diseased condition of the nervous system. The victim of the disease again and again puts forth the most heroic efforts to reform, but his disease is too absolutely overpowering to be conquered by resolutions. The will-power he would exercise if he could is no longer supreme. Alcoholic stimulants have so congested the delicate nerve cells that they cannot respond to the performance of their functional duties, and the helplessness of the victim's condition is as inexplicable to himself as it seems inaccessible to his friends.

The Keeley treatment cures this disease by restoring the nerves to a perfectly healthy state. It cures by removing the cause. The result is that the patient is left in a normal and healthy condition, and he has neither craving, desire, nor necessity for stimulants.

Over 200,000 men and women to-day have been permanently cured of the disease of Inebriety through Dr. Keeley's treatment, which is administered only at institutions authorized by him.

The treatment at these institutions is pleasant; no restraint is imposed; it is like taking a four weeks' vacation; the patient only knows he is cured.

Detailed information of this treatment and proofs of its success sent free upon application to any of the following institutions:

Address THE KEELEY INSTITUTE at either Hot Springs, Ark. Denver, Colo. 515th & Center Sts. Ward Haven, Conn. Washington, D. C., 211 North Capital St.	Detroit, Ill. Madison, Ind. 394 South Adams St. Cuba, Indiana, Ky. New Orleans, La. 126-128 Perdido St. Portland, Me. 113 Congress St.	Leavenworth, Mo. Boston Harbor, Mich. 474 Pinebush St. Kansas City, Mo. 116 W. 10th St. Newark, N. J. 40 East Park St.	North Lowell, N. H. Philadelphia, Pa. 124 North Broad St. Pittsburg, Pa. 444 Fifth Ave. Providence, R. I. Charleston, S. C., Van- dolph & Smith Sts.	San Francisco, Cal. 1250 Broadway St. Louis, Mo. 1215 Olive St. Washburn, Wis. Address the Institute anywhere.
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When you write, please mention "The Cosmopolitan."

Because drug-addicted individuals may be uncertain about entering treatment, taking advantage of available services the moment people are ready for treatment is critical. Potential patients can be lost if treatment is not immediately available or readily accessible. As with other chronic diseases, the earlier treatment is offered in the disease process, the greater the likelihood of positive outcomes.

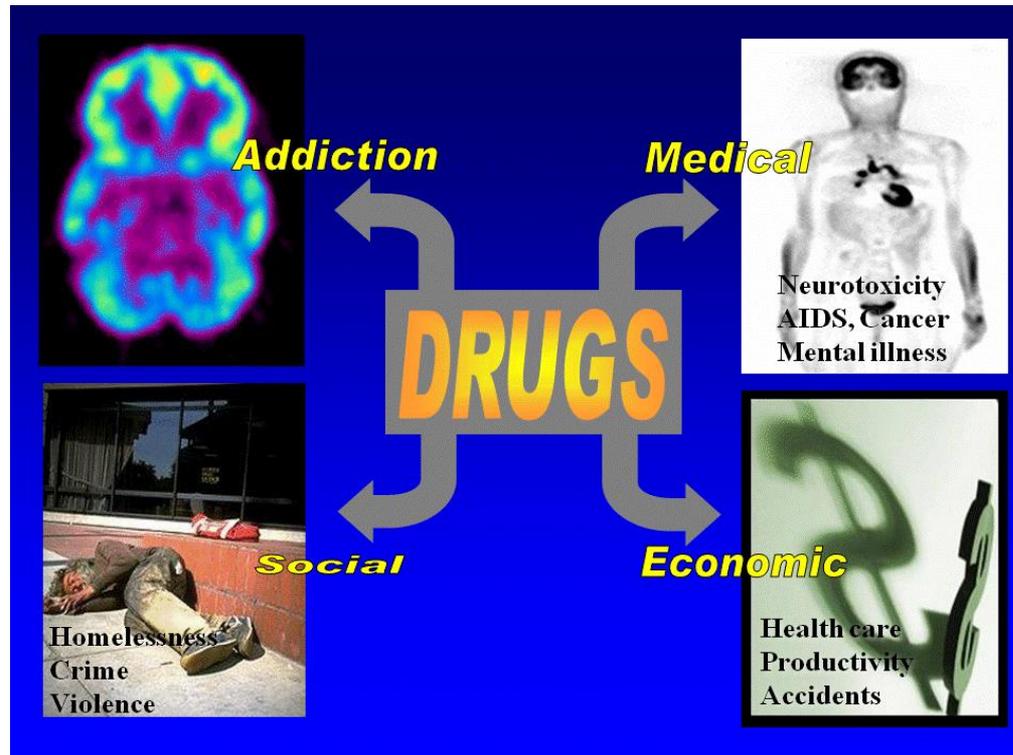


# Principles of Effective Treatment

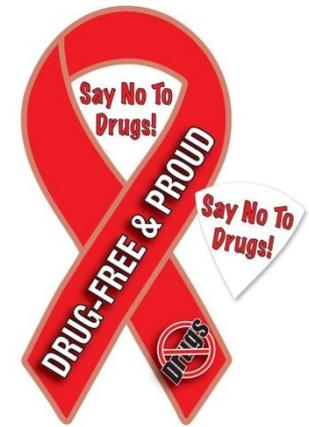
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- No single treatment is appropriate for everyone.
- Treatment needs to be readily available.
- Effective treatment attends to multiple needs of the individual, not just his or her drug abuse.

# Effective treatment attends to multiple needs



To be effective, treatment must address the individual's drug abuse and any associated medical, psychological, social, vocational, and legal problems. It is also important that treatment be appropriate to the individual's age, gender, ethnicity, and culture.



# Principles of Effective Treatment

Key principles of an effective treatment programs:

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- Remaining in treatment for an adequate period of time is critical.

# Remaining in treatment for an adequate period of time is critical

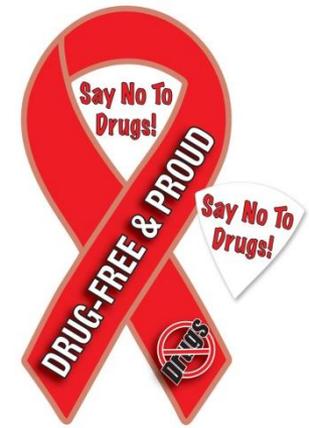


The appropriate duration for an individual depends on the type and degree of the patient's problems and needs.

Research indicates that most addicted individuals need at least 3 months in treatment to significantly reduce or stop their drug use and that the best outcomes occur with longer durations of treatment.

Recovery from drug addiction is a long-term process and frequently requires multiple episodes of treatment. As with other chronic illnesses, relapses to drug abuse can occur and should signal a need for treatment to be reinstated or adjusted.

Because individuals often leave treatment prematurely, programs should include strategies to engage and keep patients in treatment.



# Principles of Effective Treatment

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- Treatment needs to be readily available.
- Effective treatment attends to multiple needs of the individual, not just his or her drug abuse.
- Remaining in treatment for an adequate period of time is critical.
- Counseling—individual and/or group—and other behavioral therapies are the most commonly used forms of drug abuse treatment.

# Behavioral therapies—including individual, family, or group counseling



Behavioral therapies vary in their focus and may involve addressing a patient's motivation to change, providing incentives for abstinence, building skills to resist drug use, replacing drug-using activities with constructive and rewarding activities, improving problem-solving skills, and facilitating better interpersonal relationships. Also, participation in group therapy and other peer support programs during and following treatment can help maintain abstinence.

Learning to live  
without drugs



one step at a time...

# Principles of Effective Treatment

- An individual's treatment and services plan must be assessed continually and modified as necessary to ensure that it meets patients changing needs.

# **An individual's treatment and services plan must be assessed continually and modified as necessary**



A patient may require varying combinations of services and treatment components during the course of treatment and recovery. In addition to counseling or psychotherapy, a patient may require medication, medical services, family therapy, parenting instruction, vocational rehabilitation, and/or social and legal services. For many patients, a continuing care approach provides the best results, with the treatment intensity varying according to a person's changing needs.



# Principles of Effective Treatment

one step at a time...

- An individual's treatment and services plan must be assessed continually and modified as necessary to ensure that it meets patients changing needs.
- Many drug–addicted individuals also have other mental disorders.

# Many drug-addicted individuals also have other mental disorders



Because drug abuse and addiction—both of which are mental disorders—often co-occur with other mental illnesses, patients presenting with one condition should be assessed for the other(s). And when these problems co-occur, treatment should address both (or all), including the use of medications as appropriate.

6 in 10 people with an illicit substance use disorder also suffer from another mental illness



one step at a time...

# Principles of Effective Treatment

- An individual's treatment and services plan must be assessed continually and modified as necessary to ensure that it meets patients changing needs.
- Many drug–addicted individuals also have other mental disorders.
- Medically assisted detoxification is only the first stage of addiction treatment and by itself does little to change long–term drug abuse.

# Medically assisted detoxification is only the first stage of addiction treatment and by itself does little to change long-term drug abuse



Although medically assisted detoxification can safely manage the acute physical symptoms of withdrawal and can, for some, pave the way for effective long-term addiction treatment, detoxification alone is rarely sufficient to help addicted individuals achieve long-term abstinence.

Thus, patients should be encouraged to continue drug treatment following detoxification. Motivational enhancement and incentive strategies, begun at initial patient intake, can improve treatment engagement.



one step at a time...

# Principles of Effective Treatment

- An individual's treatment and services plan must be assessed continually and modified as necessary to ensure that it meets patients changing needs.
- Many drug–addicted individuals also have other mental disorders.
- Medically assisted detoxification is only the first stage of addiction treatment and by itself does little to change long–term drug abuse.
- Treatment does not need to be voluntary to be effective.

# Treatment does not need to be voluntary to be effective



Sanctions or enticements from family, employment settings, and/or the criminal justice system can significantly increase treatment entry, retention rates, and the ultimate success of drug treatment interventions.



# Principles of Effective Treatment

one step at a time...

- An individual's treatment and services plan must be assessed continually and modified as necessary to ensure that it meets patients changing needs.
- Many drug-addicted individuals also have other mental disorders.
- Medically assisted detoxification is only the first stage of addiction treatment and by itself does little to change long-term drug abuse.
- Treatment does not need to be voluntary to be effective.
- Drug use during treatment must be monitored continuously, as lapses during treatment do occur.

# Drug use during treatment must be monitored continuously



Knowing their drug use is being monitored can be a powerful incentive for patients and can help them withstand urges to use drugs.

Monitoring also provides an early indication of a return to drug use, signaling a possible need to adjust an individual's treatment plan to better meet his or her needs.



one step at a time...

# Principles of Effective Treatment

- An individual's treatment and services plan must be assessed continually and modified as necessary to ensure that it meets patients changing needs.
- Many drug-addicted individuals also have other mental disorders.
- Medically assisted detoxification is only the first stage of addiction treatment and by itself does little to change long-term drug abuse.
- Treatment does not need to be voluntary to be effective.
- Drug use during treatment must be monitored continuously, as lapses during treatment do occur.
- Treatment programs should assess patients for the presence of HIV/AIDS, hepatitis B and C, tuberculosis, and other infectious diseases as well as provide targeted risk-reduction counseling to help patients modify or change behaviors that place them at risk of contracting or spreading infectious diseases.

## Treatment programs should test patients for the presence of HIV/AIDS, hepatitis B and C, tuberculosis, and other infectious diseases



Targeted counseling focused on reducing infectious disease risk can help patients further reduce or avoid substance-related and other high-risk behaviors. Counseling can also help those who are already infected to manage their illness.

Moreover, engaging in substance abuse treatment can facilitate adherence to other medical treatments.

Treatment providers should also inform patients that highly active antiretroviral therapy (HAART) has proven effective in combating HIV, including among drug-abusing populations, and help link them to HIV treatment if they test positive.

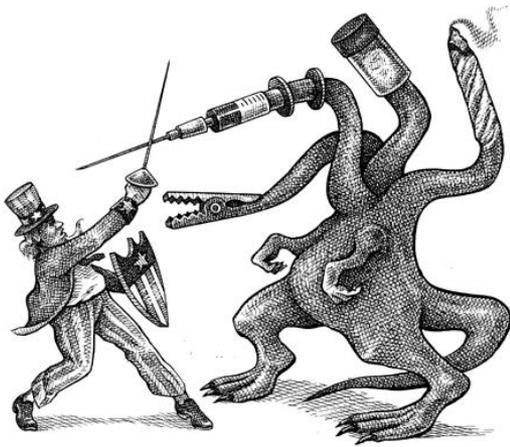
# Effective Treatment

Medication and behavioral therapy are important elements of an overall therapeutic process:

- detoxification
- easing withdrawal symptoms
- treatment
- relapse prevention
- maintaining treatment effects



A continuum of care that includes a customized treatment regimen addressing all aspects of an individual's life, including medical and mental health services and follow-up options (e.g., community-or family-based recovery support systems) can be crucial to a person's success in achieving and maintaining a drug-free lifestyle.



# Pharmacology

Medications can be used to help with different aspects of the treatment process.

- suppressing withdrawal symptoms during detoxification. Medically assisted detoxification is not in itself "treatment" —it is only the first step in the treatment process.
- reestablish normal brain function and to prevent relapse and diminish cravings.

Medications for opioids (heroin, morphine), tobacco (nicotine), and alcohol addiction. Development others for treating stimulant (cocaine, methamphetamine) and cannabis (marijuana) addiction.

Most people with severe addiction problems, however, are polydrug users (users of more than one drug) and will require treatment for all of the substances that they abuse.

# Pharmacology / Tobacco



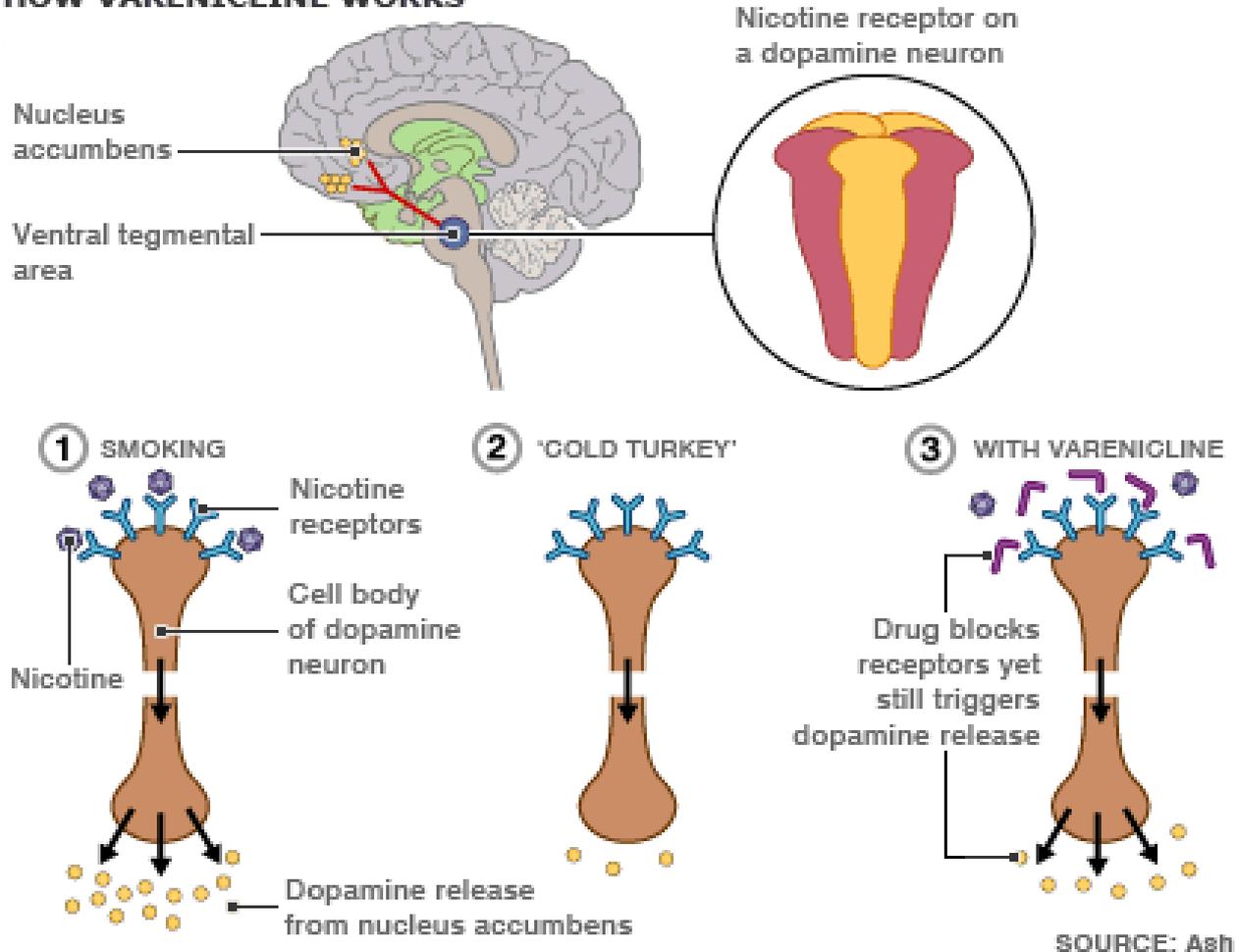
Nicotine replacement therapies; the patch, spray, gum, and lozenges (available over the counter).

In addition, two prescription medications have been FDA–approved for tobacco addiction: bupropion and varenicline (prevent relapse).

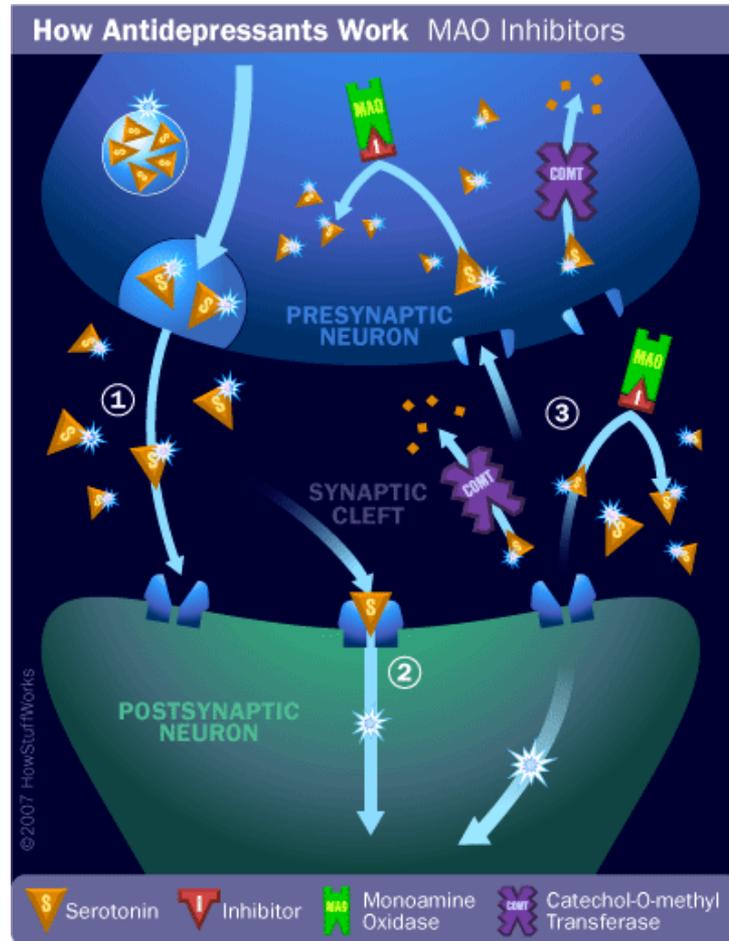
Each of the above medications is recommended for use in combination with behavioral treatments, including group and individual therapies.

# Pharmacology / Tobacco

## HOW VARENICLINE WORKS



# Pharmacology / Tobacco



Bupropion - antidepressant

# Pharmacology / Alcohol

Naltrexone,  
Acamprosate,  
Disulfiram,  
Topiramate,



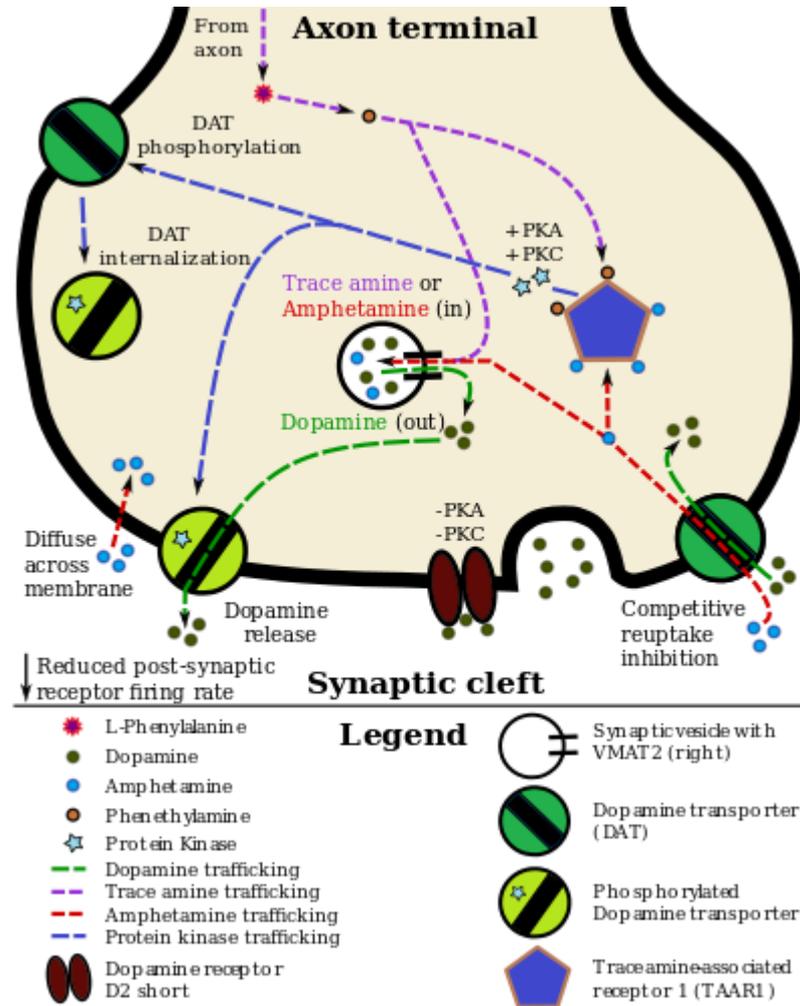
Naltrexone blocks opioid receptors that are involved in the rewarding effects of drinking and in the craving for alcohol. It reduces relapse to heavy drinking and is highly effective in some but not all patients—this is likely related to genetic differences.

Acamprosate is thought to reduce symptoms of protracted withdrawal, such as insomnia, anxiety, restlessness, and dysphoria (an unpleasant or uncomfortable emotional state, such as depression, anxiety, or irritability). It may be more effective in patients with severe dependence.

Disulfiram interferes with the degradation of alcohol, resulting in the accumulation of acetaldehyde, which, in turn, produces a very unpleasant reaction that includes flushing, nausea, and palpitations if the patient drinks alcohol. Compliance can be a problem, but among patients who are highly motivated, disulfiram can be very effective.

Topiramate is showing encouraging results in clinical trials.

# Pharmacology / Alcohol



Mechanisms of disulfiram-induced cocaine abstinence antabuse

# Pharmacology / *Opioids*

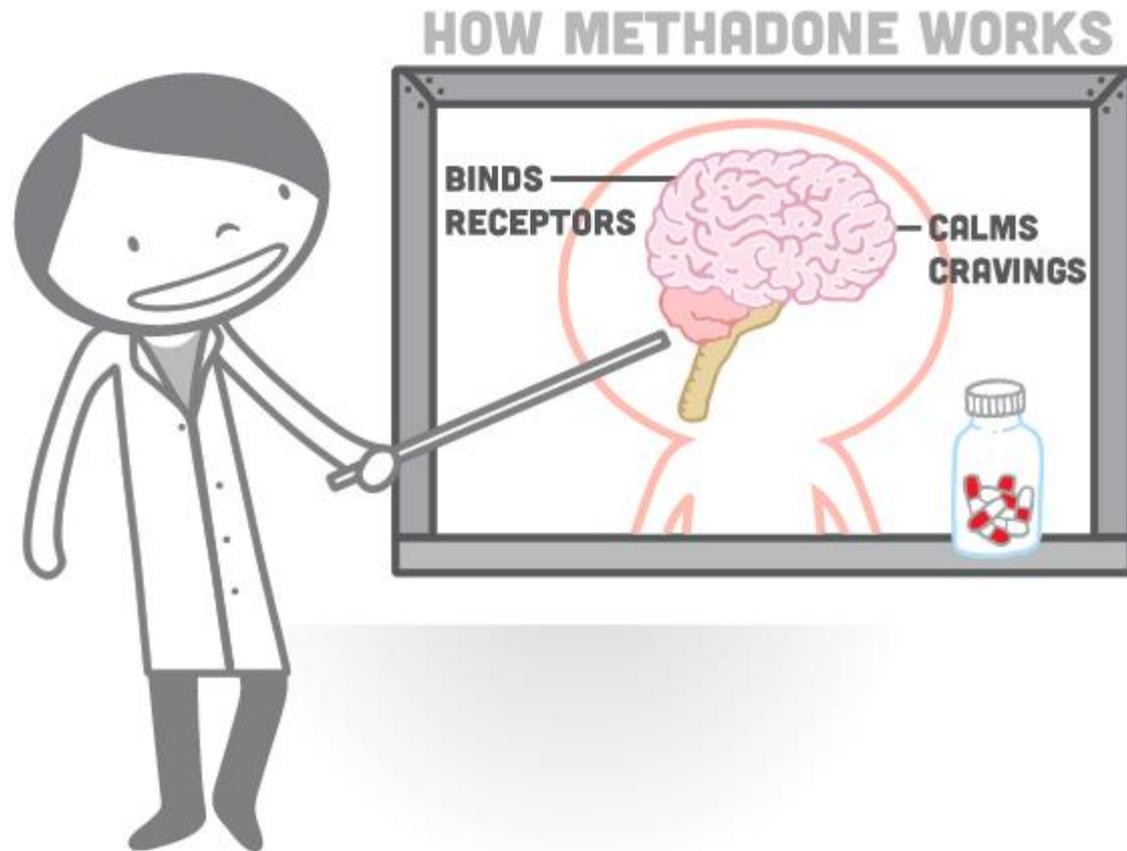
Methadone,  
Buprenorphine,  
Naltrexone,

Acting on the same targets in the brain as heroin and morphine, methadone and buprenorphine suppress withdrawal symptoms and relieve cravings.

Naltrexone works by blocking the effects of heroin or other opioids at their receptor sites and should only be used in patients who have already been detoxified.



# Pharmacology / *Opioids*



# Behavioral Treatments

Help patients engage in the treatment process,  
Modify their attitudes and behaviors related to drug abuse,  
Increase healthy life skills.

These treatments can also enhance the effectiveness of medications and help people stay in treatment longer. Treatment for drug abuse and addiction can be delivered in many different settings using a variety of behavioral approaches.

# Behavioral Treatments / Outpatient behavioral treatment



A wide variety of programs for patients who visit a clinic at regular intervals.

Most of the programs involve individual or group drug counseling. Some programs also offer other forms of behavioral treatment :

- *cognitive-behavioral therapy*; recognize, avoid, and cope with the situations in which they are most likely to abuse drugs
- *multidimensional family therapy*; for adolescents with drug abuse problems, designed to improve overall family functioning
- *motivational interviewing*, to change behavior and enter treatment
- *motivational incentives* (contingency management), which uses positive reinforcement to encourage abstinence from drugs

# Behavioral Treatments / Residential treatment



*Therapeutic communities* (TCs) are highly structured programs in which patients remain at a residence, typically for 6 to 12 months.

TC, staff and those in recovery—as a key agent of change to influence patient attitudes, perceptions, and behaviors associated with drug use.

Patients with relatively long histories of drug addiction, involvement in serious criminal activities, and seriously impaired social functioning.



Thank you 😊