THE HIJACKED BRAIN

Addiction is a devastating disease that alters the brain’s circuitry, notably in young adults. But the changes need not be permanent: improved understanding of them will help in developing ways to lessen the burden. By Margaret Munro. See a Nature Video at go.nature.com/e1gqkk.

ADDICTION CYCLE

Addiction is characterized by bingeing, withdrawal, cravings, dysfunctional emotions and an inability to abstain from the substance or behaviour. It quickly leads to disruption of interconnected brain circuits that are involved in reward, learning and control.

With time, other brain areas are recruited, including those involved in stress and anxiety — in effect an ‘anti-reward’ system.

C. Thalamus
Acts as a hub to relay sensory information and is also important in regulating arousal.

B. Nucleus accumbens
This region, which receives dopamine from the ventral tegmental area, helps to control desire, satiety and inhibition.

A. Basal ganglia
Interconnected regions that are involved in learning, reward and habit formation.

G. Hippocampus
Important for consolidation of memory.

F. Frontal cortex
Responsible for thoughts and actions. The orbitofrontal cortex is thought to play a part in controlling behaviour.

E. Amygdala
Associated with memory and with emotions, notably anxiety and fear.

STAGE 1 BINGE/ INTOXICATION

Overstimulation of the reward circuit leads to loss of control and bingeing.

D. Ventral tegmental area
A primitive structure at the top of the brain stem in which dopamine is synthesized (see ‘The dopamine connection’).

STAGE 2 WITHDRAWAL/ NEGATIVE MOOD

Chronic exposure to addictive substances and behaviours reduces the number of dopamine receptors in the nucleus accumbens (B), so more of the addictive substance or behaviour is needed to feel normal. Changes to the amygdala (E) circuitry have been tied to the irritability, anxiety and stress associated with withdrawal¹.

STAGE 3 PREOCCUPATION/ ANTICIPATION

People with dependencies have compulsive cravings to repeat the addictive behaviour. Drug misuse is thought² to alter the function of the frontal cortex (F) and the hippocampus (G) and helps to embed desires even if they have negative consequences.

27 MILLION

people had problematic drug use³ in 2012.

183,000

drug-related deaths were reported³ in 2012.

1 BILLION

or more people smoke, with the majority living in low- to middle-income countries⁴.

6 MILLION

smokers die every year; more than 5 million of the deaths are directly related to tobacco use⁴.

38.3%

of the global population drinks alcohol, with an annual average of 17 litres per person⁴.

3.3 MILLION

deaths in 2012 were attributed to alcohol consumption⁴.

DANGEROUS AGE

Many people have their first experience of drugs at a young age, placing them at high risk of addiction. The developing brain may not form properly under the influence of drugs or alcohol⁷.

HIGH COST OF A HABIT

The estimated annual cost of health care associated with substance misuse in the United States⁷.

ILLICIT DRUGS
\$11 BILLION

ALCOHOL
\$25 BILLION

TOBACCO
US\$130 BILLION

Sources: 1. Logrip, M. L., Koob, G. F. & Zorrilla, E. P. *CNS Drugs* **25**, 271–287 (2011); 2. Schoenbaum, G. & Shaham, Y. *Biol. Psychiatry* **63**, 256–262 (2008); 3. United Nations Office on Drugs and Crime *World Drug Report 2014* (United Nations, 2014); 4. World Health Organization; 5. Nestler, E. J. *Nature Neurosci.* **8**, 1445–1449 (2005); 6. Fligel, S. B. et al. *Nature* **469**, 53–57 (2011); 7. US National Institute on Drug Abuse.